

## Treatment of Vertical Deviations and Diplopia Learning Lab

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Disclosure Statement:  
No Disclosure Statement.

Please Silence All Mobile Devices

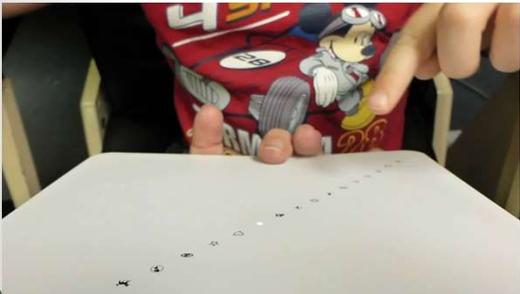
### Course Description:

Dr. Simonson and Dr. Hellerstein will share Clinical Pearls in treating vertical diplopia. This course will discuss eye alignment, prism prescribing and recommended techniques to decrease symptoms and improve fusion skills for patients with vertical strabismus and diplopia.

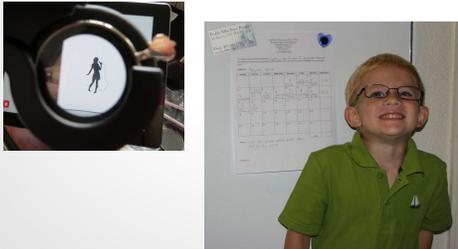


Pearl: adjust the height of your equipment to aid fusion.

1. Measurement of vertical ocular deviations including techniques to evaluate children.



2. Learn ways to determine the best prism prescription to enable fusion.



3. Learn the best types of fusional targets to use in the therapy room.



4. Add head movement and target movement to vision therapy techniques.



Pearl: Use two barrel cards and offset one higher than the other.

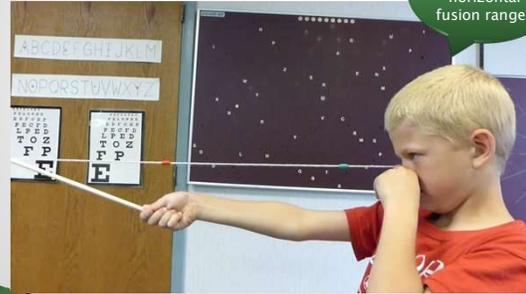
5. Understand how to program a successful sequence of vision therapy activities for treating vertical deviations.



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6. Clinical pearls for treating vertical deviations.

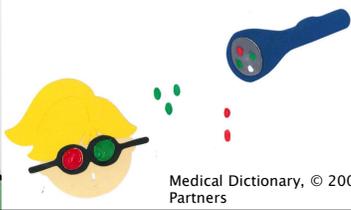
Pearl: Extend vertical AND horizontal fusion ranges



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Isophoria: (ī" sō-fō'rē-ă)

Tension of vertical muscles of each eye with visual lines in the same horizontal plane; absence of hyperphoria and hypophoria



Medical Dictionary, © 2009 Farlex and Partners

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## Signs & Symptoms

What are the Signs and Symptoms of Vertical Strabismus?

1. An eye turn
2. A sensation of monocular viewing
3. A head turn or tilt
4. Poor depth judgment
5. Fatigue
6. Double vision
7. Eye Strain (asthenopia)
8. Poor eye-hand coordination
  - o You are GREAT at training these skills! That is the GOOD NEWS.

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## COVD Prescribed Treatment Regimen Therapeutic Goals:

1. Develop adequate fusional vergences ranges (motor fusion)
  - o In all positions of gaze
  - o At near and far distances
2. Enhance accommodative/convergence ability
3. Enhance depth perception
4. Enhance fusional vergence facility and flexibility

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## Therapeutic Goals:

5. Integrate vision with accurate motor responses
6. Integrate sensory skills (vision, vestibular, kinesthetic, tactile, auditory)
7. Increase visual stamina
  - o COVD Prescribed Treatment Regimen

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### How long will therapy take?

- ▶ It is much more difficult to build vertical fusional skills compared to horizontal fusional skills.
- ▶ Successful therapy may require 60 – 80 hours of office therapy.



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### I. Use Prism to enable fusion



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### Use prism to enable fusion

1. How much prism? **Minimum to FUSE WELL.**
2. What if it is a different amount depending on where they look?  
**Create fusion in straight ahead gaze, extend to other areas with compensatory head positions and vision training.**
3. What if it depends on how tired their eyes are? **Prescribe more than 1 pair of lenses or add Fresnel as needed.**



**Goal: prevent double vision and closing one eye.**

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### Use prism to enable fusion

1. Measure the angle of the eye turn in primary gaze at distance and near distances.
2. Determine gaze and distance of best fusion stability.
3. Determine the minimal prism to fuse images well in primary gaze.
4. Measure the fusional range.
5. Trial frame prescription for stability of fusion, comfort and clarity.

