VISION THERAPY FOR NON-STRABISMIC ACCOMMODATIVE AND BINOCULAR VISION PROBLEMS: OUTLINES OF LECTURES AND LAB MANUAL

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Notes: 1. The level of coverage is designed to be consistent with the knowledge base for an entry level primary care practitioner. Additional resources are included for greater depth of knowledge. 2. Specific common training procedures are discussed within the topical areas listed in the table of contents on the next page.

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Lecture Topics:

Lab Manual:

REVIEW OF CASE ANALYSIS

Vergence Disorders

Convergence insufficiency
Convergence excess
Divergence insufficiency
Divergence excess
Basic exophoria
Basic esophoria
Reduced fusional vergence
Pseudo convergence insufficiency

(See Table 11.1 on page 108 of: Goss DA. Ocular accommodation, Convergence, and Fixation Disparity, 2nd ed., Boston: Butterworth-Heinemann, 1995, or Table 11.1 on page 109 of the 3rd edition)

Calculated ACA ratio

ACA = (conv. stim. near - dist. ph. + near ph.) / accomm. stim. near

The usual near testing distance is 40 cm, and you can use 64 as an approximation of PD, so formula becomes:

ACA = (15 – dist. ph. + near ph.) / 2.5

The range 3.6 to 6.8 can be taken as a normal range for calculated ACA (this is the widest range possible and still have normal phorias based on Morgan's norms)

Two shortcuts for estimation of calculated ACA ratio:

1. assume convergence occurs at spectacle plane (no calculation of convergence stimulus)
2. compare distance and near phorias and judge whether ACA is normal, high, or low

Shortcut no. 1 (assume convergence occurs at spectacle plane)

ACA = PD in cm + test dist. from spec. plane in m (near ph. – dist. ph.) (this is usually about 0.4 Δ/D more than the complete calculation)

Shortcut no. 2 (compare distance and near phorias and judge whether ACA is normal, high, or low) (assuming 64 mm PD)

- If near phoria is same as distance phoria (e.g., both 2 exo), ACA = 6
- If near phoria is more eso or less exo than distance phoria, AC/A > 6
- If near phoria is more exo or less eso than distance phoria, AC/A < 6
- If near phoria is 2Δ more eso or less exo than distance phoria, AC/A = 6.8
- If near phoria is 6Δ more exo or less eso than distance phoria, AC/A = 3.6

Therefore:

- If near phoria is more eso or less exo than distance phoria by more than 2Δ, the calculated AC/A > 6.8 (high)
- If near phoria is more exo or less eso than distance phoria by more than 6Δ, the calculated AC/A < 3.6 (low)

Using shortcut no. 2, is the calculated AC/A normal, high, or low in the following cases?

- A) Dist., 1 exo; 40 cm, 10 exo
- B) Dist., 1 exo; 40 cm, 5 exo
- C) Dist., 1 exo; 40 cm, 3 eso
- D) Dist., 2 eso; 40 cm, 4 eso
- E) Dist., 5 exo; 40 cm, 10 exo
- F) Dist., 5 exo; 40 cm, 14 exo
- G) Dist., 2 eso; 40 cm, 7 eso

Gradient ACA ratio

Based on difference in near phorias with BVA and a lens add (usually +1.00 D add)

More exo or less eso is expected with plus add

Grad. AC/A = (Near phoria – near phoria with add) / power of add

Morgan's normal range: 3-5Δ/D

Accommodative disorders

Accommodative insufficiency

Diagnostic findings – high lag of accommodation and/or low amplitude of accommodation
Supportive findings – high plus on BCC, difficulty on minus side of monocular and binocular lens flippers, low PRA

Accommodative infacility

Diagnostic findings – low lens flipper rates monocularly and binocularly
Supportive findings – low or difficult NRA and PRA

Accommodative excess

Diagnostic finding – a lead of accommodation on dynamic retinoscopy
Supportive findings – minus finding on BCC, difficulty on plus side of monocular and binocular lens flippers

(see Table 13.5 on page 157, Goss DA. Ocular Accommodation, Convergence, and Fixation Disparity, 3rd ed., 2009)

Lens flippers:

As a general rule:
Low monoc. and binoc. rates – accommodative disorder
Binoc. rates much lower than monoc. – vergence disorder:
Slow on minus side - eso
Slow on plus side – exo

Treatment of accommodation and vergence disorders can include lens adds, prism, *and/or* vision therapy

Power of lens adds can be based roughly upon:

Amount of plus needed to shift esophoria to ortho or low exo, or
Amount of plus needed to eliminate eso fixation disparity, or
Lag from MEM – 0.25 D

Prism power can be based upon associated phorias. If associated phorias not available, use Sheard's criterion in exo and 1:1 rule in eso:

P = 2/3 (amount of exophoria) – 1/3 (BO blur finding)

P = (amount of esophoria – BI recovery) / 2

INTRODUCTION TO VISION THERAPY

Two good definitions of vision therapy:

- The teaching and training process for the improvement of visual perception and/or the coordination of the two eyes for efficient and comfortable vision (DVS)
- A sequence of activities individually prescribed and monitored by the doctor to develop efficient visual skills and processing (AOA, AAO, COVD, OEP)

What does vision therapy do (with regard to accommodation and vergence disorders)?

Increases amplitude of accommodation
Improves accommodative facility
Increase fusional vergence ranges
Improves fusional vergence facility
Eliminates suppression
Improves stereopsis
Reduces or eliminates symptoms

For a partial bibliography of literature on the effectiveness of vision therapy, see: references 9-53 on pages 184-185 in Goss DA. Ocular Accommodation, Convergence, and Fixation Disparity, 3rd ed., 2009)

What do patients want from vision therapy?
(What can patients do for themselves with vision therapy?)

- Relief from eyestrain symptoms
- Better efficiency in reading or other nearpoint activities
- Improved performance in school, work, or sports

When should vision therapy be recommended? Consider the following factors:

1. Age of the patient – patients over 6 yrs. of age better understand procedures, accomm. training cannot be done on a presbyope, but vergence training can
2. Case type – some cases may be treated just as well with prism or lens adds
3. Prognosis – prognosis for all accommodative and non-strabismic binocular vision problems is excellent with the possible exception of divergence insufficiency
4. Motivation – very important
5. Is the patient symptomatic and will the VT address the patient's chief complaint?

6. Financial considerations – if patients/parents find that paying for VT is difficult this may limit the compliance to therapy

7. Are the patient/parents willing to commit to the time required to complete VT successfully?

Communication with the VT patient/parent is crucial – What must be communicated?

1. Why the patient is in vision therapy – the nature of the problem, how it affects performance, how the VT will improve or alleviate the condition

2. The fact that the patient is responsible for making changes in his or her own visual system; the instruments do not do the work – the patient does

3. Correct use of instruments and procedures

Sequencing of procedures

Begin training at a level of difficulty that the patient can achieve, and as ability improves increase the level of difficulty.

Always work at a level the patient can achieve and give plenty of positive reinforcement.

Some specific guidelines (based on Birnbaum, 1993, p. 288 and Scheiman and Wick, 2nd ed., pages 140-142, Scheiman and Wick, 3rd ed., pages 164-166):

1. Start with larger targets and work toward finer, more detailed targets.

2. Begin with brief periods of time on a given task with frequent breaks and work toward more sustained effort.

3. Start with complete concentration on the visual task and work toward ability to achieve the desired level of performance in the presence of distractions.

4. Begin with plenty of emphasis on visual and other feedback cues and work toward being able to perform maximally in the absence of feedback.

5. Start by emphasizing the direction of difficulty of convergence or accommodation and then work toward improving ability in both directions.

6. Emphasize amplitude first and work on improving facility.

What do I mean by feedback cues? Sources of feedback can include the following:

1. Diplopia as an indictor that level of vergence is incorrect

2. Blur as an indicator that level of accommodation is incorrect

3. Suppression cues and physiological diplopia

4. SILO effect: float and localization

5. Luster (the shiny or shimmering perception resulting from fusion of targets of different colors)

6. Awareness of the sensation of increasing and decreasing accommodation and of the sensation of converging and diverging

Classification of types of instruments used in vision therapy for non-strabismic binocular vision problems (based on Scheiman and Wick, 2002, p. 122):

1. Anaglyphs and polaroid filters
2. Lenses, prisms, mirrors
3. Septums and apertures
4. Paper, card, and chart tasks
5. Computer procedures
6. Stereoscopes

In-office and out-of-office training

Vision therapy usually includes training both in the office and by the patient at home. Relative emphasis varies from practice to practice.

At one end of the spectrum some offices do in-office training three or more times per week with each patient with variable amounts of at home work. At the other end of the spectrum there are practices in which training is only done by the patients at home.

It is likely that vision therapy will be most effective if there is both in-office and out-of-office work.

Which procedures are done in the office and which at home are dependent on factors like the nature of the equipment and the difficulty of explaining the procedures.

In-office visits offer a time for different procedures than those being done at home, for encouragement, for an opportunity to check progress, and for changing procedures being done at home.

Obviously the optometrist has better control of the in-office environment and can make sure the procedures are being correctly.

FUSIONAL VERGENCE TRAINING

SYMPTOMS OF VERGENCE DISORDERS CAN INCLUDE

- Eyestrain and headaches
- Intermittent blur
- Intermittent diplopia
- Pulling sensation of the eyes
- Burning and tearing of the eyes
- Inability to continue near work for long periods of time
- Difficulty concentrating on reading
- Print seems to move on page
- Avoidance of near work

TREATMENT CONSIDERATIONS BEFORE BEGINNING FUSIONAL VERGENCE TRAINING

Correct any clinically significant anisometropia or other refractive error (e.g., especially any hyperopia in eso cases)
Correct vertical imbalances with prism – prescribe the amount of prism on the vertical associated phoria

Amblyopia is not common in non-strabismic vergence disorders, but if present it should be treated before starting fusional vergence training

Likewise suppression if present should be treated before beginning fusional vergence training

Some optometrists recommend monocular training before beginning fusional vergence training – this involves improving pursuits, saccades, monocular accommodative facility

SUCCESS RATES FOR VISION THERAPY IN VERGENCE DISORDERS

Generally excellent (e.g., 80-95% in CI; only good for DI)
Most important factor – compliance

OPTIONS FOR TREATMENT IF VISION THERAPY NOT USED

Lens adds – best in high AC/A cases or with coexisting accommodative disorder
Prism – most convenient when prism needs are similar at distance & near (average AC/A)

SPECIFIC FACTORS IN SEQUENCING OF TRAINING PROCEDURES IN FUSIONAL VERGENCE TRAINING

(Remember the general sequencing guidelines discussed earlier – start with techniques that the patient can achieve and gradually increase difficulty)

For convergence, for example, if it helps the patient understand the procedures, you can show the patient how the procedures are done by going in the BI direction. Then emphasize BO ranges in the initial stages of training. Later work on both BO and BI so that the patient doesn't lose BI capability.

Allow some blur initially if it helps the patient achieve fusion (the patient is using both accommodative convergence and fusional convergence if blur occurs). Then later emphasize both singleness and clarity of the target.

Work on amplitude of the vergence response first (in other words improve NPC, BI & BO ranges). Then improve facility of vergence response. In other words, emphasize smooth vergences or ramp stimulus changes first and then later emphasize jump vergences or step stimulus changes.

Change in convergence stimulus with time:
Step change in stimulus (jump vergences) – sudden change in stimulus, such as introduction of prism; illustration: Figure 14.9, page 181 in Goss DA. Ocular Accommodation, Convergence, and Fixation Disparity, 3rd ed.

Ramp change in stimulus (smooth vergences) – gradual change in stimulus, such as increasing prism on a rotary prism; illustration: Figure 14.10, page 181 in Goss DA. Ocular Accommodation, Convergence, and Fixation Disparity, 3rd ed.

Ramp generally easier so it is earlier in a training program.

Procedures in which the accommodative stimulus and convergence stimulus increase and decrease together are generally easier than procedures where one changes and the other is constant. So start with procedures in which they change together and work toward separating the accommodative and convergence stimuli.

DESCRIPTION AND USE OF SPECIFIC FUSIONAL VERGENCE TRAINING PROCEDURES

Brock string

A string with colored wooden beads on it

The patient is instructed to keep the bead being fixated single.

Patients can either move one bead at a time (smooth vergence – emphasizing amplitude) or jump from one bead to another (jump vergence – emphasizing facility)

As the patient move the bead or jumps from one to another, both the accommodative stimulus and the convergence stimulus are changing.

suppression cues – physiological diplopia – the beads not being fixated are seen double and the string makes an X crossing at the bead being fixated.

This is a fairly easy technique and should be incorporated at an early stage in the VT program.

Initially you can instruct patients to hold the bead that they are trying to fuse. This provides additional kinesthetic input. As they improve, they should be able to fuse without the kinesthetic input.

The Brock string helps to improve the near point of convergence and to help the patient learn the feeling of converging and diverging the eyes.

As patients improve on the Brock string, you can show them how to voluntarily converge and diverge using “bug on a string”.

Other procedures that can be incorporated into use of the Brock string later in the VT program are to add use of BO prism or binocular lens flippers.

Brock string illustration: Scheiman & Wick, 3rd ed., Fig. 5.5, p. 152

Vectograms and Tranaglyphs
These are plastic sheets that come in pairs, one member of each pair seen by the left eye and one member of the pair seen by the right eye.

On Vectograms, the figures on each sheet are polarized and the patient wears Polaroid goggles to make one seen by the left eye and one seen by the right.

Vectogram illustration: Goss, 3rd ed., 2009, Fig. 14.3, p. 172

On Tranaglyphs, the figures on one sheet are red and green on the other. The patient wears red-green glasses to make one sheet seen by the left eye and one seen by the right. Generally in red-green glasses the red lens is over the right eye. The right eye then sees the figures on the sheet with the green markings (The right eye does not see the red figures because they are red against a red background).

Convergence stimulus is changed by sliding the sheets apart. To increase convergence, move the sheet seen by the right eye to the left and the one seen by the left eye to the right. To increase divergence, move the sheet seen by the right eye to the right and move the sheet seen by the left eye to the left. Accommodative stimulus remains constant.

If blur occurs, then you know that accommodation has moved from the plane of the target. Initially you can let the patient have some blur, but you want to work toward not having blur.

Illustrations of some of these in 2nd edition of Scheiman and Wick:
Vectograms – Figure 5.6 on page 157; Fig. 6.6 on p. 180 in 3rd ed.
Tranaglyphs – Figure 5.2 on page 150; Figs. 6.2 & 6.3 on p. 173 in 3rd ed.
Quoit Vectogram in Polachrome Trainer – Figure 5.5 on page 155; Fig. 6.5 on p. 177 in 3rd ed.

Various suppression controls are used on the different targets.

These can be used to start a VT program.

Various things can be done later in a training program to make them more challenging, such as adding prism or lens flippers when doing them or having two Vectograms or Tranaglyphs with different convergence stimulus levels – this would result in step changes in stimulus (otherwise they have a ramp change in stimulus).

Commercially available computer procedures

There are two commercially available computer training packages:
- (a) Computer Orthoptics
- (b) HTS (Home Therapy System)

The patient wears anaglyph (red-blue) glasses or liquid crystal glasses so that some features of the targets are seen by the right eye and some by the left eye.

