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Basic vision training manual

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Abstract
Basic vision training manual

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BASIC VISION TRAINING MANUAL

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ABOUT THE AUTHORS...

JANE E. KIMURA received a B.S. from the University of Arizona. She served one year as the screenings coordinator for AMIGOS EYECARE and was treasurer for C.O.V.D. for two years. She is a member of B.S.K., C.O.V.D. and a SMART READER volunteer. Jane is currently working towards a masters of education, visual function in learning degree. She plans to serve the needs of school-aged children and to specialize in visual training.

D. CORY RATH received a B.Sc. in Zoology from the University of Calgary. He was the recipient of the Peg Gilbert Award for Outstanding Achievement in Basic Visual Science, and acted as an Honorary Scholar for SOLA Quest. He is a member of B.S.K., C.O.V.D., and the Sports Vision Section of the A.O.A. Cory plans to return to Calgary, Canada to practice full-scope optometry and to promote excellence and safety in sports vision.

This project is dedicated to C.O.V.D., Pacific University chapter. We would like to acknowledge Hannu Laukkanen for his sincere interest in the project, and Paul Kohl for his valuable input.

BASIC VISION TRAINING MANUAL

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Stages of Learning in Training

Stages of Learning in Training

Pre-performance stage

State the problem; define the goal of the exercise. Inform the patient of the feedback mechanism. Define success.

Performance stage

Patient performs the task and describes what they see. Let patient do the test at the level they are familiar with. Don't talk. Patient is allowed to try without assistance. Ensure that the patient does not become too frustrated when performing the task.

Post performance stage

Critique from the patient on his or her own performance. Critique from doctor. Provide other techniques to improve performance like lenses, sticks, relaxing words.

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Stereoscopes

Stereoscopes

Stereoscopes measure and train vergences, phorias, fixation disparity and various levels of fusion at variable distances. They can also measure other visual abilities (VA's, color vision, reading fluency, etc…) under binocular viewing conditions.

Key Terms

Prism diopter
is an angular measure of convergence or divergence. It is equal to the tangent of the angle multiplied by 100.

Meter angle
is the amount of vergence, in prism diopters, for a patient to converge to a point in space. It takes into account the patient's PD.
i.e. at 1M a patient with a 60 pd will converge 6 pd/MA while a patient with a 70 pd will converge 7 pd/MA

Optical infinity
is defined by the power of the stereoscope lenses and the stereoscope "PD" or distance between the optical centers of the objective lenses.

Dioptric vergence
accommodative demand

Relative vergence
convergence over or under the ortho demand

Chiastoptic
crossed/BO demand

Orthoptic/Ortho
uncrossed/BI demand

Brewster Stereoscopes

Optics:

For the Keystone Telebinocular, the separation LS is 95 mm. The standard ortho card separation at infinity is 87mm. A septum is used to dissociate. The objectives are +5.00D lenses cut in half. The lenses are split doublets and are prism corrected for normal ranges of PD's.

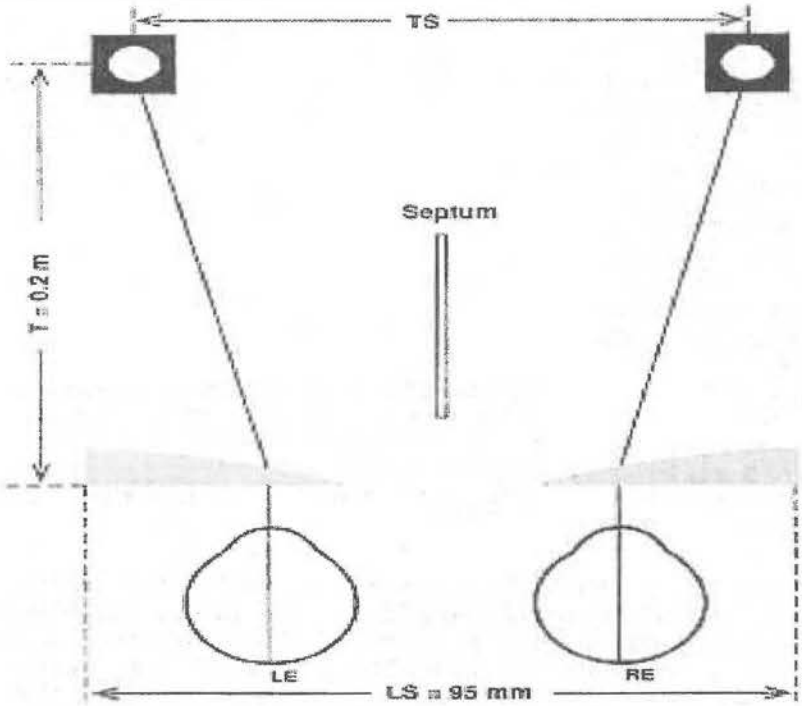


Fig 2-1 Optics of a Brewster Stereoscope:

Most people have proximal convergence in scope of approximately 4 pd BO. If the scope's lenses are +5 D, then at 20cm distance, 1 pd=2mm. 95-87mm=8mm 8mm/2=4 pd. This separation negates the patient's shift in esophoric proximal convergence. This is why Keystone card TS of 87mm theoretically represents orthophoric posture at infinity, despite the LS of the Keystone being 95mm.