If the patient has suppression, I do not initially prescribe prism glasses.

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### Prescribing Options:

1. Yoked prism
2. Compensatory Vertical BU/BD prism
3. Combination of Vertical, Horizontal, and/or Yoked Prism
4. Different prism glasses for different distances/task-specific
5. Addition of Fresnel prism end of day/task-specific

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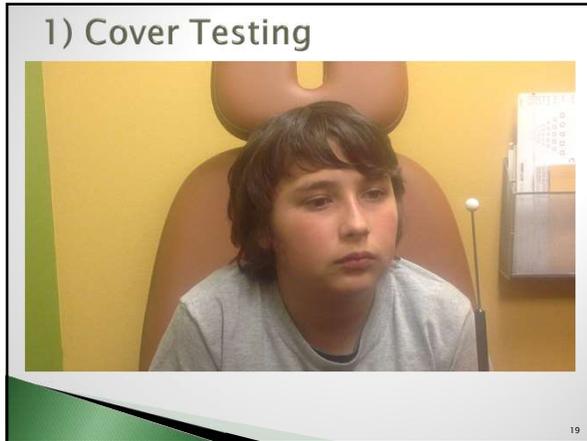
### Measurements to determine vertical prism prescription:

- ▶ Measure the angle of the eye turn in primary gaze (straight ahead, with no head turn or head tilt) at distance and near distances.



Pearl: Make sure the head is straight. Most patients will have a compensatory head tilt.

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### Determine gaze and distance of best fusion stability.

1. Which eye is higher?
2. Is it worse when looking to the right or left side?
3. Is it worse tilting to the right or left shoulder?
4. Is it worse looking up or down?

### Park's 3-Step Test

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### 1) Cover Testing

This test gets boring for kids – use animals and cartoons – just ask them to focus on the small details like eyes and noses.

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### Targets:

Pearl: use a target stick to make it easy to get straight-ahead and down gaze. If needed, recommend separate distance glasses and reading glasses.

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### Great on-line tool:

<http://www.eyedock.com/>

1. Which eye is hyper deviated in primary gaze?
2. Is the vertical deviation greater in right gaze or left gaze?
3. Is the vertical deviation greater with right head tilt or left head tilt?

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### Prism Neutralization

When the prism moves the image of the target to where the eye was aiming, the patient no longer has to move their eye to point at the target.

What you MEASURE, may not be the best amount to prescribe.

- More prism = more distortions in the lens optics.
- May feel pulling/too strong/too much "swim" motion
- Prism adaptation concerns

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# Learning Lab #1

## Park's 3-Step Test

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## 2) Von Graefe Phoria Testing

- The patient reports when the targets LOOK level.



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### Von Graefe measurement of a Vertical Phoria/Tropia

- Typical Set Up:
  - One eye: 12 BI prism (Use Horizontal Prism to dissociate)
  - Other eye: Vertical Prism to measure
    - Move prism until patient sees targets line up "like headlights on a car"
    - Patient instructed to watch the non-moving target
- Interpretation**
  - Base Up Prism to neutralize: hypo
  - Base Down Prism to neutralize: hyper



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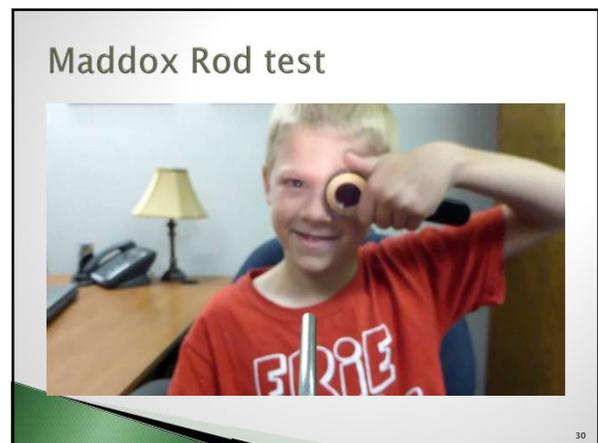
### Maddox Rod



- This is my recommended test for getting an accurate subjective response from young children (as young as age 3).
- It combines the red lens test to look for comitancy in different gazes.

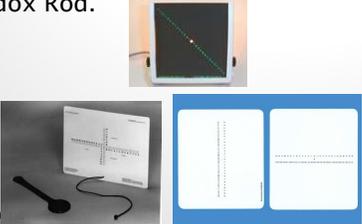


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### 4) Modified Thorington

- Use a scale to measure the amount of eye turn.
- It is used with a transilluminator and a Maddox Rod.