Computer Orthoptics is mostly used as an in-office procedure. HTS is designed as a package to be purchased by patients and used at home.

Several different procedures are available including fusional vergence. Basically the fusional vergence training operates much like Vectograms and Tranaglyphs.

These procedures can be sequenced in the training like Vectograms and Tranaglyphs.

Aperture rule
Available from Bernell

Consists of a plastic stand and a set of cards that are viewed through one aperture for convergence training and two apertures for divergence training.

See the following figures in the 2nd edition of Scheiman and Wick:

Aperture rule showing single and double apertures: Figure 5.9 on page 165; Figure 6.9 on page 187 in 3rd edition
Patient at the aperture rule: Figure 5.11 on page 168; Figure 6.11 on page 188 in 3rd edition
Planes of accomm. and conv. On the aperture rule: Figure 5.13 on page 168; Figure 6.13 on page 190 in 3rd edition

On each card there are two images, one being seen by each eye. The object is then to fuse them into one.

Each card requires a different aperture placement on the rule bar. As the two images on a card are separated more, the convergence stimulus is greater.

Each image has suppression controls – something that is seen by one eye but not by the other.

The aperture rule is a more difficult than Vectograms and Tranaglyphs, so it is used late in a training program. To help the patient get started with the aperture rule you can have them use a pointer or their finger to try to localize where convergence should be in order to fuse.

Prism flippers
Usually BI on one side and BO on other side

Prism flippers result in a step change in convergence stimulus. Accommodative stimulus is constant.

They can be started midway in a training program. They can be used with any binocular target with suppression controls, e.g., Vectograms, Tranaglyphs, aperture rule, etc.

The goal is to improve vergence facility.

Illustration: photo from Bernell catalog

Lens flippers
Binocular lens flippers can also be used to improve fusional vergence. With each flip of the lenses, there is change in accommodative convergence, and consequently fusional vergence must change to make the total amount of convergence remain constant.

In exophoria, the plus side of binocular lens flippers is usually difficult, so work to make it easier and quicker.

This also can be started about midway in a training program. The lens flippers can be used with any binocular target with suppression controls.

Illustration: photo from Bernell catalog

Keystone Lifesaver cards, Bernell Free space fusion cards, eccentric circles, and similar targets

Free space fusion, definition: voluntary shift in convergence away from the plane of two similar objects resulting in binocular fusion of those two objects, achieved without the use of apertures, filters, or other instrumentation

Chiastopic fusion, definition: fusion obtained by voluntarily converging to fixate two fusible targets, laterally separated in space, such that the right eye directly fixates the left target and the left eye fixates the right target (Dictionary of Visual Science); thus the plane of convergence is closer than the accommodative stimulus plane

Orthopic fusion, definition: fusion obtained by voluntarily diverging to fixate two fusible targets, laterally separated in space, such that the right eye directly fixates the right target and the left eye fixates the left target (Dictionary of Visual Science); thus the plane of convergence is farther than the accommodative stimulus plane

These procedures are very simple in terms of instrumentation, but can be difficult for patients to do, so they are usually done fairly late in a training program after the patient has shown improvements in fusional vergence.

These are targets are used for free space fusion work. The eyes converge to produce physiological diplopia. Then the two middle circles are fused. A pointer or the patient’s finger can be used to help them localize the plane of convergence necessary to free fuse.

Keystone Lifesaver cards have pairs of circles that look like Lifesaver candies. The red one is seen by one eye and the green one by the other when free fusion occurs.

The Bernell Free space fusion card is very similar.

Each has suppression cues and letters for blur feedback.

The patient can initially use a little bit of blur to help fusion. Then the patient should work toward keeping the letters clear. When the letters are clear accommodation is in the plane of the card and convergence is in front of the card. When the patient can keep the letters clear you know that the convergence being used for fusion is fusional vergence instead of a little bit of accommodative convergence.

Once the patient can maintain fusion and clarity then difficulty can be increased by moving the card closer or using lens or prism flippers.

Eccentric circles are similar except that the two fused targets are on separate cards. This has the advantage that the cards can be separated farther thus increasing the convergence stimulus.

You can ask the patient about float on eccentric circles.

Illustrations of eccentric circles in Scheiman and Wick, 2nd edition:
Planes of accommodation and convergence: Figure 5.15 on page 171; Figure 6.15 on page 192 in 3rd edition
Patient's perception of float with chiastopic and orthopic fusion: Figure 5.16 on page 172; Figure 6.16 on page 193 in 3rd edition

Illustrations of lifesaver cards, Bernell free space fusion cards, others: photos in Bernell catalog

BOP & BIM
Flippers with BOP on one side and BIM on the other
BOP – base out and plus
BIM – base in and minus
Very difficult, used late in therapy program
With each flip, accommodation is going in one direction and convergence in the other direction

Changes in AS & CS with different procedures
Figure 14.8 on page 179 of Goss DA. Ocular Accommodation, Convergece, and Fixation Disparity, 3rd edition

Difficult procedures for toward the end of a fusional vergence training program:
(1) BOP and BIM procedures – such as doing BI work (Tranaglyphs, Vectograms, aperture rule, etc.) with minus and BO work with plus, or doing binocular lens flippers while viewing Vectograms or Tranaglyphs at various BI and BO settings
(2) jump vergences from BO to BI (Tranaglyphs, Vectograms, stereoscope cards, etc.)
(3) Lifesaver or Free space fusion cards
(4) combining vergence with version movements (for example, keeping free space fusion card targets fused while moving the card around)

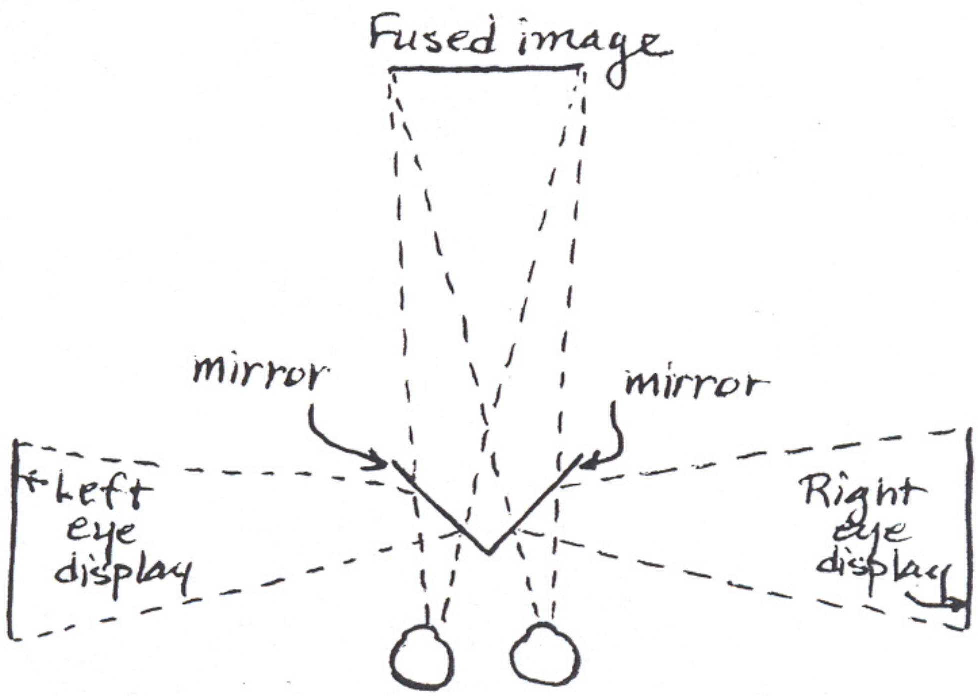
Additional vergence training procedures to be discussed later: prism stereoscopes, mirror stereoscopes

KEYSTONE TELEBINOCULAR STEREOSCOPE AND BERNELL-O-SCOPE STEREOSCOPE

TYPES OF STEREOSCOPES

The two main types of stereoscope are the Wheatstone stereoscope, designed by Charles Wheatstone (1802-1875), and the Brewster stereoscope, designed by David Brewster (1781-1868).

The Wheatstone stereoscope has a separate display seen by each eye and each display is viewed reflected from a mirror.



The accommodative stimulus is dependent on the combined distance from the eye to the mirror and from the mirror to the display and on whether there are any lenses in place. The convergence stimulus is dependent on the angle of the mirrors.

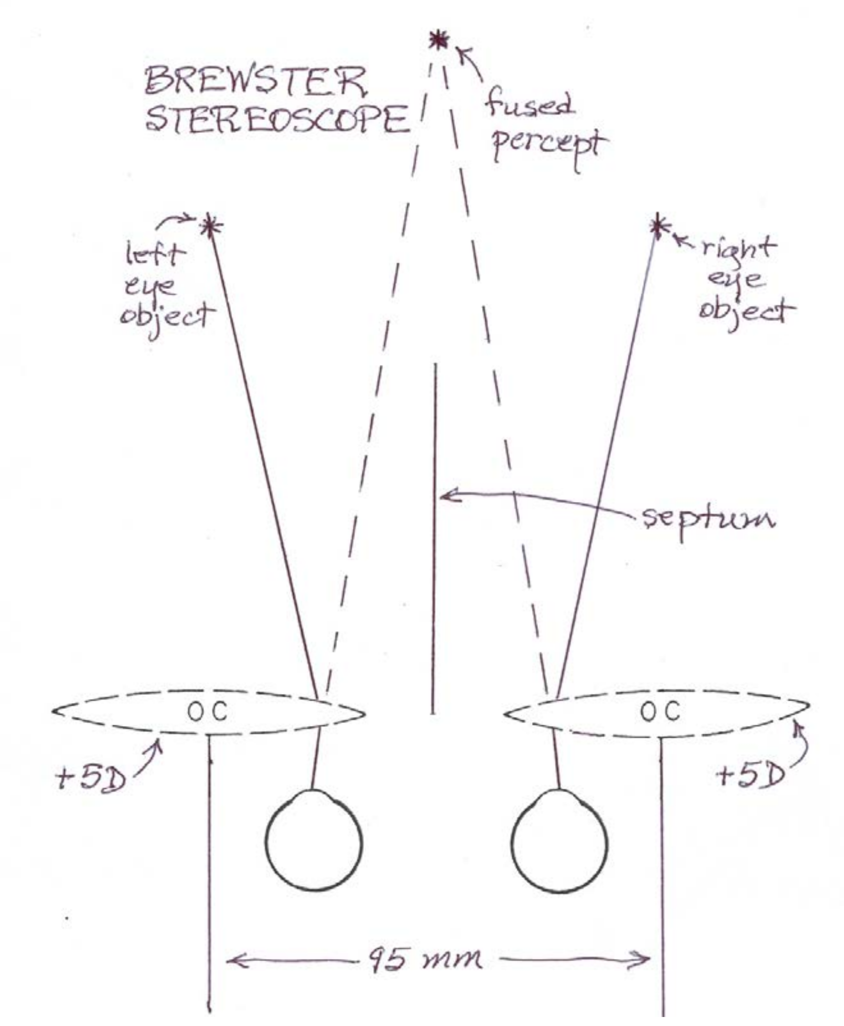
There are both testing and training instruments based on the Wheatstone mirror stereoscope design.

Bernell makes a mirror stereoscope for training vergence (illustration from Bernell catalog).

- Accommodative stimulus: dependent on
  - combined distance from the eye to the mirror and from the mirror to the display (~33 cm in Bernell mirror stereoscope)
  - any lens add
- Convergence stimulus: dependent on the angle of the mirrors
  - narrowing angle between mirrors induces convergence
  - increasing angle between mirrors induces divergence

A synoptophore, troposcope, or amblyoscope is a Wheatstone stereoscope that can be used for testing or training.

The Brewster stereoscope uses widely separated plus lenses or sometimes base-out prisms. It is sometimes called a prism stereoscope or lenticular stereoscope. Each eye views a separate display and the there is a partition so that one eye does not see the display intended for the other eye.



Today's commercially available Brewster stereoscopes have two +5 lenses with their optical centers separated 95 mm. There are distance and near settings for testing or training.

The distance setting has the display cards 20 cm from the +5 D lenses, so the accommodative stimulus is 0 (when patients are wearing their exact refractive corrections):
L = 1 / -0.2 m = -5 D
L' = L + F = -5 D + (+5 D) = 0
Accommodative stimulus = 0

The near setting usually is with the targets 13.3 cm from the +5 D lenses. This results in an accommodative stimulus of 2.5 D when patients are wearing their exact refractive corrections:
L = 1 / -0.133 m = -7.50 D
L' = L + F = -7.50 D + (+5 D) = -2.50 D
Accommodative stimulus = 2.50 D

Ortho on the Telebinocular is assumed to be a target separation of 87 mm for farpoint and 63 mm for nearpoint

Convergence stimulus – farpoint setting on Brewster stereoscope:

- Farpoint setting: cards are at focal plane of the lenses
- When cards are in focal plane of lenses:
    - CS = (LS – TS) / f
    - LS = lens separation; TS = target separation; f = focal length of lenses
    - (Flax, Am J Optom Physiol Opt 1976;53(6):297-302)
- So CS=0 when TS = LS
- LS on most Brewster stereoscopes = 95 mm, so CS = 0 when TS = 95 mm
- However, Keystone Telebinocular assumes a certain amount of proximal convergence

Assumed Ortho at Distance (Keystone)

- Lens OCs 95 mm apart
- Proximal convergence assumed 4Δ
- 2 mm change in target separation: 0.2 cm / 0.2 m = 1 Δ
- 4Δ X 2 mm/Δ = 8 mm
- 95 – 8 = 87 mm
- 87 mm separation: ortho
- (Bernell-O-Scope stereoscope assumes 85 mm separation for ortho)

When the separation of the two displays is 95 mm, the convergence stimulus is 0. For each 2 mm change in separation of the displays, there is a 1 prism diopter change in convergence stimulus.

The assumption is usually made in the design of testing and training cards that there is proximal convergence of about 4 prism diopters. So therefore a target separation of 87 mm is usually considered to represent ortho status and convergence stimulus is thus determined starting from 87 mm separation rather than 95 mm.

Varying convergence stimulus for distance vergence training

- 87 mm separation: assumed 0 CS
- Decreased separation: BO effect
- Increased separation: BI effect
- Examples:
    - 77 mm separation: (87-77)/2 = 5 Δ BO
    - 95 mm separation: (95-87)/2 = 4 Δ BI

Convergence stimulus – nearpoint setting on Brewster stereoscope

- CS = (F x LS) – (TS / TD)
    - F = lens power; LS = lens separation (cm); TS = target separation (cm); TD = distance of cards from lenses (m)
    - (Flax, Am J Optom Physiol Opt 1976;53(6):297-302)
- On most Brewster stereoscopes: F = +5 D; LS = 9.5 cm; TD for nearpoint = 0.133 m
- CS = 0 when TS = 6.3 cm

When the displays for the two eyes are separated by 63 mm at the near setting, the convergence stimulus is zero. For each 1.33 mm change in separation, the convergence stimulus changes 1 prism diopter.