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### Modified Thorington

Pearl: Useful for young children



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### Modified Thorington

Pearl: you can order cards with number scales and picture scales. Each picture is 2 prism diopters apart.



Near Phoria Test with LED light  
Item #: EC120BL

Near Phoria Test cards now have option of LED light (LED100) attached with set screw allowing you...

Pearl: you can order cards with a battery powered light.

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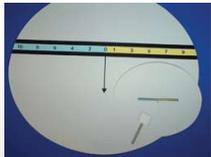
### Learning Lab #2 & #3

Variable Maddox Rod Test  
Modified Thorington Test

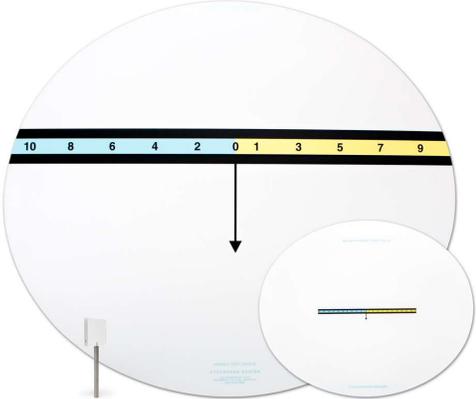
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### 5) Howell Phoria Cards

- These cards allow direct measurement of the distance and near phorias in real space.
- The patient simply has to tell which number the arrow points to.



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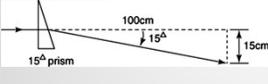


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### A prism diopter



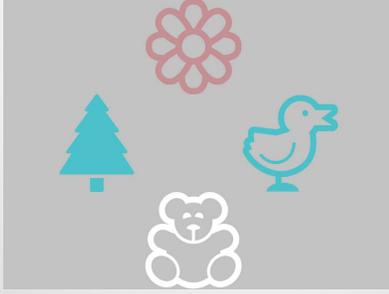
- ▶ The unit measuring the deflection of light passing through a prism equal to a deflection of 1 centimeter at a distance of 1 meter.



Use a meter stick to determine the distance in centimeters the second image is above the true target. Then measure the patient's distance from the target in meters.

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### 6) Worth 4 Dot Testing



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### Learning Lab #4

Howell Phoria Card Test  
Worth 4 Dot Test

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### 7) Laser-Assisted Hess Lancaster Test



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### Learning Lab #5

Laser Assisted Hess Lancaster Test

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### 8) Fixation Disparity Testing