Change in convergence stimulus at near

- Ortho: 63 mm separation
- 1.33 mm change in separation: 0.133 cm / 0.133 m = 1Δ
- Examples:
    - 49.7 mm separation: (63-49.7)/1.33 = 10Δ BO
    - 72.3 mm separation: (72.3-63)/1.33 = 7Δ BI
- (Bernell-O-Scope stereoscope uses 65 mm separation for ortho for near)

KEYSTONE TELEBINOCULAR STEREOSCOPE

The Keystone Telebinocular is a Brewster stereoscope.

Diagram of the Telebinocular from www.keystoneview.com

One of the main uses of the Keystone Telebinocular is to provide an alternative testing procedure for dissociated phorias, suppression, stereopsis, and visual acuity.

Reminder – Dissociated phoria tests have:

- A method of eliminating fusion
  - Exclusion (e.g., alternating cover test)
  - Diplopia (e.g., von Graefe)
  - Distortion (e.g., Maddox rod, modified Thorington)
  - Dissimilar targets (e.g., *stereoscope cards*)
- A method of measuring phoria angle
  - Prism (e.g., alternating cover test, von Graefe, Maddox rod)
  - Scale (e.g., modified Thorington, *stereoscope cards*)

(Note this in the Keystone phoria test cards)

Go over Instructions for Keystone View Telebinocular Stereoscope Visual Skills Tests (illustrations – scans of visual skills test cards)

There are many stereoscope card training sets available for the Keystone Telebinocular. For example, there are cards with two different stereo pictures, one above with one convergence stimulus level and one below with another convergence stimulus level. These can be used for jump vergence training.

They also have a hand-held stereoscope that can be used with these cards for training.

BERNELL-O-SCOPE STEREOSCOPE

The Bernell-O-Scope is also a Brewster stereoscope. Its basic design is very similar to the Keystone Telebinocular except that the Bernell-O-Scope is made of plastic to keep the costs lower. (illustration – Bernell catalog)

It has a set of testing cards similar to those for the Telebinocular, but they are not as commonly used as the Telebinocular.

The Bernell-O-Scope is used more frequently for training.

There are sets of cards designed for jump vergence training in the Bernell-O-Scope. There is a base-out set of cards and a base-in set of cards.

Bernell also has a hand-held Brewster-type stereoscope with training targets they call Bioptograms. Examples of some Bioptograms and Keystone stereoscope training cards are shown in Figure 5.19 on page 177 in Scheiman and Wick, 2nd ed.

CHEIROSCOPE FOR TRAINING

This is another type of stereoscope, essentially a Brewster stereoscope. One eye sees a pattern and the other eye can be used to trace the pattern. This is useful for anti-suppression therapy.

Bernell makes cheiroscopes (illustrations – Bernell catalog)

Keystone Correct-Eye-Scope – a Brewster stereoscope used as a cheiroscope (illustration – Bernell catalog)
Examples of cheiroscopic tracings with Correct-Eye-Scope: Figures 6.22, 6.23, 6.24 on pages 202-203 in Scheiman & Wick, 3rd edition.

Van Orden (VO) Star

- Done in the Keystone Correct-Eye-Scope; distance setting
- Pencil in each hand
- Left pencil on top figure, right pencil in lowest figure
- Draw lines until pencils meet
- Repeat with successive figures
- Can help to show eso, exo, vertical tendencies, central suppression
- If points where lines meet are about 80 mm apart, ortho; >80 mm, exo; <80 mm, eso

Examples of VO star: Figures 12.11 and 12.12 on pages 251 and 252 in Birnbaum, Optometric Management of Nearpoint Vision Disorders, 1993.

TRAINING ACCOMMODATION

Accommodative Disorders

Prevalence – Accommodative disorders are very common. Hokoda found that among 119 symptomatic patients, accommodative disorders were the most common cause. Scheiman et al. a prevalence of accommodative disorders of 6% in a large group of children. Porcar and Nartinez-Palomera found that 17% of 65 university students had accommodative disorders.

Effectiveness of VT for accommodation – highly effective, see for example:
Bobier WR, Sivak JG. Orthoptic treatment of subjects showing slow accommodative responses. Am J Optom Physiol Opt 1983;60:678-687.

Hoffman LG. The effect of accommodative deficiencies on the developmental level of perceptual skills. Am J Optom Physiol Opt 1982;59:254-262.

Liu JS, Lee M, Jang J, Ciuffreda KJ, Wong JH, Grisham D, Stark L. Objective assessment of accommodation orthoptics: dynamic insufficiency. Am J Optom Physiol Opt 1979;56:285-291.

Ciuffreda KJ. The scientific basis for and efficacy of optometric vision therapy in nonstrabismic accommodative and vergence disorders. Optom 2002;73(12):735-762.

Wold RM, Pierce JR, Keddington J. Effectiveness of optometric vision therapy. J Am Optom Assoc 1978;49:1047-1054.

Sterner B, Abrahamsson M, Sjöström A. Accommodative facility training with a ong term follow-up in a sample of school aged children showing accommodative dysfunction. Doc Ophthalmol 1999;99:93-101.

Sterner B, Abrahamsson M, Sjöträm A. The effects of accommodative facility training on a group of children with impaired accommodation – A comparison between dioptric treatment and sham treatment. Ophthal Physiol Opt 2001;21:470-476.

Goss DA, Strand K, Poloncak J. Effect of vision therapy on clinical test results in accommodative dysfunction. J Optom Vis Dev 2003;34(2):61-61.

Goss et al.:
26 patients with accommodative disorders who underwent vision therapy at the IU optometry clinic at Atwater.

23 of 26 had reduction or elimination of symptoms

statistically significant improvements in Amplitude of accommodation, NPC, lens rock facility, NRA, PRA, distance BO blur, near BI blur, near BO blur

Considerations before beginning accommodative VT:
Correct significant hyperopia, anisometropia, astigmatism
Rule out systemic disorders and drug effects (see Tables 11.2, 11.6 and 11.10 in Scheiman & Wick, 2nd ed.; Tables 12.2, 12.6, and 12.10 in 3rd ed.)

Sequencing considerations in accommodative VT

- Monocular before binocular
- Amplitude before facility
- Distance rock before lens rock
- Lower powers before higher powers

Procedures used in all accommodative disorders

- Monocular lens sorting
- Brock string
- Distance rock
- Lens rock
- Tranaglyphs and Vectograms (emphasize clarity)
- Free space fusion cards (emphasize clarity)
- BOP and BIM

VT procedures

Monocular lens sorting – this is a procedure done early in the training program. It uses loose lenses or trial lenses of power from about +2 to -4 D in about 1 D intervals. The patient is asked to look at nearpoint print through each lens and arrange them in order of power. The objective is for the patient to learn how increasing and decreasing accommodation feels and to learn to be able to do that easily.

Brock string – this is also used to help the patient learn an appreciation of looking close and looking far away

Hart charts, accommodative screen, transparencies for distance rock procedures- These are early procedures because they should be relatively easy. Accommodation and convergence are moving together. On Hart charts, the patient looks form one chart to another. (illustrations – Figure 10-13 on page 299 in 4th edition of Griffin & Grisham; scan of a Hart chart)
On accommodative screen, the patient looks through a little square of screen and then looks at the screen.
Transparencies can be used the same way as the accommodative screen. (illustration – Bernell catalog)

Distance rock

- No well-established norms
- About 18 cpm or better expected for young adults
- Means from Miller et al.: monoc., 21.7 cpm (SD=4.9); binoc., 24.1 cpm (SD=4.8)
- Binoc. faster than monoc. – different from lens rock because AS & CS changing together whereas in lens rock CS constant while AS changes

Tranaglyphs and Vectograms – work on BI and BO ranges while making sure the patient keeps the targets clear
Lifesaver cards – work on fusing easily and keeping the letters clear

Lens flippers – Start monocularly and with lower powers. Work toward binocular and higher powers, getting up to +/-2.00 D or even +/-2.50 D.

Lens rock

- Rates higher for:
  - Lower power lenses
  - Closer target distance
  - Larger letters
  - Monocular compared to binocular
- Our norms for +2/-2, 40 cm, 20/30 letters:
  - At least 10 binoc.
  - At least 11 monoc.
  - Monoc. – binoc. 4 or less
- Means from Loerzel et al., 40 cm, 20/30 letters, OU:
  - +2/-2: 11.6 cpm (SD=3.4)
  - +1.5-/-1.50: 15.6 cpm (SD=3.4)
  - +1/-1: 18.8 cpm (SD=3.5)
- So for reduction of +/-0.50 D, cpm increases 3-4 cpm on average

Additional procedures for accommodative insufficiency

- Push-ups with letters
- Minus lens pull-up
  - Distance Hart chart
  - Monocular
  - Start minus lens at arm's length
  - Maintain clarity while moving minus lens closer (effectivity increases)
- Accommodative tromboning
  - Select interesting reading material
  - Hold at arm's length
  - Read while slowly bringing it closer and try to maintain comprehension
  - Bring in to NPA
  - Slowly move it back out

        - Continue back and forth

Additional considerations in accommodative infacility

- Also work on fusional vergence ranges
- Lens rock – start with low power monoc. flippers, work up to at least +2/-2 binoc.
- Flippers can be used with Tranaglyphs, Vectograms, free space fusion cards
- If concerned about suppression on binocular flippers
    - Tranaglyph or vectogram as target
    - Bar reader (illustration – Bernell catalog)

Additional procedures in accommodative excess

- Peckham procedure
    - 1. Start about 0.25 D less than NRA
    - 2. Add BI
    - 3. Add plus
    - 4. Repeat 2, 3 maintaining clarity
    - 5. Reduce BI maintaining clarity
- Hart chart walk away
    - Distance Hart chart
    - +1.00 D add
    - About 1 m away
    - Move back maintaining clarity
- Modified Updegrave method
    - NRA in trial frame
    - Reading material at 40 cm
    - Push print away keeping clarity
    - When that is easy, increase power by +0.50 D and repeat
    - Continue increasing plus power

Additional consideration in accommodative excess

- If secondary to high exo
    - Work on vergence ranges
    - BOP, BIM

EFFECTIVENESS OF VISION THERAPY FOR ACCOMMODATION AND VERGENCE

References: references 9-53 in chapter 14 of Goss, 3rd ed., pages 184-185

Some illustrative papers on VT effectiveness

Daum, VT in exo cases, Table 14.1 on page 177 in Goss, 3rd ed.

Table 1 in Grisham literature review on early CI studies, 1988 (reference 41 in Goss, 3rd ed.)

Results from CITT studies, Tables 14.4 & 14.5, pages 178 & 179, Goss, 3rd ed.

Alvarez et al., Optom Vis Sci 2010;87:985-1002

- Time to complete 4 deg. conv. before VT: controls (n=13), all < 500 msec; CI subjects (n=4), 750 msec – 2 sec
- Time to complete 4 deg. conv. after VT: 500 msec – 1 sec
- Mean peak vel. during 4 deg. conv.: before VT, 6 deg/sec; after VT, 11 deg/sec
- Mean NPC: before, 13.4 cm; after, 8.1 cm
- Mean near BO prism bar break: before, 14; after, 40
- Mean symptom survey score: before, 26; after, 10
- Functional MRI showed increased activity in frontal lobe, cerebellum, and brain stem during convergence after VT

Grisham study on improvement in vergence response times, Figure 14.7 on page 176 in Goss, 3rd ed.

Convergence excess, 66-84% success

- Daum KM. Negative vergence training in humans. Am J Optom Physiol Opt 1986;63:487-496.
- Shorter AD, Hatch SW. Vision therapy for convergence excess. New Eng J Optom 1993;45:51-53.
- Gallaway M, Scheiman M. The efficacy of vision therapy for convergence excess. J Am Optom Assoc 1997;68:81-86.
- Ficarra AP, Berman J, Rosenfield M, Portello JK. Vision training: predictive factors for success in visual therapy for patients with convergence excess. J Optom Vis Dev 1996;27:213-219.

Ciuffreda et al., Optom – J Am Optom Assoc 2008;79:18-22

- Patients who underwent VT, 33 with mild TBI, 7 with mild stroke
- Mean ages: TBI, 42 yrs.., stroke, 57 yrs.
- Diagnoses: vergence disorders, 34; eye movement disorders, 38; strabismus, 5; accommodative disorders, 4.
- Most common symptoms: difficulty reading, eyestrain, diplopia, headaches

- Most common signs: receded NPC, reduced near BO ranges, abnormal DEM eye movement test results
- Treatment success criterion: marked or total improvement in at least 1 primary symptom and at least 1 primary sign
- Treatment success attained with 90% of TBI patients and 100% of stroke patients

Liu et al. optometer recordings of accommodation, pre and post VT, Figure 14.6, page 175 in Goss, 3rd ed.

Daum, VT in accommodation disorders, Table 14.2, page 177 in Goss, 3rd ed.

Improvement in NRA & PRA with VT, Table 14.3, page 178 in Goss, 3rd ed.

Change in ZCSBV with VT for accommodation disorders, Figure 14.11, page 182 in Goss, 3rd ed.

Effectiveness of VT – see also:

- Am Optom Assoc Task Force. Special report: the efficacy of optometric vision therapy. J Am Optom Assoc 1988;59:95-105.
- Am Acad Optom and Am Optom Assoc Joint Statement. Vision therapy: information for health care and other allied professionals. Optom Vis Sci 1999;76:739-740.
- Ciuffreda KJ. The scientific basis for and efficacy of optometric vision therapy in nonstrabismic accommodative and vergence disorders. Optom – J Am Optom Assoc 2002;73:735-762.

EYE MOVEMENT DISORDERS

Disorders of saccadic and pursuit eye movements are often known as ocular motor dysfunction or oculomotor dysfunction.

Saccades are version eye movements which rotate the eyes to shift fixation from one object to another. Saccades are very high velocity eye movements.

Pursuits are version eye movements which rotate the eyes to maintain fixation on a moving object. Maximum pursuit velocities are much slower than saccades – on the order of one-tenth of the velocity of saccades.

If pursuits cannot keep up with a moving target, saccades will occur to help catch up to the target.

Oculomotor dysfunction is diagnosed if saccade and/or pursuit function is below normal.

Impairment of saccades and pursuits can occur as a result of various drugs, neurological diseases, and neuromuscular diseases (see Tables 12.2, 12.3, 12.4, in Scheiman & Wick, 2nd ed., pp. 378-380; Tables 13.2, 13.3, 13.4 on pages 390-391 of 3rd ed.), so these must be ruled out.

Oculomotor dysfunction is sometimes distinguished from these pathological causes by referred to it as functional oculomotor dysfunction.

Disorders of saccades and pursuits can occur separately or together, but in treatment the assumption is usually made to work on both saccades and pursuits.

Oculomotor dysfunction can be primary condition or it can be secondary to accommodation or vergence problems. Sohrab – Jam (AJOPO, 1981;53:720-726) found that when nearpoint plus was applied when indicated by dynamic retinoscopy there were improvements in eye movements during reading.

If oculomotor function is not improved by correction of refractive errors or accommodation and vergence problems, then VT to improve pursuits and saccades may be indicated.

Prevalence of oculomotor dysfunction

- Has not been studied extensively in unselected populations
- In persons with reading problems – common
    - E.g., Maples, study of elementary school children, low results on parts of NSUCO Oculomotor test; good readers: 0.2, 13.3, 16.1, 8.6, 0, 12, 19, 8.1%; poor readers: 11.9, 29.3, 32.7, 22.7, 0, 29.5, 43.4, 14.4%

- Maples, study of elementary school children, low results on parts of NSUCO Oculomotor test; gifted readers: 0, 18.8, 18.8, 6.2, 3.1, 68.7, 15.6, 6.2%; learning disabled: 10.3, 31, 41.4, 24.1, 6.9, 75.9, 39.5, 34.5%

Various studies have found that VT for oculomotor dysfunction improved reading speed and improved efficiency of eye movements during reading (e.g., Solan et al., OVS, 1995; Rounds et al., JAOA, 1991; Young et al., JOVD, 1982; Solan, book chapter, 1973 – see references 7, 51-53 in S&W, 2nd ed., pp. 390-391.
It has sometimes been suggested that poor oculomotor function in reading and learning problems is sometimes due to poor visual attention, but regardless of that, VT can improve eye movements. So it has been suggested that VT for oculomotor dysfunction also improves visual attention.

Symptoms of oculomotor dysfunction can include head movement when reading, skipping lines and loss of place when reading, poor reading speed and comprehension, difficulty copying from chalkboard, poor sports performance such as difficulty following the flight of a ball.

The eye movements that occur between fixation pauses during reading are saccades.

Better readers tend to make fewer fixations and fewer regressions than poor readers.

TESTS OF SACCADES

Tests of saccades can be grouped into three categories:
1) electro-oculographic recordings
2) standardized charts requiring a verbal response
3) direct observation

(1) Examples of commercially available electro-oculographic instruments:
Eye Trac, Visagraph, Readalyzer.

These use infrared reflections from the eyes to monitor eye position.

They yield right eye and left eye traces of eye position as a function of time.

The Visagraph & the Readalyzer are usually operated while the patient is reading. They give right eye and left eye traces of eye position as a function of time along with sophisticated print-outs of number of fixations, regressions, duration of fixations, reading rate, and grade equivalence.

Example of trace from Visagraph

(2) The two most commonly used standardized charts for saccade testing which require a verbal response are the King-Devick test and the Developmental Eye Movement (DEM) test. They were preceded by the Pierce Saccade test, published by Jack Pierce in 1972.

The King-Devick test was developed in the early 1980’s based on the Pierce saccade test. The King-Devick test has 8 rows of 5 single-digit numbers on each of 4 cards: a demonstration card, Test I, in which the numbers are connected by horizontal lines, Test II, in which there are no lines between the numbers, and Test III, in which the 8 rows of numbers are close together. Patients are instructed to call out all numbers on the card without using their fingers. The test is timed and the number of errors is recorded. Norms for time and errors for 8 to 14 year olds are provided with the test cards.

A recent application of the King-Devick test

- King-Devick test has been suggested as a rapid sideline screening test for concussion in sports
- K-D test results were worse than baseline in athletes who had undergone concussion
    - Galetta et al. Neurology 2011;76:1456-1462.
    - Galetta et al. J Neurol Sci 2011;309:34-39.

Garzia et al. announced the DEM test in 1990. They developed this test because they felt the King-Devick test did not distinguish between problems with saccades and problems with the automaticity of naming numbers.

On the DEM test, there is a Pre-test to demonstrate what is expected of the patient, then two vertical tests (Test A and B), and lastly a horizontal test (Test C). On Tests A and B, the patient reads the numbers down the vertical columns. Time and errors are recorded. Then on Test C the patient reads the 5 single-digit numbers on each of the 16 rows. Again time and errors are recorded. It is thought that the ratio of horizontal time to vertical time is a measure of saccadic function with automaticity of naming numbers factored out.

DEM scoring

- Vertical time = Test A time + Test B time
- Horizontal test – count errors of substitution (read wrong letter) (s), omission (o), addition (a), and transposition (switched letters) (t)
- Adjusted horizontal time = Test C time X [80/(80-o+a)]
- Ratio = Adjusted horizontal time / Vertical time
- Total errors = s + o + a + t
- Compare these scores to norm charts

DEM

- Norm charts used to derive percentile performance for horiz. time, vert. time, ratio, and errors
- Separate charts for ages 6 to 13

DEM means show improvement with age

- Vertical time
  - 63.1 at 6 yrs; 33.8 at 13 yrs
- Adjusted horizontal time
  - 98.3 at 6 yrs; 37.6 at 13 yrs
- Horizontal to vertical ratio
  - 1.58 at 6 yrs; 1.12 at 13 yrs
- Errors
  - 15.2 at 6 yrs; 1.6 at 13 yrs

Interpretation of DEM results

- Normal horiz. time, normal vert. time, normal ratio: normal performance
- Abnormally high horiz. time, normal vert. time, abnormally high ratio: oculomotor dysfunction
- Abnormally high horiz. time, abnormally high vert. time, normal ratio: difficulty in number naming automaticity, no oculomotor dysfunction
- Horiz. time, vert. time, and ratio are all abnormally high: oculomotor dysfunction & difficulty in number naming automaticity

The third type of saccade test is direct observation. There have been a number of descriptions of how saccadic eye movements should appear to the examiner.

But there seems to have been just one standardized direct observation test. This is the NSUCO oculomotor test developed and standardized by Maples at Northeastern State University College of Optometry in Oklahoma.

There has been relatively more interest in assessing saccades than in assessing pursuits because the eye movements occurring during reading are saccades.

TESTS OF PURSUITS

The primary tests of pursuit function used clinically are the Groffman Visual Tracing Test and the NSUCO Oculomotor Test for pursuits.

On the Groffman Visual Tracing Test, there is a demonstration card and two test cards, A and B. You use one of the two test cards. There are five letters, A, B, C, D, E, at the top of the card and five numbers, 1 through 5, at the bottom of the cards. Lines wind all over the page starting at the letters (one line per letter) and eventually reach one of the numbers at the bottom of the page.

The task for the patient is to follow each of the lines, in order, starting with A, and tell you what number it goes to. The time it takes to go from each letter to a number is timed. A particular number of points is awarded for a given range of times. If the patient did not get the correct number, zero points are assigned. The points for the five letters are then totaled and compared to age norms. There are age norms that range from 7 years of age to 12 and over. (Illustrations – demonstration card, Test cards A & B, Scoring directions sheet)

NSUCO OCULOMOTOR TEST

On the NSUCO Oculomotor test for saccades the patient stands directly in front of the examiner. The examiner holds two fixation sticks at the Harmon distance or no more than 40 cm from the patient. The targets are about 10 cm either side of the patient's midline. The patient is instructed to look at one target when the examiner says a color of that target and then the other when the examiner says the color of it. The examiner has the patient make five round trips from one target to the other and back. The examiner observes the patient's eye movements and rates the head movement, body movement, saccade ability, and saccade accuracy on scales from 1 to 5 according to established criteria (see Table 1.8 on p. 28 in S&W, 2nd ed., or appendix B on p. 43 in Maples OEP monograph). There are norms for the test for ages 5 years to 14 years and above (see Table 1.9 on p. 29 in S&W, 2nd ed., or table 10-6 on p. 59 in Maples OEP monograph).

The NSUCO Oculomotor Test also has a component for pursuits. The patient stands in front of the examiner. A fixation target is held at the Harmon distance or no more than 40 cm from the patient. The fixation target is moved in a circle no more than 20 cm in diameter around the midline of the patient.

Two clockwise circles are made and two counterclockwise circles. The patient is graded on ability, accuracy, head movement, and body movement. The criteria for grading these aspects are given in Table 1.10 on p. 32 of S&W, 2nd ed.

Age norms extending from 5 years to 14 years and over are given in Table 1.11 on p. 33 of S&W, 2nd ed.

(Illustrations – wands available from Bernell that can be used for NSUCO test, excerpts from Maples monograph summarizing test procedure, photo of test being done, excerpts from Maples monograph summarizing scoring of test)

STEPS IN MANAGEMENT OF OCULOMOTOR DYSFUNCTION

- Correct refractive error
- Prescribe lens add as appropriate for any accommodative or vergence conditions
- Vision therapy

EFFECTIVENESS OF VT FOR OCULOMOTOR DYSFUNCTION

Basic science laboratories have shown that various metrics of saccade performance can be improved with training.

Clinical studies have shown improvements in saccade and pursuit test results after VT. Clinical studies have also used measurements of reading eye movements to assess effects of eye movement training. A number of studies have demonstrated reduced numbers of fixations and regressions and improved reading speed without loss of comprehension after training. These studies are discussed on pages 372-374 in S&W, 2nd ed.

VT PROCEDURES FOR OCULOMOTOR DYSFUNCTION

There are many procedures that can be used for improving saccades and pursuits.

1) Letter tracking workbooks. There are various workbooks available from Bernell and other sources. An example is given in Figure 7.1 on p. 213 in S&W, 2nd ed. The task is to go across each line and mark each a and then start over mark each b and so on. This can be timed. In most workbooks the letters get smaller and closer together as you go through the workbook. The purpose is to improve saccadic eye movements.

2) Visual tracing workbooks. Similarly there are workbooks in which are patterns like the Groffman Visual Tracing Test. When starting at this, the patient uses a pen to follow each line. As patients improve their times on this, more difficult tracings can be used. The purpose is to improve pursuit eye movements. (See Figure 7.3 on p. 215 in S&W, 2nd ed., for an example)

3) Rotator instruments. There are various instruments which rotate which can be used to improve pursuits. Figs. 7.4 and 7.5 on p. 216 in S&W, 2nd ed., give two examples. On the pegboard rotator the task is to put a golf tee into a hole on the stripe with the same color on the rotator (Fig. 7.4). Other rotators have stereo and suppression cues (Fig. 7.5). (Additional illustrations – Bernell catalog)

4) Arrow fixations and other projector or blackboard exercises. A series of targets can be presented by an overhead projector or drawn on a blackboard. For example, there can be rows of arrows in different orientations. The patient calls out the direction of each arrow in order (see Richman and Cron, Guide to Vision Therapy, Activity B-8). (Illustrations – Figure 15.3 on page 323 in Birnbaum; Figure 14-4 on page 413 in Griffin & Grisham, 4th ed.)

5) Wayne Saccadic Fixator, AccuVision, and similar instruments. These are automated instruments designed to improve saccades. A light comes on at a

particular place and the patient touches that spot and/or calls out the letter at that spot. It can be timed. These instruments may also help to improve awareness of objects in peripheral vision. (Illustrations – Figure 15.4 on page 330 in Birnbaum; Bernell catalog)

6) Computer procedures. Computer Orthoptics and HTS have procedures for the improvement of saccades and pursuits. There are also other computer programs available. Check the Bernell catalog for what is available.

7) Marsden ball. A suspended ball with letters on it can be swung back and forth. The patient calls out a letter at particular points in the ball's path. The purpose is to improve pursuit eye movements.
(Illustrations – Bernell catalog; photo of Dr. Robert Johnson with Marsden ball)

8) Flashlight tag. The therapist and the patient each hold a flashlight. The patient is instructed to follow the pattern of movement of the therapist's flashlight.

9) Procedures with the distance Hart chart. Have the patient call out letters at particular points on the Hart chart. For example, 1st letter in 1st row, then last letter in last row, then 2nd letter in 1st row, then 2nd to last letter in last row, etc.
(illustration – scan of Hart chart)

10) Combination of vergence and version. For example, movement of a Brock string, Life saver card, etc., as the patient maintains fusion.

11) Many other procedures. Check Bernell catalog and other sources.

COMPUTER TRAINING PROCEDURES

There are several different computer VT programs available – if you look at the Bernell catalog you can find some of them.

The programs that we have are Computer Orthoptics and HTS, which stands for Home Therapy System. Both of these were designed by Jeffrey Cooper

HTS

Pursuits – The task here is to hit the arrow key which matches the orientation of a tumbling E. The computer keeps track of average response time and percent correct.

Saccades – Here the task is to hit the arrow key which matches the direction of the arrow on the screen. The computer keeps track of average response time and percent correct.

BI vergence – A randot stereo pattern of a square within a square. Press the arrow key corresponding to the direction of the square within the square. The BI stimulus increases with each correct answer.

BO vergence – same as BI vergence but with a BO stimulus

Autoslide vergence – same task as BI & BO vergence, but the stimulus changes at intervals instead of at each patient response

Jump ductions – same as autoslide vergence except that it jumps back and forth between BI and BO

Accommodative rock – trains monocular accommodative facility, plus over one eye and minus over other; patient wears red-blue glasses. A red acuity task alternates with a blue acuity task. The computer keeps track of cycles per minute and percent correct responses for each eye.

COMPUTER ORTHOPTICS

Computer Orthoptics is more of an in-office procedure.

Liquid crystal goggles are worn during training so that some features on the screen are seen by the right eye and some by the left eye.

There are several different training procedures available:

Pursuits – The purpose of this procedure is to improve pursuit eye movement. The task is to keep a square on a bird or dinosaur or other object which is moving across the screen. The speed of the object can be adjusted. The computer will keep track of the percent time you are on the target

Saccades – This procedure is designed to improve saccadic eye movements. The task is to hit the arrow key which points in the direction of the arrow which appears on the screen. As soon as you respond, another arrow appears in another area of the screen. The computer keeps track of your average response time and the percent correct responses

Vergence – Press the right arrow key to increase the BI stimulus and press the left arrow key to increase to BO stimulus. The computer keeps track of the maximum BI stimulus and the maximum BO stimulus that you can achieve. There are many different targets available.

Multiple choice vergence – In this procedure targets have stereo cues. The patient is supposed to move the joystick in the direction of the stereo cue. If correct, there is a high-pitched "beep." If incorrect, there is a low-pitched sound that their instruction manual calls a "boop." There is a gradual increase in the BI or BO stimulus.

Jump duction – This is the same as the multiple choice vergence except that the stimulus jumps back and forth between BI and BO.