**Fixation disparity** exists when there is a small misalignment of the eyes when viewing with binocular vision.

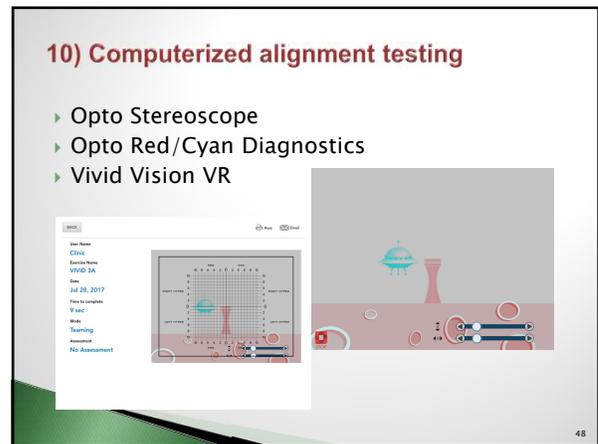
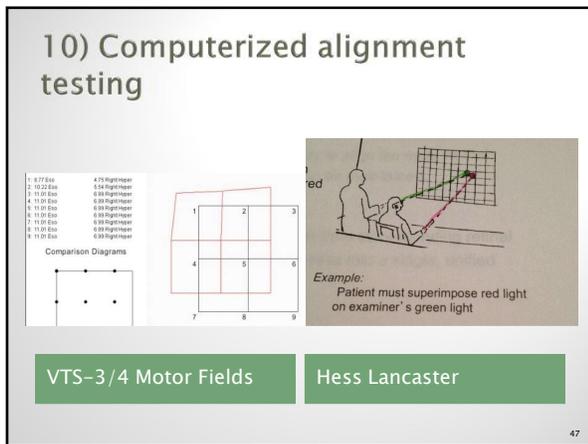
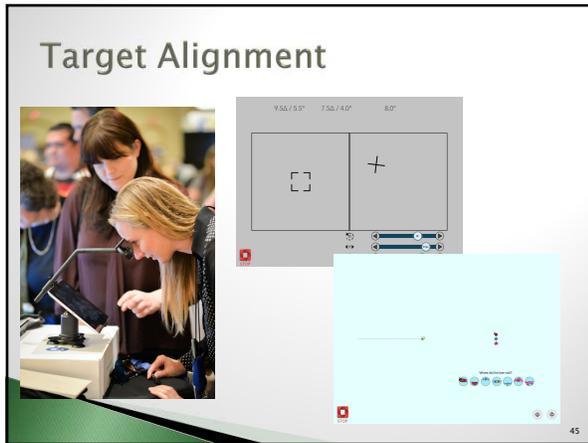
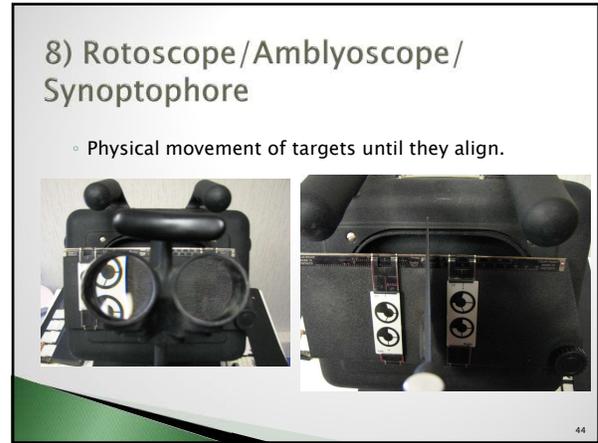
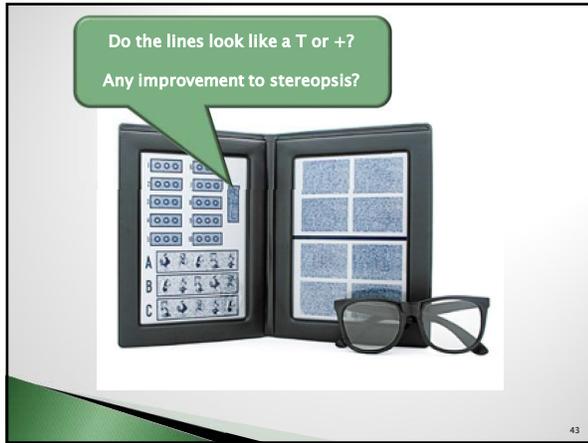


- Mallet card
- Bernell lantern slide
- Wesson Card
- Disparometer
- Saladin's Card

A patient's **associated phoria** is the amount of prism needed to reduce their fixation disparity to zero minutes of arc.



Product Number BGMAL002



### 11) Keystone

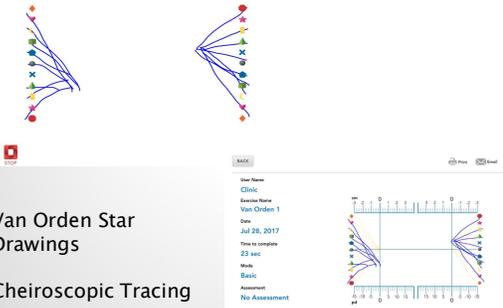


**Biopter**

- ▶ Bernelloscope



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Van Orden Star Drawings

Cheirosopic Tracing

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### 12) Trial Frame Testing



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### Rationale:

- ▶ There IS fusion during this testing.
- ▶ The patient can also report clarity and comfort differences between the prism choices.
- ▶ Determine the minimal prism to fuse images WELL in primary gaze

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## II. Use the minimal amount of prism for MAXIMUM ability

Don't under-prescribe  
Bias towards comfort  
The patient may actually note better CLARITY

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### Use the minimal amount of vertical prism for MAXIMUM ability

- ▶ For a tropia, this is about 90% of the turn.
  - Example: A 4 pd Left Hypertropia (4 pd BD OS)
    - $90\% \times 4 \text{ pd} = 3.6 \text{ pd BD OS}$



Pearl: If a vertical phoria, it will usually be 50% of the turn.

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### Measure the Fusional Range

1. Prism bar
2. Risley prism
3. Rotoscope
4. Vectograms




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### Measure the Fusional Range



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Center the amount of prism in the middle of the fusional range.

➤ **Example 1:** The left eye can move from 1 BD to 6 BD without seeing double.

- How large is the fusional range? = 5
- Where is the center of the fusional range?  $\frac{1}{2}$  of 5 = 2.5
- $1 \text{ BD} + 2.5 \text{ BD} = 3.5 \text{ BD}$  (The 90% rule matches = 3.6 pd BD)



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### Determine the minimal prism to fuse images WELL in primary gaze.

- Behind the phoropter
- Prism bar
- Trial frame

Ask the patient to report clarity and comfort differences between the prism choices.