Rotations – same as the vergence program except that the targets also rotate around the screen

Accommodative rock – trains monocular accommodative facility, plus lens over one eye and minus over the other eye (with liquid crystal glasses). Targets alternate between the two eyes. The task is to use joystick or arrow keys to indicate whether a dot is toward the top, right, left, or bottom within a box

SANET VISION INTEGRATOR

- One of the newest systems
- Developed by Robert Sanet, OD, and Rodney Bortel of HTS
- Training for saccades, pursuits, eye hand coordination, visual reaction time
- www.svivision.com
- See page 119 in 2012 Bernell catalog

ANTI-SUPPRESSION THERAPY

Some definitions

- Suppression – the lack or inability of perception of normally visible objects in all or part of the field of vision of one eye, occurring only on simultaneous stimulation of both eyes and attributed to cortical inhibition. (Dictionary Vis Sci, 2000)
- Suppression scotoma – a unilateral area of lack of perception found only under binocular conditions and not present monocularly
- Central suppression – occurs within 5º of fovea
- Peripheral suppression – occurs in periphery or extends beyond 5º from the fovea

Suppression Tests – some examples

- Worth dot
- Red lens test
- Some stereoscope targets
- Maddox rod (deep suppression)
- Lateral vergence range testing – suppression if target moves left or right
  - BI: target moves toward seeing eye
  - BO: target moves toward suppressing eye
- Vectographic projector charts, e.g., AO vectographic slide (see Fig. 10.1 on page 77 in Goss, 2nd ed.)
- Pola Mirror test (illustration)
  - Patient wears polaroid goggles
  - Patient looks in mirror
  - Patient reports if sees both eyes (OD sees OD, OS sees OS)
  - Room illumination must be full
- Vis-à-vis
  - Patient and examiner wear polaroid goggles
  - Patient reports if sees both of examiner's eyes
  - Patient's OD sees examiner's OS
  - Patient's OS sees examiner's OD
  - Room illumination must be full
- Vectogram targets, e.g., Bernell SOV9 Vectogram Lines (illustration – Bernell catalog)
  - 1,2,3,5 seen by OD & OS
  - Line 4 seen by OS
  - Line 6 seen by OD
- Four prism diopter base-out test
  - For small central suppression scotoma in suspected small angle strabismus
  - Patient wears Rx
  - Room illumination sufficient to allow examiner to see patient's eyes
  - Patient views a distance letter one line larger than best VA in poorer eye

- 4Δ BO loose prism placed over better VA eye
- Watch other eye (illustrations – from von Noorden's Atlas of Strabismus)
- Repeat with prism over other eye
- Advantage – objective
- Disadvantages – frequent atypical results, poor repeatability (see: Frantz KA, et al. Optom Vis Sci 1992;69(10):777-786)
- Don't base diagnosis of central suppression or small angle strabismus on this test alone

Suppression tests – depth of suppression
Table 5-2 on page 139 of Griffin & Grisham, 4th ed.

Anti-suppression training procedures
1. TV Trainer
A plastic sheet which is red on one side and green on the other is placed on a television screen. The patient watches television while wearing red-green glasses. If either eye is suppressed, the patient will not be able to see the all of the TV screen. (illustration – Bernell catalog)

Anaglyphic materials are generally preferred to polaroid for anti-suppression therapy because tilting the head will change the relative orientation of the polaroids

2. Bar reader
Red and green bars alternate across a clear sheet of plastic. This sheet is placed on a book while a patient reads. (illustrations – Bernell catalog)

It can also be placed over nearpoint targets while doing binocular lens flippers and prism flippers. It can be placed over Hart charts.

3. Cheiroscope
A cheiroscope is a Brewster stereoscope with some type of pattern or form seen by one eye. (illustrations – Bernell catalog)
The patient is then expected to copy that pattern on paper seen by the other eye.

4. Brock string
The Brock string can be used for anti-suppression training

5. Sherman playing cards
Red suit cards are printed with red numbers, letters, and symbols on a white background. Black suit cards are printed with black numbers, letters, and symbols on a red background. The patient plays cards while wearing red-green glasses.
The patient sees the red suit cards with one eye and the black suit cards with the other eye.

6. Monocular fixation in a binocular field (MFBF)
The patient does activities involving seeing a fine task by only one eye (MF) within a field which is seen binocularly (BF).

For example, the patient wears red-green glasses while doing a black on white maze (binocular field). The patient traces his way through the maze with a red pen which is cancelled out by the red filter.

Ordinarily, the green filter is over the left eye in red-green glasses. But here the green filter should be placed over the eye being treated for suppression if a red pen is used.

7. Tranaglyphs

8. Mirror superimposition
- Some definitions
    - First degree fusion – simultaneous binocular perception of dissimilar objects projected into the same visual direction
    - Second degree fusion – single simultaneous binocular perception of identical objects viewed separately by the two eyes
    - Third degree fusion – stereopsis, fusion of targets that result in a perception of three dimensions
- Mirror superimposition
    - Patient views a target with one eye (target in front of patient)
    - Patient holds small mirror in front of other eye at 45º angle and views another target (to side of patient)
    - Patient superimposes or fuses targets
    - Used for deep suppression
    - Illustrations – Figures 6.33 & 6.34 on page 215, Scheiman & Wick, 3rd ed.

9. Rotators with red-green features

10. Stereoscopes

11. Many other procedures

To decrease likelihood of suppression
- Move fixation target
- Increase illumination or contrast
- Increase clarity of target seen by suppressing eye
- Flash target
- Blink eyes
- Use target with more color
- Increase target size

- Touch the target

VERTICAL PHORIAS

Testing

The cover test is not sufficient by itself to rule out a clinically significant vertical phoria because the minimum eye movement that can be seen on the cover test is in the range of 2 to 4 prism diopters. *So not seeing vertical on cover test does not rule out clinically significant vertical imbalance – if you do not do both cover test and a dissociated phoria test, you are providing substandard care.*

Use dissociated phoria tests (such as von Graefe, Maddox rod, modified Thorington) as a screener for a vertical imbalance.

If a non-zero value is found on the dissociated phoria, follow it up with associated phoria testing (Mallett unit, AO Vectgraphic slide, Borish card, for example).

Treatment for vertical phorias

The most common treatment for vertical phoria is vertical prism. The prism prescription should be based on the vertical associated phoria.

Indications for VT for vertical phorias:
(1) Prism doesn't relieve symptoms completely.
(2) The patient doesn't want to wear prism.

Vision Therapy for vertical phorias

A vision therapy program for vertical phorias should include three elements:
(1) Improve horizontal fusional vergence ranges
(2) Do anti-suppression procedures
(3) Improve vertical fusional vergence ranges

Procedures that can be used to improve vertical fusional vergence ranges

(1) Variable Tranaglyphs can be turned 90 degrees so that the plastic sheets are separated vertically

Vectograms can also be used, but Tranaglyphs are preferred because patients with vertical phorias sometimes tilt their heads

(2) Nonvariable Tranaglyphs with vertical separations (illustration – scan of nonvariable Tranaglyph)

(3) Vertical loose prisms and vertical prism flippers
Patients should be encouraged to fuse as quickly as possible when a vertical loose prism is placed in front of one eye or when vertical prism flippers are flipped back and forth.

(4) Vertically separated eccentric circles or other similar targets. (illustration – scan of eccentric circles)

OTHER AREAS AND APPLICATIONS OF VISION THERAPY

Peripheral Awareness

- Intense concentration or stress can lead to reduced peripheral awareness
- Some optometrists theorize that increasing peripheral awareness can help in divergence training

Procedures include:
MacDonald Form Field card used for training peripheral awareness
(illustration – Figure 15.20 on page 371 in Birnbaum)

Peripheral numbers

- Numbers on cards or on computer screen
- Patient fixates dot and reads numbers
- (illustration – page 98 in The Athletic Eye, Seiderman & Schneider)

Wayne saccadic fixator and similar instruments

Procedures with Hart charts

By the way, peripheral awareness is reduced during cell phone use.

- Sodhi et al. Behav Res Methods Instr Comp 2002;34:529-538.
- Barkana et al. Am J Ophthalmol 2004;138:347-353.
- Atchley & Dressel. Human Factors 2004;46:664-673.
- Oommen & Stahl. Neurology 2005;65:754-756.
- Maples et al. Optom – J Am Optom Assoc 2008;79:36-42.
- Thumser & Stahl. Hum Mov Sci 2012; epub PMID 23273423.

A few comments on amblyopia

- Definition (DVS): “Low or reduced visual acuity not correctable by refractive means and not attributable to ophthalmoscopically apparent structural or pathological anomalies or proven afferent pathway disorders….There may also be an increase in contour interaction (crowding phenomenon), reduced contrast sensitivity, inaccurate accommodative response, poor monocular fixation, poor eye tracking, and abnormal spatial distortion and uncertainty.” (note the emphasis on abnormal function of the amblyopic eye, not just low VA)
- Amblyopia is usually associated with anisometropia or strabismus or both
- VT for amblyopia may address many or all of the areas of abnormal function in the amblyopic eye.
- Management of amblyopic can include some combination of:
    - Refractive correction
    - Patching or atropine penalization
    - Vision therapy
- Vision therapy for amblyopia can include:

    - Monocular fixation in a binocular field
    - Anti-suppression training
    - Monocular accommodation VT
    - Monocular pursuits VT
    - Monocular saccades VT
    - Monocular tachistoscopic presentation
    - Other procedures to improve monocular function and perception
    - Training with Haidinger brush to reduce eccentric fixation
    - Binocular procedures including vergence training when monocular skills have been improved
- Improvements can be made in adults with amblyopia, but active training needed, not just occlusion (go over Figure 17.3 on page 490 from Scheiman & Wick, 3rd edition)

Tachistoscopic presentation – for visual reaction time

- Low tech – card covers numbers, letters, or words
- Projector systems with shutters
- Commercial computer software – Supertach, Sanet Vision Integrator
- Various symbols can used instead of numbers or letters
- (illustrations – pages 100, 113 in The Athletic Eye, Seiderman & Schneider; Bernell catalog)

A Few Comments on 3D Media and Associated Vision Problems

Three common methods for 3D presentation

- Anaglyph
- Polarization
- Active shutter
    - Battery powered glasses receive signals from TV or projection equipment
    - Shuttering occurs ~120 times/second

Vision problems associated with 3D media and possible causes

- Unable to see depth
    - Strabismus, suppression
- Eyestrain, headache
    - Depth achieved by varying convergence stimulus
    - Conv. stimulus different from accomm. stimulus
    - Vergence disorders
- Dizziness, nausea
    - Visually induced motion sickness
    - Mismatch of visual and vestibular inputs
    - Oculomotor dysfunction?
- Management
    - Sit farther from screen
    - Appropriate optometric management

Recent reports on 3D media

- Shibata et al.: 3D symptoms correlated with diss. phoria, Sheard's criterion, Percival's criterion
- Sheedy: ZCSBV comfort zone for 3D viewing narrower than Percival's comfort zone; perhaps because of rapid changes in CS
- Sheedy: symptoms less likely with passive (polaroid) systems than with active (shutter) systems
- Scrogan: more than a million 3D projectors installed in U.S. classrooms, but not fully implemented; suggests potential collaboration between optometry and education
- Duenas: suggests that 3D can be used to educate public about vision problems – www.3deyehealth.org

Computer vision syndrome

- Eyestrain, headache, ocular fatigue, ocular discomfort common with computer use
- Evaluate for uncorrected refractive error
- Evaluate for accommodation and vergence disorders
- Dry eye symptoms can occur due to infrequent blinks
- Visual aspects of work station
    - Eliminate sources of glare and reflections
    - Monitor should be in position of about 10 degrees downgaze

Studies on difficulty viewing with diagnostic instruments

- Frantz et al. Binocular test findings associated with difficulty fusing images in the slit lamp. J Optom Vis Dev 2000;31:23-28.
    - Optometry students reported frequency of difficulty (0, 25, 50, 75, or 100% of time)
    - 75 or 100% considered symptomatic
    - 0% considered asymptomatic
    - Higher percent of symptomatic subjects had accommodation or vergence disorder (χ^2, p=0.017)
    - Most common vergence disorders: convergence excess, fusional vergence dysfunction, convergence insufficiency
    - Also one subject with basic eso and one with basic exo
- Winters et al. Accommodative and vergence difficulties interfering with image clarity through a binocular indirect ophthalmoscope. Optom Vis Sci 2004;81:260-267.
    - Higher percentage of optometry students reporting blur had a diagnosis of accomm. or verg. disorder than of those who didn't (p=0.03)
        - Various diagnoses
    - Optometry students who reported blur had lower findings on the following (p<0.05):
        - NRA

- Monoc. & binoc. lens rock
- Distance BO blur
- Near BO break
- Near BO recovery

ADDITIONAL TOPICS IN VISION THERAPY

Symptom Survey Forms

- Useful for
  - Asking the right questions to find nearpoint symptoms
  - Evaluating relief of symptoms from vision therapy (doing survey pre & post VT)
- Two forms with published studies
  - Convergence Insufficiency Symptom Survey (from CITT studies)
  - COVD Quality of Life Assessment Survey

A Few Comments on Sports VT

Training procedures that can be used for vision enhancement in sports VT

- Accommodation and vergence
- Pursuits and saccades
- Eye hand coordination
- Peripheral awareness
- Visual reaction time

Different visual skills are required for different sports (table from Press, p. 288)

Loading or distractions that can be used for sports VT

- Increase speed
- Change gaze position
- Change body position or posture
- Challenge balance
- Add movement
- Vary lighting or use strobe light
- Cognitive or verbal distractions – problem solving, talking, etc.

For more information on sports VT

- Chapters 13 & 21 in: Press LJ, ed. Applied Concepts in Vision Therapy. St. Louis: Mosby.
- Chapters 2 & 8 in: Loran DFC, MacEwen CJ, eds. Sports Vision. Oxford: Butterworth-Heinemann.
- Pages 171-182 in: Classé JG, ed. Optometry Clinics: Sports Vision. Norwalk, CT: Appleton & Lange.
- Erickson GB. Sports Vision: Vision Care for the Enhancement of Sports Performance. Oxford: Butterworth-Heinemann.
- Sports Vision Section, American Optometric Association: http://www.aoa.org/x4787.xml.

CI patients can have ADHD-like symptoms – could some CI cases be misdiagnosed as ADHD?

- Granet et al., Strabismus 2005;13(4):163-168.

    - 9.8% of CI patients had been diagnosed with ADHD, compared to 1.8-3.3% prevalence of ADHD in general US population
    - 15.9% of ADHD patients had CI, about 3x prevalence of CI
    - "CI could aggravate the academic performance of a patient with ADHD….the presence of CI may cause misdiagnosis…of ADHD."
- Borsting et al., Optometry 2005;76(10):588-592.
    - Children with accomm. dysfunction or CI had higher scores on the cognitive problems/inattention, hyperactivity, and ADHD index categories on the Connors Parent Rating Scale (CPRS-R:S) than the mean ($p<0.001$).
- Damari et al., J Behav Optom 2000;11(4):87-91.
    - Case reports of two patients who had CI, in hindsight misdiagnosed as ADHD
    - After VT for CI could be taken off meds for ADHD

Accommodation and vergence disorders are common in mild traumatic brain injury (mTBI)

Green et al. Accommodation in mild traumatic brain injury. J Rehab Res Develop 2010; 47:183-210.
Accommodative disorders common in mTBI; in this study:
12 persons, ages 18-40, with near vision symptoms and mild traumatic brain injury:

- Lower velocity accommodative responses than controls
- Lower amplitude of accommodation than age norms
- Half had low NRA and/or PRA or unbalanced NRA & PRA
- Fatigue on lens flippers when repeated for three minutes

Thiagarajan et al. Vergence dysfunction in mild traumatic brain injury (mTBI): a review. Ophthalmic and Physiological Optics 2011; 31:456-468.
Vergence disorders common in mTBI, particularly:

- Abnormal phorias, especially exo
- Increased prevalence of CI
- Receded NPC
- Reduced BO vergence ranges
- Reduced vergence facility

Information on vision problems in traumatic brain injury

- Suchoff IB, Ciuffreda KJ, Kapoor N, eds. Visual and Vestibular Consequences of Acquired Brain Injury. Santa Ana, CA: Optometric Extension Program, 2001.
- Suter PS, Harvey LH, eds. Vision Rehabilitation: Multidisciplinary Care of the Patient Following Brian Injury. Boca Raton, FL: CRC Press, 2011.

MISCELLANEOUS PATIENT MANAGEMENT ISSUES

Now that we have covered various VT procedures, we'll do a quick review of some of the principles of sequencing VT procedures.

Principles of sequencing training procedures

Now that we have talked about how various VT procedures are done, we can go back and do a quick review of sequencing of training procedures. These principles should hopefully make more sense now.

1. Start with larger targets and work toward finer, more detailed targets.

2. Begin with brief periods of time on a given task and frequent breaks and work toward more sustained effort

3. Start with complete concentration on the visual task and work toward ability to achieve the desired level of performance in the presence of distractions.

4. Begin with plenty of emphasis on visual and other feedback cues and work toward being able to perform maximally in the absence of feedback.

5. Start with emphasizing the direction of difficulty of convergence and/or accommodation and later work on improving ability in both directions.

6. Emphasize amplitude first and later work on improving facility. With regard to vergence, another way of saying this is: work on smooth vergences first and then later jump vergences.

Scheduling and time commitment issues

Most optometrists expect the patient to do both in-office and home training. A typical pattern of in-office training is one 45-minute visit per week. A typical home training schedule is 20 to 30 minutes a day, 5 to 6 days a week. Most nonstrabismic accommodative and binocular vision problems require 8 to 12 weeks of training.

It is important that your in-office visits be as organized as possible. You should plan what you will be doing in advance of the patient's visit. The in-office visit may include a few tests to check progress, five to ten minutes on each of three to five training procedures, and perhaps a check of how the patient is doing the home training procedures (to make sure that the patient is doing them correctly).

The home training should also be carefully organized and carefully explained. The 20 to 30 minutes of daily activity should be divided among 2 or 3 training procedures.

Presenting the VT plan to patients and parents

1. Review the patient's chief complaint and symptoms.

2. Explain the nature of the patient's vision problem. Explain how this vision problem can result in the symptoms that the patient has.

3. Explain what vision therapy is and why it is a good treatment for the patient's condition. Discuss the effectiveness of vision therapy for the condition and emphasize the importance of doing all the training procedures regularly.

4. Discuss the time commitment – frequency of in-office visits, time expectations of at home training, and how many weeks of therapy are likely to be needed if the patient does the procedures regularly. This may also be an appropriate time to discuss financial considerations.

5. Lastly provide an opportunity for the patient and parents to ask questions.

ADDITIONAL RESOURCES IN VISION THERAPY

In this course our goal is to provide information on vision therapy on a level that it could be incorporated into a primary care practice. We have "barely scratched the surface" of information on VT. There are many sources of additional information available.

General references and textbooks

1. Birnbaum MH. Optometric Management of Nearpoint Vision Disorders. Boston: Butterworth-Heinemann, 1993.

2. Griffin JR, Grisham JD. Binocular Anomalies: Diagnosis and Vision Therapy, 4th ed. Boston: Butterworth-Heinemann, 2002.

3. Press LJ, ed. Applied Concepts in Vision Therapy. St. Louis: Mosby, 1997.

4. Rutstein RP, Daum KM. Anomalies of Binocular Vision: Diagnosis and Management. St. Louis: Mosby, 1998.

5. Scheiman M, Wick B. Clinical Management of Binocular Vision: Heterophoric, Accommodative, and Eye Movement Disorders, 2nd ed., Philadelphia: Lippincott, Williams, and Wilkins, 2002 (3rd ed., 2008).

Books containing descriptions of training procedures

1. Getz DJ. Strabismus and Amblyopia, revised edition. Santa Ana, CA: Optometric Extension Program, 1990.

2. Richman JE, Cron MT. Guide to Vision Therapy. South Bend, IN: Bernell

3. Rosner J, Rosner J. Vision Therapy in a Primary-Care Practice – Procedures Manual. New York: Professional Press, 1988.

4. Swartwout JB. Optometric Vision Therapy, revised edition. Santa Ana, CA: Optometric Extension Program, 1988.

5. for an index of VT procedures, see: J Behav Optom 2008; 19(1):15-19. (http://www.oepf.org/sites/default/files/journals/jbo-volume-19-issue-1/19-1%20Goss.pdf)

Practice management and vision therapy

1. Bleything WB, ed. Developing the Dynamic Vision Therapy Practice. Santa Ana, CA: Optometric Extension Program, 1998.

2. Chapter 23 in Press's book

Effectiveness of vision therapy

1. Studies on effectiveness of VT: references 9-53 on pages 184-185 of Goss DA. Ocular Accommodation, Convergence, and Fixation Disparity, 3rd ed., 2009.

2. Am Optom Assoc Task Force. Special report: the efficacy of optometric vision therapy. J Am Optom Assoc 1988;59:95-105.

3. Am Acad Optom and Am Optom Assoc Joint Statement. Vision Therapy: Information for Health Care and Other Allied Professionals. Optom Vis Sci 1999;76(11):739-740.

4. Ciuffreda KJ. The scientific basis for and efficiacy of optometric vision therapy in nonstrabismic accommodative and vergence disorders. Optom 2002;73(12):735-762.

American Optometric Association Clinical Care Practice Guidelines
(http://www.aoa.org/x4813.xml)

1. Care of the Patient with Amblyopia
2. Care of the Patient with Strabismus: Esotropia and Exotropia
3. Care of the Patient with Accommodative and Vergence Dysfunction

4. Care of the Patient with Learning Related Vision Problems (this, of course, isn't the topic of this course, but this is mentioned just to let you know that this is available)

Organizations

1. College of Optometrists in Vision Development, 243 N. Lindbergh Boulevard, St. Louis, MO 63141 (www.covd.org); COVD publishes Optom Vis Perf in conjunction with OEP

2. Optometric Extension Program, 1921 E. Carnegie Avenue, Suite 3-L, Santa Ana, CA 92705-5510 (www.oepf.org); OEP publishes one or two monographs per year and Optom Vis Perf in conjunction with COVD

Information on COVD & OEP

- College of Optometrists in Vision Development; www.covd.org; quarterly journal – Optometry and Vision Development; annual meeting; has fellowship program (FCOVD)
- Optometric Extension Program; www.oepf.org; publish about two monographs per year; Journal of Behavioral Optometry, six issues per year; regional CE courses and seminars
- Both COVD and OEP have student memberships
- Starting this year COVD & OEP now jointly publish Optometry and Visual Performance which replaces their separate journals, will have six issues per year: http://www.covd.org/Home/OVPJournal/tabid/104/Default.aspx

Student memberships

- COVD
    - Free
    - http://www.covd.org/Portals/0/2010Student-ResidentMembershipApplication.pdf
    - Discounted registration fee to attend annual meeting & can apply for travel grants to annual meeting
- OEP
    - Free
    - See President of IU Student OEP Club for information

In-depth seminars on vision therapy

1. COVD has in-depth seminars for one or two days preceding their annual meeting.

2. OEP Clinical Curriculum (www.oepf.org)
OEP offers a repeating series of in-depth seminars, on various topics, lasting 1-5 days: http://www.oepf.org/curriculum/course-description

Residencies
Many optometry schools offer a residency in Binocular Vision and Pediatrics

VT equipment sources

- Bernell Corporation; www.bernell.com
- Optometric Extension Program; www.oepf.org
- Keystone View; www.keystoneview.com
- Optego Vision Inc.; www.optego.com
- Stereo Optical; www.stereooptical.com

SCHOOLS OF THOUGHT IN VISION THERAPY/ORTHOPTICS

- Javal and the French School
  - Louis Emil Javal (1839-1907)
  - Orthoptics for strabismus
  - Emphasis on anti-suppression techniques
  - Used Brewster and Wheatstone stereoscopes and free space training of vergence ranges
- Worth and the English School
  - Claud Worth (1869-1936)
  - Orthoptics for strabismus
  - Emphasized importance of sensory fusion
  - Development of the amblyoscope for fusion training
  - Emphasized early intervention
- Optometric Vision Therapy
  - Addition of treatments for accommodation and vergence disorders, oculomotor dysfunction, visual processing deficiencies
  - Expansion of binocular vision literature
  - Development of use of lens adds and prisms
  - Development of many free space training techniques

Schools of Thought in Optometric Vision Therapy

- Classical, Traditional
- Behavioral

Distinctions of Classical and Behavioral OVT that I **don't** see as helpful

- Classical
  - "Structuralist"
- Behavioral
  - "Functionalist"
  - "Behavior affects vision and vision affects behavior"
  - "Vision is the dominant sense for acquiring information and directing movement"
- I would think that everyone sees:
  - both structure and function as important and inter-related
  - inter-relations of behavior and vision

        - vision as the dominant sense

Schools of Thought of Optometric Vision Therapy

- Classical, Traditional
    - More conservative
    - Emphasis on diagnostic and management procedures which have direct supportive evidence
- Behavioral
    - Uses classical techniques plus procedures which have indirect or anecdotal support
    - Tends to be more holistic
    - Techniques more likely to include integration of vision with other sensory or motor modalities

Some of the Leading Names in Optometric Vision Therapy

- Classical, Traditional
    - Early: Sheard, Flom, Fry, Hofstetter, Morgan
    - More recent: Daum, Griffin, Grisham, Sheedy, Saladin, Scheiman, Wick
- Behavioral
    - Earlier: Skeffington, Lesser, Manas, Birnbaum
    - Recent: Harris, Hohendorf, Maples, Press, Sanet

“Father of Behavioral Optometry”: A. M. Skeffington (1890-1976)
Skeffington portrayed vision as being a product of the interaction of four components

- Spatial orientation and localization, balance, position in space; includes vestibular input
- Selection of an area of space for attention and for orientation of the eyes, head, and body to that area (centering); includes convergence
- Resolution and discrimination of details and derivation of meaning from area of space attended to (identification); includes accommodation
- Analysis and communication of what is seen
- (thus a very inclusive view of what constitutes vision)

SOME EXAMPLE CASES

Case A
33 year old female school teacher
Loses place when reading, eyestrain when reading
Cover test: dist., ortho; near, high XP
BVA: OD +0.75-0.25X75; OS +1.00-0.50X120
von Graefe: dist., 2 exo; near, 14 exo
Dist BI: X/8/0; Dist. BO: X/8/4
Near BI: 18/24/16; Near BO: X/2/-8
NRA: +1.25; PRA: -2.50
BCC: +0.50; MEM: 0.50 lag

The ACA ratio in Case A is:
- a. high
- b. normal
- c. low

The diagnosis in case A is:
- a. convergence insufficiency
- b. convergence excess
- c. divergence excess
- d. basic exophoria
- e. pseudo convergence insufficiency

One of the training procedures that would be good to start a VT program in this patient is:
- a. Tranaglyphs with small detailed targets
- b. aperture rule
- c. free space fusion cards
- d. Brock string

Of the following the one most likely to be used only late in the VT program would be:
- a. Tranaglyphs
- b. lens rock
- c. BOP & BIM
- d. prism rock
- e. stereoscopes

Example of a training program for CI
- First few weeks
  - In-office: Vectograms with large peripheral targets, Computer Orthoptics
  - At home: Brock string, HTS, Tranaglyphs
- Middle weeks

    - In-office: More detailed Vectograms, jump vergence on Vectograms, prism flippers, jump vergence on stereoscope, aperture rule
    - At home: Tranaglyphs, HTS, lens flippers
- Last few weeks
    - In-office: aperture rule, free space fusion (later with rotation), Computer Orthoptics
    - At home: free space fusion cards, HTS

Case B

9 year old boy, occasional double vision at near, reading difficulty
Cover test: dist., ortho; near, high XP
NPC: 19 cm; NPC with +1.00 D: 9 cm
BVA: OD +0.25-0.25x180; OS +0.50-0.25x180
von Graefe: dist., 1 exo; near, 12 exo
Dist. BI: X/7/4; Dist. BO: X/15/8
Near BI: 15/24/12; Near BO: X/6/-1
MEM (over pl): 1.50 lag

The diagnosis in case B is:

a. convergence insufficiency
b. convergence excess
c. divergence excess
d. basic exophoria
e. pseudo convergence insufficiency

The VT program in this case would be:

a. essentially the same as for case A
b. similar to case A with additional emphasis on lens rock, distance rock, clarity of targets
c. quite different from case A with emphasis on procedures like lens rock, distance rock

Example of a VT program for pseudo CI

- First few weeks
    - In-office: Vectograms with large peripheral targets, Computer Orthoptics, lens sorting
    - At home: Brock string, distance rock, lens flippers
- Middle weeks
    - In-office: More detailed Vectograms, jump vergence on Vectograms, prism flippers, minus lens pull-up, lens flippers
    - At home: Tranaglyphs, HTS, lens flippers
- Last few weeks
    - In-office: aperture rule, free space fusion (later with rotation), Computer Orthoptics, BOP & BIM

- At home: free space fusion cards, HTS, lens flippers

Case C
11 year old girl, blurred vision at times, both distance and near; difficulty reading
Cover test: dist., ortho; near, low XP; NPC: 4 cm
BVA: OD +0.25 D sph; OS +0.25-0.25x90
von Graefe: dist., 1 exo; near, 4 exo; +1.00 add, 7 exo
Dist. BI: X/6/3; Dist. BO: 8/15/10
Near BI: 12/15/9; Near BO: 14/18/10
NRA: +2.00; PRA: -2.00
+2/-2 flippers: 4 OU, 5 OD, 5 OS
DEM: WNL; MEM, 0.50 D lag

The diagnosis in case C would be:
a. convergence insufficiency
b. accommodative insufficiency
c. accommodative infacility
d. accommodative excess
e. basic exo

Of the following, the most likely starting point with lens flipper training would be:
a. +1.50/-1.50, monocular
b. +2/-2, monocular
c. +1.50/-1.50, binocular
d. +2/-2, binocular
e. +2.50/-2.50, binocular

Other training procedures in this case could include:
a. Vectograms emphasizing clarity
b. monocular lens sorting
c. distance rock
d. free space fusion cards emphasizing clarity
e. all of the above

Example of a training program for accommodative infacility
- First few weeks
  - In-office: Vectograms with large peripheral targets, Computer Orthoptics, lens sorting, lens flippers
  - At home: Brock string, distance rock, Tranaglyphs
- Middle weeks
  - In-office: More detailed Vectograms, jump vergence on Vectograms, lens flippers
  - At home: Tranaglyphs, HTS, lens flippers
- Last few weeks

        - In-office: aperture rule, free space fusion, Computer Orthoptics, lens flippers
        - At home: free space fusion cards, HTS, lens flippers

Case D

19 year old male student, occasional blur at distance and near, eyestrain when reading
Cover test: dist., high XP; near, high XP
NPC: 11 cm
BVA: OD pl-0.25x105; OS +0.25-0.50x75
von Graefe: dist., 7 exo; near, 11 exo
Dist. BI: X/12/8; Dist. BO: X/7/2
Near BI: 17/24/14; Near BO: X/7/1
NRA: +1.00; PRA: -4.75
BCC: -0.75; MEM (over pl): 0.50 lead
+2/-2 D flippers: 4 OU (slower on plus side), 11 OD, 12 OS

The diagnosis in case D is:

a. convergence insufficiency and accommodative excess
b. divergence excess and accommodative excess
c. basic exo and accommodative excess
d. convergence insufficiency and accommodative infacility
e. divergence excess and accommodative infacility
f. basic exo and accommodative infacility

Which of the following would be useful in this case:

a. Hart chart walk away
b. Peckham procedure
c. modified Updegrave procedure
d. lens rock
e. all of the above

BOP & BIM would be a good procedure in this case.

a. true
b. false

Example of a VT program for basic exo and accommodative excess

- First few weeks
    - In-office: Vectograms with large peripheral targets, Computer Orthoptics, lens sorting, Hart chart walk away
    - At home: Brock string, distance rock, Tranaglyphs
- Middle weeks
    - In-office: More detailed Vectograms, jump vergence on Vectograms, lens flippers, Peckham procedure
    - At home: Tranaglyphs, HTS, lens flippers

- Last few weeks
    - In-office: aperture rule, free space fusion, Computer Orthoptics, lens flippers, prism flippers, BOP & BIM
    - At home: free space fusion cards, HTS, lens flippers

A FEW CLOSING COMMENTS

Who can benefit from vision therapy?