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### Determine the minimal prism to fuse images WELL.

- Functional Testing:
  - There IS fusion during this testing.
  - The patient can also report clarity and comfort differences between the prism choices.
  - This is typically my final prescription.



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### Prescribing Recommendations:

- Split vertical prism between the two eyes to decrease prism distortion in the glasses.
- Trial frame testing allows the demonstration of the planned glasses prescription and the evaluation of small differences to finalize the prescription.



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### Prescribing Recommendations:

- Vertical prism can be ground into the patient's glasses or applied with Fresnel prism.
- Increase or decrease the amount as needed to make the patient functional.

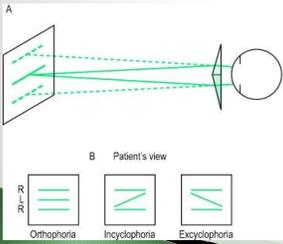
Pearl: Ask the patient when you do version testing when they see the target double and come back together. Measure with a vision disk.



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### Prism

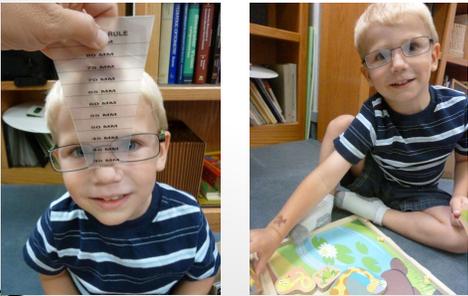
- Angle the prism as needed if there is a diagonal misalignment.
- Rotate the TARGET if there is cyclotorsion.



PRISM does not compensate for cyclotorsion.

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### Consider bi-nasal occlusion



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### When is it challenging to use prism?

- Near and distances vertical deviations are not equal.
- Contact lens wearers or Emmetropia.
- Induced hyperphoria due to spectacle correction (anisometropia).
- Torsional deviations (cyclophoria rotation).
- Patient who does not wear glasses.
- The need for very high amounts of prism.
- Non-comitant eye turns (amount varies depending on the direction the patient looks).

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### Vision Therapy for Vertical Deviations

Therapy Concepts

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### Clinical Notes:

- Place targets in the position of best fusion (they may need to adjust their work station or hold a book off center)
- Place the person's gaze in the position of best fusion. (they may need to sit a certain distance from a presentation screen or move to the other side of the classroom).

Write down these recommendations. They are very helpful for teachers.

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### Use VERY STRONG stereo targets: 3D

1. Vectograms (choose clown over quito)
2. Computerized 3D Targets: VTS
3. Phantograms
4. 3D Movies



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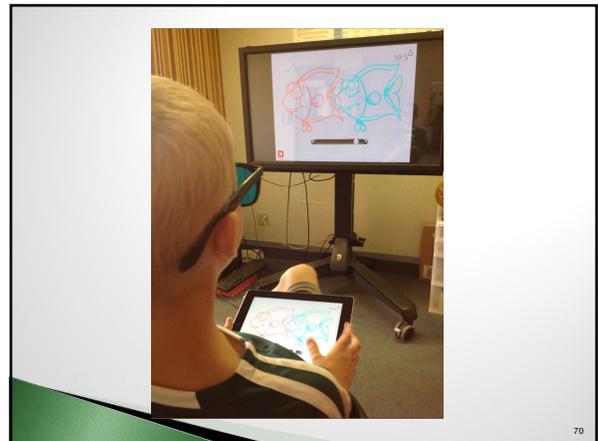


### Use Computer generated targets

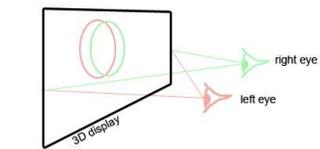
- ▶ VTS vertical fusion targets are better for initial training than HTS random dot targets.
- ▶ Home use of computer vergence programs are very supportive to therapy progress.



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### When to Use Anaglyphs:



- ▶ Typically you will use polarized targets before red/green targets
- ▶ EXCEPTION: when a cyclorotation or head tilt will prevent cancellation of the polarization.

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### Learning Lab #6

Phantograms, Anaglyphs, Tranaglyphs™

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### Training Pearls:

- Determine gaze and distance of best fusion stability.



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### Determine gaze and distance of best fusion stability

- Seat/Stand the patient in the best position for fusion.



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- Place targets in the position of best fusion. This may be to the side.
- Place the person's gaze in the position of best fusion. This may require a head tilt or turn.



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Use a rotating target to help determine areas of best fusion ability.



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### Do not increase the demand too quickly.

1. Add head movement before increasing fusional demand.
2. Work on the edge or border of fusion (not just single/double).
3. Use depth and perception of SILO (small-in/large-out) to judge quality of fusion.

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### Recommended Vision Therapy Exercise Sequence

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### 1. Equalize Monocular Skills:

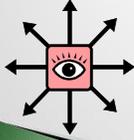
1. **Eye stretches**
2. Ball on Back
3. String & Dowel
4. Pursuit Tracking
5. Face of Clock
6. 4-corner Saccades
7. Baseball Saccades
8. Eye rotations
9. Pegboard
10. Saccadic Fixator
11. Directional Sequencer
12. Space Fixator



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### Learning Lab #7:

- ▶ Do wide monocular eye stretches
  - to free adhesions and strengthen tissue from disuse
  - Attempt 10 times per day.




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### Eye movements

OKN - Optokinetic nystagmus




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### 2. Build sensory fusion skills

- ▶ If the patient suppresses an eye, progress through:
  - Anti-suppression therapy
  - MFBF - monocular fixation in a binocular field
  - Superimposition
  - Secondary fusional targets
  - Stereoscopic fusional targets





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### 3. Use strong depth perception targets.

Make it EASY for the patient to MAINTAIN binocularity.

1. **Vertical Vectogram**
2. Horizontal Vectograms (can move diagonally)
3. HTS or VTS-4 Vertical vergences
4. Rotoscope/Amblyoscope
5. Bernelloscope with Visicare vertical fusion cards
6. Wheatstone "Flying W" Cheiroscope





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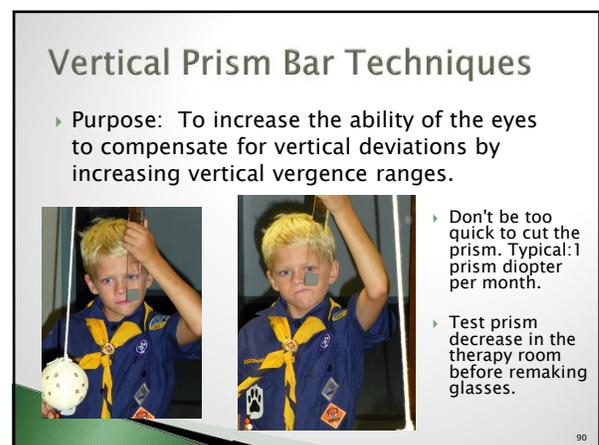
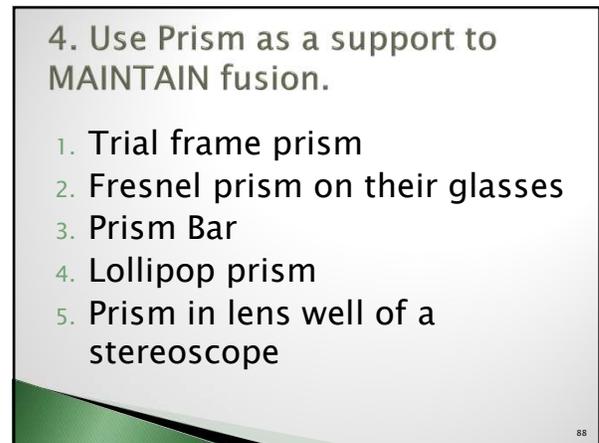
### Use VERY STRONG stereo targets

**Vectograms are great!**

- ▶ A clown vectogram has more depth, use it first.
- ▶ Work from stronger fusional targets (3<sup>rd</sup> degree stereo) to 2<sup>nd</sup> and 1<sup>st</sup> degree targets.

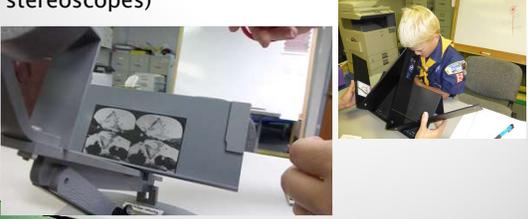


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### 5. Use Target Position as a Support to MAINTAIN Fusion

- ▶ Off-set free-space fusion targets
- ▶ Off-set in-instrument targets (cheirosopes, stereoscopes)



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### Modify Target Positions:

- ▶ Offset Targets Diagonally
- ▶ Use Prism to move target positions optically.



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### Prism Rotations

This is one exercise that helps patients FEEL their eye position.



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### CHIASTOPIC THUMBS PROCEDURE

STEP 1 - convergence

1. Hold your thumbs at arms length, at eye level, 5 cm apart.
2. Slowly cross your eyes.....you should notice that each thumb doubles.
3. Overlap the two inner thumbs so that you see a total of three thumbs.