- Children with difficulty in school
- Adults with eyestrain or difficulty on the job
- Persons who avoid reading or near work
- Athletes wanting to improve performance
- Persons with accommodation and binocular vision problems
- Mild traumatic brain injury cases
- (That's a lot of people!)

Lack of a chief complaint does not mean lack of a binocular vision problem – from Birnbaum's Optometric Management of Nearpoint Vision Problems (p. 56):

"Patients who present with impaired accommodative and binocular findings, but without asthenopia, are generally asymptomatic either because they have developed myopia or because they avoid reading. When asthenopia is absent, many practitioners assume that existing visual problems are insignificant and do not require treatment. Recognition that patients with functional vision disorder may be asymptomatic because they avoid or adapt leads the clinician to consider treatment in such cases, to eliminate the need for continued avoidance or further development of adaptive vision disorder."

In the future

- I hope that many of you will include VT in your future practices.
- If you don't, please do a comprehensive work-up of accommodation and vergence and refer cases who need VT to a colleague.

Lab Manual

Vision Therapy for Non-Strabismic Binocular Vision Disorders

V666
Binocular Vision
Indiana University School of Optometry

Spring Semester, 2013

Instructor:
David A. Goss, OD, PhD

V666 Lab – Testing Name________________________________
Date________________ Lab section________________________

Equipment to bring to lab: penlight or transilluminator, prism bars, trial lens set, retinoscope, dynamic retinoscopy cards, trial frame, nearpoint test cards, cover paddle, lens flipper/holder, Maddox rod, calculator, Saladin card

Lab partner____________________________

Complete and record the following tests on your lab partner (all testing done with habitual Rx or BVA unless otherwise noted):

Prism neutralized cover test:
- Distance_____________________________________
- Near____

Modified Thorington dissociated phorias:
- Distance lateral_________________________
- Distance vertical_________________________
- Near lateral__________________________
- Near lateral with +1.00 D add__________________________
- Near vertical__________________________

Prism bar vergence ranges:
- Distance BI______/______/______
- Distance BO______/______/______
- Near BI______/______/______
- Near BO______/______/______

Saladin card associated phorias:
- Near lateral________________
- Near vertical_________________

Near point of convergence:
- _______________________________
- circle one: done easily / some effort / much effort

MEM dynamic retinoscopy:
- ____________________________

+2/-2 D flippers, 40 cm, 20/20 letters:
- OD__________cpm; slower on plus or minus?________________
- OS__________cpm; slower on plus or minus?________________
- OU__________cpm; slower on plus or minus?________________

Questions:
What is the calculated ACA ratio based on the cover test?

What is the calculated ACA ratio based on the modified Thorington dissociated phorias?

What is the gradient ACA ratio?

Which of the dissociated phorias and fusional vergence ranges are outside of Morgan's norms?

Which of the other test findings are outside normal ranges?

What is the accommodation/vergence diagnosis? How did you arrive at that diagnosis?

Notes on normal ranges:
Normal associated phoria: 0 for both lateral and vertical
Normal on MEM: 0 to +0.75 D*
Failure on +2/-2 flippers, 40 cm, 20/30 letters: monocular less than 11, binocular less than 10, monocular minus binocular difference greater than 4*
Failure on NPC: break greater than 6 cm or much effort required*

*Please note that various authorities give different values for normalcy on these tests.

Morgan's norms:
Dist. Diss. Phoria: 0 to 2 exo
Near Diss. Phoria: 0 to 6 exo
Dist. BI: X / 5 to 9 / 3 to 5
Dist. BO: 7 to 11 / 15 to 23 / 8 to 12
Near BI: 11 to 15 / 19 to 23 / 10 to 16
Near BO: 14 to 20 / 18 to 24 / 7 to 15
Gradient ACA: 3 to 5

V666 Lab – Training fusional vergence　　Name________________________________
Date____________________　　Lab section______________________

The purpose of this lab exercise is to familiarize you with some of the common instruments and methods for the training of fusional vergence. Use each of the instruments listed below to gain an understanding of how they work and to determine your best performance on each.

I. Vectogram – use one of the available targets
A. Which of the Vectogram targets did you use?

B. What are the suppression cues on this target?

C. The scales at the bottom indicate the change in convergence stimulus in prism diopters when the patient is 40 cm from the Vectogram. What was the maximum BI amount to which you could keep the target single and clear? __________
What was your maximum BO amount? __________

D. Did you notice SILO and float?

II. Tranaglyph – use one of the available targets
A. Which of the Tranaglyph targets did you use?

B. What are the suppression cues on this target?

C. The scales at the top and bottom indicate the change in convergence stimulus in prism diopters when the patient is 40 cm from the Tranaglyph. What was the maximum BI amount to which you could keep the target single and clear? __________
What was your maximum BO amount? __________

D. Did you notice SILO and float?

III. Brock string
A. What is the difference between smooth vergences and jump vergences on the Brock string?

B. What is the cue for suppression on the Brock string?

C. What is the closest you could see the bead singly without suppression?

IV. Keystone Lifesaver cards and Bernell Free space fusion cards – use both of these
A. What are the suppression cues on the Lifesaver card?

B. What are the suppression cues on the Bernell Free space fusion card?

C. How many pairs of circles were you able to fuse holding the Lifesaver card at 40 cm? If you could fuse all four, how close could you hold the card and still fuse the most difficult pair of circles?

D. How many pairs of circles were you able to fuse holding the Bernell Free space fusion card at 40 cm? If you could fuse all four, how close could you hold the card and still fuse the most difficult pair of circles?

E. Was it easy for you to fuse the circles and keep the letters clear? What is the significance of keeping the letters clear?

V. Aperture rule – The single aperture is for convergence training. The double aperture is for divergence training.
A. Which card was the best that you could achieve on convergence?

B. Which card was the best you were able to achieve on divergence?

C. What were some of the suppression cues on the cards you used?

General questions:
1. What diagnosis did your lab partner come up with for you last week? Does that diagnosis make sense when you consider what you had difficulty with and/or found to be easy on today's lab?

2. (a) Which of the methods used today require(s) both convergence and accommodation to move in and out together? (b) Which requires convergence to move in and out while accommodation should remain fairly constant? (c) Which of these two types of procedures is generally more challenging in training fusional vergence?

V666 Lab – Stereoscopes Name___________________________________
Date_________________ Lab section______________________________

The purpose of this lab is to familiarize you with: (a) the Keystone Telebinocular Stereoscope and the Keystone Visual Skills Tests done in the Telebinocular, (b) the Bernell-O-Scope (or Bernell Brewster Stereoscope) and the jump vergence training card sets used in the Bernell-O-Scope, and (c) other stereoscope systems used for training vergence.

I. Keystone Telebinocular Visual Skills Tests

A. See the hand-out on the Keystone Visual Skills Tests for the proper instructions on these tests. Complete tests 1, 2, 3, 4, 4 1/2, 5, 6, and 7, at the distance test setting and tests 10, 11, 12, 13, and 14 at the near test setting on your lab partner. Record your results on the Keystone recording sheet. Which tests are outside the normal range shown on the recording sheet?

B. Are your results consistent with the results from the first lab? Explain.

II. Jump vergence training with the Bernell-O-Scope

A. Place the Base-In book at the 0 setting on the shaft. The convergence stimulus for the bottom picture is the same on all cards. The convergence stimulus for the top target is given inside the front page of the book. On how many of the cards could you fuse both targets? What was the convergence stimulus for the top picture on the most difficult card that you could fuse?

B. Place the Base-Out book at the 0 setting. The convergence stimulus for the top picture is the same on all cards. The convergence stimulus for the bottom target is given inside the front page of the book. On how many of the cards could you fuse both targets? What was the convergence stimulus for the bottom picture on the most difficult card that you could fuse?

C. Were your results on the Bernell-O-Scope consistent with the diagnosis from the first lab? Explain.

III. What targets did you use on the mirror stereoscope? What were the maximum convergence and divergence values you were able to achieve?

IV. Look at some of the Keystone stereoscope training cards. Which ones did you look at? On which ones were you able to fuse both targets and what were the vergence stimuli?

INSTRUCTIONS FOR KEYSTONE VIEW TELEBINOCULAR STEREOSCOPE VISUAL SKILLS TESTS

Test 1 – DB-10A (Dog-Pig)
"What do you see?"

"Do you see all of the dog and all of the pig all of the time?"

"Take this pointer in your left hand and hold it as you would a pencil, and place the tip in the middle of the black stripe on the dog's side."

(expected: stripe between (and above) tail and head of pig)

Test 2 – DB-8C (Vertical Phoria)

"Through what number does the yellow line pass?"
(expected: zero)

(if not, find out whether the line is passing above or below the zero)

"Do the numbers or the line or any parts of them ever fade or disappear?"

Test 3 – DB-9 (Far Point Lateral Phoria)

"To what number does the arrow point?"

(three seconds later)
"To what number does the arrow point?"

(three seconds later)
"and now?"

"Do any of the numbers, or the arrow, ever fade or disappear?"
(expected: 8 to 11)

Test 4 – DB-4K (Far Point Fusion)

"How many balls are there?"
(expected: 3)

(if 4, then 3, ask:)
"When there where first four, was the red ball to the right or to the left of the blue ball?"

(if it stays 4, ask:)
"Is the red ball to the right or the left of the blue ball?"

Test 41/2 – DB-1D (Far Point Usable Vision, Right Eye)

"In this bridge scene there are a number of what we'll call signboards."

"These signboards are numbered. This one is #1, here is #2, and so on…"

"Within each signboard there are five diamonds (pointing) *top, bottom, left, right, and center. In one of these diamonds is a black dot. In which diamond is the dot in this #1 signboard?"*

(Passing: 7–10 right)

Test 5 – DB-3D (Far Point Usable Vision, Right Eye)

"In this bridge scene there are a number of what we'll call signboards."

"These signboards are numbered. This one is #1, here is #2, and so on…"

"Within each signboard there are five diamonds (pointing) *top, bottom, left, right, and center. In one of these diamonds is a black dot. In which diamond is the dot in this #1 signboard?"*

(Passing: 7–10 right)

Test 6 – DB-2D (Far Point Usable Vision, Left eye)

Same as test 5

(Passing: 7-10right)

Test 7 – DB-6D (Far Point Stereopsis)

"Here we have a large rectangle, with numbered rows of symbols inside it."

"How many large rectangles are there?"
(expected: one)

"Look at the row of symbols. Are all the symbols the same distance from you – or are some closer or farther away than others?"

"In row #1 what symbol is out of line?"
(expected: the plus sign)

"Is the plus sign closer or farther away than the rest?"
(expected: closer)

"In row #2, what's closer?"

(expected: 10-12 right)

Move to Near Point

Test 10 - DB-9B (Near Point Lateral Posture)

Same directions as Test 3

(expected: 4 ½ to 6 ½)

Test 11 – DB-5K (Near Point Fusion)

same directions as Test 4

Test 12 – DB-15 (Near Point Usable Vision, Both Eyes)

"Here we have a large circle, made up of a number of smaller circles, each numbered. In the center are three circles showing the patterns used in the outer circles. The pattern in this top circle we shall call <u>lines</u>; the one in the middle circle we shall call <u>dots</u>; the one in the bottom circle we shall call <u>gray</u>. Now for example, we'll go to circle #1. The pattern here we'll call dots. What's the pattern in circle #2?" etc.

(Passing: 13 to 22 right)

Test 13 – DB-16 (Near Point Usable Vision, Right Eye)

"Here we have a large circle, made up of a number of smaller circles, each numbered. In the center are three circles showing the patterns used in the outer circles. The pattern in this top circle we shall call <u>lines</u>; the one in the middle circle we shall call <u>dots</u>; the one in the bottom circle we shall call <u>gray</u>. Now for example, we'll go to circle #1. The pattern here we'll call dots. What's the pattern in circle #2?" etc.

(Passing: 13 to 22 right)

Test 14 – DB-17 (Near Point Usable Vision, Left Eye)

Same as Test 13

(Passing: 13 to 22 right)

V666 Lab – Accommodation and flipper procedures
Name_____________________________________
Lab section____________________ Date______________________

Equipment to bring to lab: retinoscope, dynamic retinoscopy cards, trial lens set, occluder, timer to time one minute, Saladin card

The purpose of this lab is to familiarize you with procedures used in vision therapy for accommodative disorders and to help you continue to develop very important skill in dynamic retinoscopy. Work in pairs. Record what your lab partner finds on you and what you find on your lab partner.

Lab partner ___________________________________

I. MEM retinoscopy

Do MEM retinoscopy before any other procedures.

your lag of accommodation ________

your partner's lag of accommodation ________

II. Lens flippers

Lens flippers are used for training as well as testing. The standard power for testing is +2/-2. In a vision therapy program for an accommodative disorder, you can start the patient with lower power and then after a few weeks increase the power. Record your flipper rates:

+1.50/-1.50 OD, yourself _______ slower on plus or minus? ________
+1.50/-1.50 OS, yourself _______ slower on plus or minus? ________
+1.50/-1.50 OU, yourself_______ slower on plus or minus? ________
+1.50/-1.50 OD, your lab partner _______ slower on plus or minus? ________
+1.50/-1.50 OS, your lab partner _______ slower on plus or minus? ________
+1.50/-1.50 OU, your lab partner _______ slower on plus or minus? ________
+2/-2 OD, yourself _______ slower on plus or minus? ________
+2/-2 OS, yourself _______ slower on plus or minus? ________
+2/-2 OU, yourself _______ slower on plus or minus? ________
+2/-2 OD, your lab partner _______ slower on plus or minus? ________
+2/-2 OS, your lab partner _______ slower on plus or minus? ________
+2/-2 OU, your lab partner _______ slower on plus or minus? ________

Was the difference in rates between the +1.50/-1.50 flippers and +2/-2 flippers about the average difference?

Could you feel a difference between +1.50/-1.50 and +2/-2?