*\*May need to make thumbs diagonal.*



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### ORTHOPTIC THUMBS PROCEDURE

STEP 2 - divergence/base-in

1. Hold your thumbs at arms length about 2 cm apart.
2. Look beyond the thumbs through the separation. You will see four thumbs.
3. Relax your eyes to get three thumbs.
4. Slowly separate your thumbs while maintaining the center thumb clear and single.



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### THUMBS PROCEDURE

STEP 3

1. Separate your thumbs 3 cm. Look through the separation and relax your eyes to fuse the four thumbs into three clear thumbs.
2. Next, cross your eyes and get 3 clear thumbs again. Continue this relax - crossing - relax - crossing pattern for several minutes.
3. For more of a challenge, increase the thumb separation and continue.

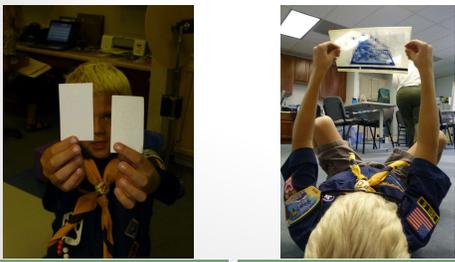
Use fingernail polish, stickers, or a marker as a suppression control



Offset intentionally.

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### Offset Targets



Tilt one as needed!

Split Vectogram, but don't tilt!

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### Offset targets and work to make them level.



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### Learning Lab #9



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### 6. Add head movement:

Have the patient stop when the target looks

- ▶ “less clear”
- ▶ “less 3D”
- ▶ “different”
- ▶ “less solid”

(not single-double)

1. Turn Left and Right
2. Tip Up and Down
3. Tilt to right shoulder and left shoulder
4. Rotate Head

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▶ Allow the patient to put their head in the BEST POSITION to FUSE, then work towards straight



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### Strategies:

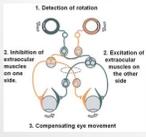
- ▶ Try to encourage gradual straightening of the head to primary gaze (slowly!).
- ▶ Add head movement *before* increasing the fusional demand.



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### Eye movements

- ▶ (VOR – vestibular ocular reflex)
- ▶ Trampoline



### Exercise Ball



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3

### VOR

Use a shadow for visual feedback on head posture.




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### VOR

Use a mirror for visual feedback on head posture



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### Learning Lab #10

- ▶ Draw a horizontal line on a board or use a horizontal edge in the room. Place your hand in front of your nose with your arm extended straight. Look at your hand.
  - Is the line straight, or is the left or right side higher?
  - What happens with a head tilt?
  - Tilt head to align the left and right lines and then work to gradually straighten head.



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### 7. Use Free Space Fusion Techniques.

Offset targets as needed to enable fusion.

- If there is a cyclorotation, you may also need to tilt the targets to fuse.
- Use CIRCULAR TARGETS, and you won't have to rotate the targets to fuse the images.

1. String and Dowel
2. Brock String
3. Chiasmotic Thumbs
4. Eccentric Circles
5. Life saver cards (cut apart)



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### 8. Increase the Difficulty

1. Move the head position
  - Move to level to a more difficult position (opposite tilt/turn)
  - Move the body closer and further from the target
2. Change the target positions:
  - Go from diagonal to level for all targets
  - Move targets closer and further
  - Increase BI and BO ranges first
  - Work on vertical fusional ranges



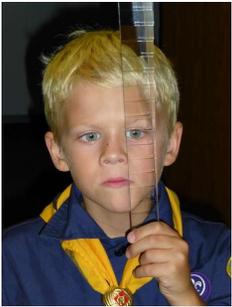
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### 3. Decrease the supportive prism

- Use a prism bar to back down step by step.
- Use a prism flipper with slightly less prism.
- Decrease Fresnel prism.
- Decrease prism on Bernelloscope.
- Decrease prism in the patient's glasses prescription.



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### 9. Use more challenging fusional targets:

1. Tranaglyphs
2. Morgenstern Color Fusion Cards
3. Sports Disk
4. BC Fusion Cards (\*70 series is vertical fusion)
5. Keystone or Alphabet fusion Cards
6. Aperture Ruler
7. Magic Eye




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### Pull eyes into vertical alignment WITHOUT 3D FUSION:

1. Squinchel
2. After-image flash tracking
3. Voluntary Vergences
4. Red light/red ring
5. Simultaneous perception targets



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### Increase the ease and speed of alignment

- ☐ Start with small transitions:
  1. Prism flipper (example: 3 BD/2 BD and increase increments to 3 BD/1 BD etc)
  2. Prism Bar
  3. Double vectograms
  4. Jump ductions on the computer
- ☐ Near-far targets
  1. Start with small transitions ("walk away" techniques)
  2. Build up to a projected vectogram, projected computerized target, or window target to a hand-held target
- ☐ Look away or Close eyes - work on speed to regain fusion.




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### Build a RANGE of fusion

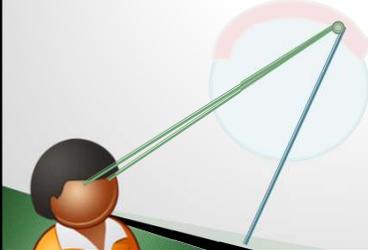
- Maintain fusion with Rotating Targets (variable gaze)
  1. Chiastopic Thumbs – rotate them in a circle, move them horizontally, vertically, and diagonally
  2. Sports Disc
  3. Rotating peg boards
  4. Projected targets rotating (mirror rotation/VTS-3)




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### Recommended Therapy Exercises:

5. Rotate free space fusional targets at arms length: eccentric circles, Brock string, string and dowel, vectograms, and tranaglyphs for home therapy.




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### Vertical Vergences

► Compensating vertical vergence ranges can be improved in patients with a vertical misalignment.



- ✓ Maintain fusion in activities of daily living = functionally less double vision and eye strain.
- ✓ Maintain fusion with good posture (no compensations with head or body)
- ✓ Maintain fusion in all gazes
- ✓ Maintain fusion with rotating and moving targets

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### Specific Vertical Fusion Exercises:

1. Vertical Vectogram
2. Vertical Visicare Cards for the Bernelloscope
3. Variable prism Bernelloscope
4. Vertical VTS4 and HTS
5. Prism (bar and lollipop)
6. BC Cards – 70 series
7. Vertical Tranaglyphs






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### Vertical Vectograms and Tranaglyphs

► Purpose: To increase vertical vergence range, recovery and flexibility




**Vertical VTS-4, HTS and Virtual Reality Programs (Vivid Vision/Optics Trainer VR)**

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### Vertical Fusion Target

Purpose: To increase vertical vergence range, recovery and Flexibility





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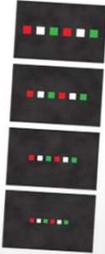
### Vertical Fusion Target

Dr. Ludlam recommended performing jump duction activities when treating vertical misalignments.

These targets are designed to be used on a light box and looked at from various distances.



- ▶ The patient wears red/green glasses (supplied)
- ▶ Start with the minimum prism necessary to see the horizontal row of boxes single and in a line.



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### Vertical Fusion Target

Use target to complete jump duction activities with handheld prisms:

1. Use a lollipop prism of 2-3 diopters placed in the direction that would reduce the amount of compensatory prism.
2. For a moment the single horizontal line will turn into two lines. The prism should trigger a fusion response and the two lines should resolve to one line.

Example: 10 base down over the right eye is needed to get the boxes aligned with minimal to no head tilt. Use 2SD over the left eye or base up over the right eye.



**In Illuminated Cabinet**

3. Hold the image of the one line for 5-10 seconds and then remove the prism to return to base line.
4. Repeat for 8-10 minutes a day.
5. Over time the fusing with the handheld prism in place should get easier (and then lessen compensatory prism)

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### Reminder: Don't increase the demand too quickly.

Make sure that when the patient is fused, that the patient is **FUSED WELL**.

1. Add head movement before increasing fusional demand.
2. Work the border of fusion. Do not alternate between single and double: adjust from blurry/uncomfortable back to single and comfortable.
3. Make it a goal to see tiny changes – “just noticeable differences.”



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### References:

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2. Robertson, KM and L. Kuhn. "Effect of Visual Training or the Vertical Vergence Amplitude" *American Journal of Optometry & Physiological Optics*, October 1985, Vol. 62, No. 10: pgs 659-668.
3. Cooper, Jeffrey, OD, MS. "Orthoptic treatment of vertical deviations" *Journal of the American Optometric Association*, 1988, Vol. 59, No. 6: 463-8.
4. <http://www.nova.edu/hpd/otm/otm-b/phoria.html>
5. [http://www.tedmontgomery.com/the\\_eye/index.html](http://www.tedmontgomery.com/the_eye/index.html)
6. The College of Optometrists in Vision Development Fact sheets
7. Correspondence with Drs. Bob Sanet, Leanna Dudley, Roger Dowis, and Gabby Marshall.
8. Courses by Drs. Cathy Stern, Curt Baxstrom, Bob Sanet
9. Clinical Experience with patients with decompensating vertical phorias, nerve palsies, Brown's Syndrome, vertical misalignment following strabismus, cataract, and scleral buckle surgeries, disease/tumor-induced diplopia and orbital blow-out fractures.

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