Which was lower, monocular rates or binocular rates? Why?

III. Hart charts (distance rock)
Record your rates

- yourself OD ________
- yourself OS ________
- yourself OU ________
- your lab partner OD ________
- your lab partner OS ________
- your lab partner OU ________

Which was lower, monocular rates or binocular rates? Why?

Which accommodative rock procedure (lens rock, distance rock) keeps the convergence stimulus constant and which changes convergence stimulus along with accommodative stimulus? Which do you think would be more difficult? Why? Which do you think felt more difficult?

IV. Prism flippers
This is commonly used for training vergence. It can also be used for testing. What were the prism powers in the flippers you used? ______________________
Record your flipper rates:

- yourself ___________
- your lab partner ___________

V. Monocular lens sorting

This is a training procedure which can be used early in a vision therapy program for accommodation. Have your lab partner set out the following trial lenses: +2, +1, -1, -2, -3, -4. Cover one eye. Without looking at the labeled power of the lenses, look through the lenses one at a time at some nearpoint print. Try to sort them by power by what you see and feel looking through them. Were you able to do it correctly? What cues did you use? How did your eyes feel differently with the different lenses?

VI. BOP and BIM

What were the lens and prism powers in the BOP and BIM flippers you used?

____

Record your flipper rates:

yourself ___________

your lab partner ___________

Did you notice anything different using these compared to the lens or prism flippers?

VII. MEM retinoscopy

Perform MEM retinoscopy again after all of the other procedures.

your lag of accommodation ____________

your lab partner's lag of accommodation ____________

Did your lag change from the measurement at the beginning of the lab period? If there was a change, why do you think it occurred?

V666 Lab – Computer training procedures Name________________________________
Date____________________ Lab section__________________________

Bring to lab: Bernell catalog

The purpose for this lab is to familiarize you with various computer programs for vision therapy. Work in pairs to obtain results on each of the procedures below for you and for your lab partner.

Lab partner____

I. HTS
Red-blue glasses are used when using this program so that some features are seen with the left eye and some with the right eye.

A. Vergence
On both the BI and BO programs there is a randot square within the larger square. Each time the little square changes location hit the arrow key to indicate its location within the larger square. The vergence stimulus increases with each correct answer. What were your best results?

Yourself, BI _______________
Yourself, BO _______________
Your lab partner, BI ______________
Your lab partner, BO ______________

Are these results consistent with your diagnoses from the first lab? Explain.

B. Pursuits
The task here is to hit the arrow key matching the orientation of the tumbling E. Pursuit eye movements are required to follow the Es. Record your best results:

Percent correct for yourself ____________________
Average response time for yourself _________________________
Percent correct for your lab partner ___________________
Average response time for your lab partner ______________________

C. Saccades

The task here is to hit the arrow key which matches the direction of the arrow on the screen. The arrows appear at various locations on the screen thus requiring you to make saccadic eye movements from one arrow to the next.

Average response time for yourself ______________________
Percent correct for yourself _________________________
Average response time for your lab partner ______________________
Percent correct for your partner _________________________

II. Computer Orthoptics

Liquid crystal goggles are used on the vergence and accommodative facility programs so that some features of the target are seen by the left and some by the right eye.

A. Vergence

The right arrow key increases BI convergence stimulus and the left arrow key increases BO convergence stimulus. What are the maximum levels you were able to achieve?

Yourself, BI ________________
Yourself, BO ________________
Your lab partner, BI _______________
Your lab partner, BO _______________

Are these results consistent with your diagnoses from the first lab? Explain.

B. Pursuits

What is the patient's task for this training procedure?

Record your results:

Percent time on target for yourself _____________________
Speed for yourself ___________________________
Percent time on target for your lab partner ____________________
Speed for your lab partner _______________________

C. Saccades
What is the patient's task for this training procedure?

Average response time for yourself ______________________
Percent correct for yourself _________________________
Average response time for your lab partner ______________________
Percent correct for your partner _________________________

D. Accommodative facility
Hold a +2 D lens over one eye and a -2 D lens over the other eye. How does the accommodative facility program work on Computer Orthoptics?

E. Rotations
How does the Rotations program differ from the Vergence program? Which of the two programs would be the most challenging and why?

III. Other computer VT programs
A. Briefly describe the Gemstone program.

B. What are the three phases of the Gemstone program?

C. Check which of the following are trained in the Gemstone program.

_______ vergence ranges
_______ accommodative facility
_______ pursuits
_______ saccades

D. Are there any other computer programs in the Bernell catalog for the training of vergence, accommodation, saccades, and/or pursuits? If so, what is it/are they?

V666 Lab – Saccades and Pursuits Name_______________________________
Date________________________ Lab section__________________________

Equipment needed: two nearpoint fixation targets, timer to record seconds, handout on NSUCO Oculomotor Test, calculator

The purpose of this lab is to familiarize you with some of the tests available for evaluating saccade and pursuit function and with some of the training procedures available for oculomotor dysfunction.

Lab partner_________________________________

I. Tests

These tests have established norms for school-age children, but they can be performed on persons of any age. Because there are developmental trends in performance on these tests, you and your lab partner will likely exceed the published norms.

A. King-Devick (K-D) Test

Record times (in seconds) and numbers of errors in the blanks below.
A copy of a K-D test score sheet is attached.
Your times: Test I ______ Test II ______ Test III ______ Total ______
Your errors: Test I ______ Test II ______ Test III ______ Total ______
Your lab partner's times: Test I ______ Test II ______ Test III ______ Total ______
You lab partner's errors: Test I ______ Test II ______ Test III ______ Total ______

B. Developmental Eye Movement (DEM) Test

Have your lab partner record your performance on the attached DEM scoresheet.
What were your times and ratios?
Your vertical adjusted time _______
Your horizontal adjusted time _______
Your ratio _______
Your lab partner's vertical adjusted time _______
Your lab partner's horizontal adjusted time _______
Your lab partner's ratio _______

C. Groffman Visual Tracing Test

On the Groffman Visual Tracing Test the patient follows the lines from each letter to a number and reports that number to the examiner. The examiner keeps the time for each letter to number tracing. If the patient reports the correct number for a given letter, the examiner assigns a number of points based on the patient's time (see attached chart).

When patients reach a wrong number or use their fingers for a given trace, they get zero points for that letter. Record the test results for you and your lab partner in the tables on the next page.

Yourself: Total points _______

Letter	Correct number	Number Reached	Seconds Elapsed	Points
A	3			
B	4			
C	1			
D	5			
E	2			

Your lab partner: Total points _______

Letter	Correct number	Number Reached	Seconds Elapsed	Points
A	3			
B	4			
C	1			
D	5			
E	2			

D. NSUCO Oculomotor Test
Perform this test according to the instructions on the hand-out materials on this test.
Record your results below:
Your lab partner’s evaluation of your saccades: ability _______ accuracy _______ head movement _______ body movement _______
Your lab partner’s evaluation of your pursuits: ability _______ accuracy _______ head movement _______ body movement _______
Your evaluation of your lab partner’s saccades: ability _______ accuracy _______ head movement _______ body movement _______
Your evaluation of your lab partner’s pursuits: ability _______ accuracy _______ head movement _______ body movement _______

E. Which of the tests evaluate saccades and which evaluate pursuits?

F. What do you think are some of the advantages and disadvantages of each of these tests?

II. Examples of some training procedures for oculomotor dysfunction

A. Ann Arbor Letter Tracking Book I

Turn to a page in this book. Have your lab partner keep track of the time it takes you to circle the first a, then as you continue across the line the first b, etc., through the alphabet, until you find a z just before the end of the paragraph.

Your total time ______
Your lab partner's total time _______

B. Bernell Visual Tracking Workbook

Have your lab partner keep track of your time and number of errors on two of the four exercises on a page from this workbook.

Your total time _______
Your total number of errors _______
Your lab partner's total time _______
Your lab partner's total number of errors _______

C. Bernell Saccadic Workbook Level 2

Have your lab partner keep track of your time and number of errors on two of the four exercises on a page from this workbook.

Your total time _______
Your total number of errors _______
Your lab partner's total time _______
Your lab partner's total number of errors _______

D. Rotators

Describe the two rotators you used and what the patient's task is during training.

E. Give some examples of some other procedures that can be used in vision therapy for oculomotor dysfunction.

NYSOA K-D TESTS

Sample Score Sheet

I	II	III
2 - 5 - 8 - 0 - 7	3 - 7 - 5 - 9 - 0	5 - 4 - 1 - 8 - 0
3 - 7 - 9 - 4 - 6	2 - 5 - 7 - 4 - 6	4 - 6 - 3 - 5 - 9
5 - 3 - 1 - 6 - 4	1 - 4 - 7 - 6 - 3	7 - 5 - 4 - 2 - 7
7 - 9 - 7 - 3 - 5	7 - 9 - 3 - 9 - 0	3 - 2 - 6 - 9 - 4
1 - 5 - 4 - 9 - 2	4 - 5 - 2 - 1 - 7	1 - 4 - 5 - 1 - 3
6 - 5 - 5 - 7 - 3	5 - 3 - 7 - 4 - 8	9 - 3 - 4 - 8 - 5
3 - 1 - 8 - 6 - 4	7 - 4 - 6 - 5 - 2	5 - 1 - 6 - 3 - 1
5 - 3 - 7 - 5 - 2	9 - 0 - 2 - 3 - 6	4 - 3 - 5 - 2 - 7

		Average Time (by age)				Average Errors (by age)			
	Age	I	II	III	Total	I	II	III	Total
Time	6	30.98	37.05	51.00	119.03	1.32	3.81	10.84	16.97
Deviation	6	10.10	12.96	19.39	40.92				
Time	7	26.71	31.12	43.06	100.89	1.12	2.10	8.75	11.97
Deviation	7	5.97	8.75	15.36	25.16				
Time	8	22.98	24.89	31.26	79.13	.34	.53	2.48	3.35
Deviation	8	6.37	7.75	11.59	27.35				
Time	9	21.02	22.89	29.53	73.44	.28	.45	2.02	2.75
Deviation	9	7.20	7.50	10.82	26.03				
Time	10	19.72	20.79	27.76	68.27	.28	.43	1.12	1.83
Deviation	10	6.08	7.37	10.21	26.22				
Time	11	17.58	18.95	20.39	56.92	.25	.33	.62	1.20
Deviation	11	4.60	4.51	7.45	13.85				
Time	12	16.94	17.68	19.42	54.04	.18	.21	.44	.83
Deviation	12	3.60	4.43	5.31	13.51				
Time	13	16.29	16.96	18.98	52.23	.12	.12	.36	.59
Deviation	13	2.52	2.72	3.26	7.50				
Time	14	14.86	16.87	18.73	50.46	.07	.07	.33	.47
Deviation	14	2.40	2.33	2.49	5.84				

TIME	I	II	III	Total	ERRORS	I	II	III	Total

Note For Screening Purposes: Failure results when norm plus (+) one standard deviation is exceeded.

DEM SCORESHEET

NAME______________________ DOB______________________ AGE__________ GRADE______

ARTICULATION PRE-TEST Y N NUMBER KNOWLEDGE PRE-TEST Y N

/ = substitution error
a = addition error
o = omission error
< or > = transposition error

TEST A

3	4
7	5
5	2
9	1
8	7
2	5
5	3
7	7
4	4
6	8
1	7
4	4
7	6
6	5
3	2
7	9
9	2
3	3
9	6
2	4

______sec

TEST B

6	7
3	9
2	3
9	9
1	2
7	1
4	4
6	7
5	6
2	3
5	2
3	5
7	7
4	4
8	6
4	3
5	7
2	5
1	9
7	8

______sec

TOTAL TIME: ______sec
ADJ TIME: ______sec
ERRORS: ______

TEST C

3	7	5	9	8
2	5	7	4	6
1	4	7	6	3
7	9	3	9	2
4	5	2	1	7
5	3	7	4	8
7	4	6	5	2
9	2	3	6	4
6	3	2	9	1
7	4	6	5	2
5	3	7	4	8
4	5	2	1	7
7	9	3	9	2
1	4	7	6	3
2	5	7	4	6
3	7	5	9	8

TIME:________sec

______s errors ______o errors
______a errors ______t errors

$$\text{ADJ TIME} = \text{TIME} \times \frac{80}{(80 - o + a)}$$

ADJ TIME = ________sec

TOTAL ERRORS (s + o + a + t) = __________

$$\text{RATIO} = \frac{\text{HORIZONTAL ADJ TIME}}{\text{VERTICAL ADJ TIME}} = \_\_\_\_\_\_\_\_$$

V666 Lab – Anti-suppression training procedures Name________________________
Date___________________________ Lab section____________________

The purpose of this lab is to familiarize you with some training techniques which are used to decrease the frequency and depth of suppression.

A. TV Trainer

Look at the screen with the red-green TV Trainer on it. Look at it through red-green glasses, with the red filter over the right eye as usual. Which part of the screen is seen by the right eye and which by the left eye?

B. Bar reader

Put the red-green bar reader over this page. Read across the page while wearing red-green glasses, with the red filter over the right eye as usual. Which eye sees the letters under the green bars? Which eye sees the letters under the red bars?

C. Sherman playing cards

Describe the Sherman playing cards. Look at the cards while wearing red-green glasses, with the red filter over the right eye as usual. Which cards are seen by the right eye? Which cards are seen by the left eye?

D. Monocular fixation in a binocular field (MFBF)

Use a red pen which has ink that cannot be seen through the red filter of red-green glasses, and is seen only by the eye behind the green filter. Complete a maze while wearing red-green glasses with the red filter over the right eye as usual. Then switch the two filters so that the green filter is over the right eye and the red filter is over the left eye. Complete a dot-to-dot picture while wearing the red-green glasses with the green filter over the right eye. Explain what you saw as you completed these exercises. Why are exercises of this nature referred to as “monocular fixation in a binocular field”?

E. Cheiroscope

Use the cheiroscope to view a pattern with your left eye and copy it with your right eye. Then switch it around and view a pattern with your right eye and copy it with your left eye. (Copy into the space below) Describe your perceptions as you did this procedure.

F. Vis-A-Vis

Perform the vis-à-vis technique with your lab partner. Which of your lab partner's eyes did you see with your left eye? Which of your lab partner's eyes did see you with your right eye?

G. Brock string
Look at one of the beads on a Brock string. What are the suppression cues on a Brock string?

H. Questions:
1. Which of the following are likely to decrease the likelihood of suppression (write yes in the blank if they are and no if they are not):

_____ increasing the illumination of the target seen by the eye which tends to suppress
_____ increasing the contrast of the target seen by the eye which tends to suppress
_____ increasing the clarity of the target seen by the eye which tends to suppress (or decreasing the clarity of the target seen by the other eye)
_____ moving the target seen by the eye which tends to suppress
_____ flashing the target seen by the eye which tends to suppress

2. What are some tests used to detect the presence of suppression?

3. Look at a Tranaglyph while wearing red-green glasses with the red filter over the right eye. Which eye sees the green patterns on the Tranaglyph? Which eye sees the red drawings on the Tranaglyph? Explain how this relates to what is seen by each eye with the TV Trainer and red-green bar reader.