Clinical Application 2-1
Figuring the Prismatic Demand of a Stereocard.

The accommodation demand is indicated on the shaft, and can be calculated if you know the power of the stereoscope's lenses and the distance of cards from the lenses. The vergence demand must be calculated and depends on two things: the LS for the scope and the separation of homologous points on the stereocard of choice. It's easy to calculate if the accommodation demand is set to infinity. Use the equation:

$$\mathbf{V = (P \times LS) - TS/TD}, \text{ where}$$

V = vergence demand in prism diopters (positive for convergence, negative for divergence)
P = power of stereoscope lenses in diopters
LS = separation of optical centers of the stereoscope lenses in centimeters
TS = separation of corresponding points of stereogram half-views in centimeters
TD = distance of stereogram from stereoscope lenses in meters.

Example : The AN Series Card #10 has a target separation between the number 1 on each side of the card of 62mm. The OC separation on the Keystone telebinocular is 95mm. The card is positioned at infinity setting.

V = (P x LS) - TS/TD
V= (5x 9.5) - 6.2/(.2)
V= 47.5 -31
V= 16.5

Positive value represents convergence. The vergence demand is 16.5 prism diopters BO.

If you wish to train accommodation other than at infinity, you need to specify the TD in terms of accommodation demand for that distance.

A = 1/TD - P, where
A = accommodation in diopters
TD = distance of the stereogram form stereoscope lenses in meters
P = power of stereoscope lenses in diopters

Example: The patient fuses an AN Series Card #10 at 40cm(2.5D) in the Keystone telebinocular.

A= 1/TD - P	V= (P x LS) - TS/ TD
2.5 + 1/TD - 5	V= (5x 9.5) - (6.2) (7.5)
1/TD = 7.5	V = 47.5 - 46.5
	V=1D BO

The demand of the card changes from 16.5pd when the card is moved from infinity to the 2.5D setting.

There are many trade names of Brewster-type stereoscopes and stereograms:

Biopter and Bioptogram ™cards
Bernell-o-scope and Bernell bioptogram cards
Telebinocular (open and closed handles, pedestal mounts) and
Keystone stereogram card series (Keystone View):
AN series, adult eye comfort series, children's story sets,
base-out training units-alpha, delta, gamma, eta; and
base-in training units-beta, gamma, epsilon, zeta, and theta
Correct-eye-scope

Types of Brewster Stereoscopes

Purpose:

Tests many monocular and binocular sensory functions. Trains antisuppression, smooth vergence ranges (isometric) and facility (step vergence) with or without changes in accommodation (tromboning), stereopsis.

Advantages:

Dissociates accommodation and vergence in training; great for building BI ranges on esophores or esotropes; great for tromboning.

Disadvantages:

BO range limited by accommodation: pushing the card further away past simulated infinity makes the card blurry.

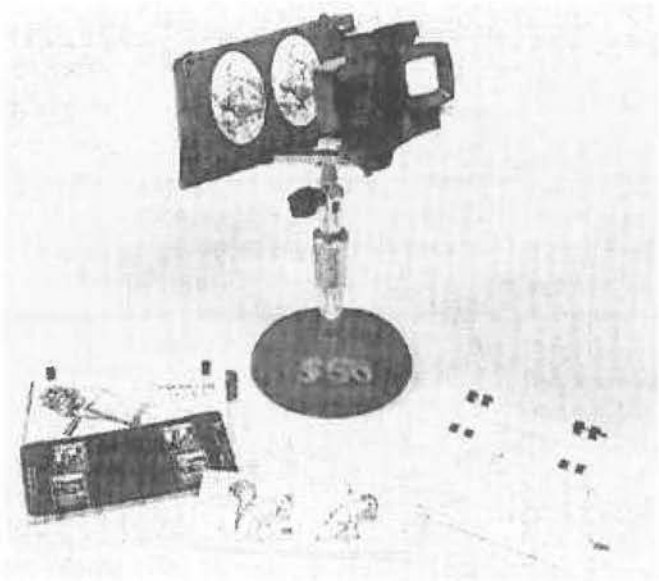


Fig 2-2 Brewster Stereoscope

Techniques with this instrument:

Tromboning the stereocard closer produces a paradoxical accommodation and vergence relationship, increase stimulus to accommodation and divergence: BIM BOP training.

- Note: Shaft calibrated for the accommodation stimulus.

Bernell-o-scope
LS = 90 mm.
Lens Power = +5 D

Fig 2-3 Bernell –o-scope

Also tests monocular VA's under binocular viewing conditions.

Numbers are third degree fusion.

Whichever set of pictures that has the R/L next to them is the set for ortho at the infinity shaft setting

Large pictures are second degree fusion.

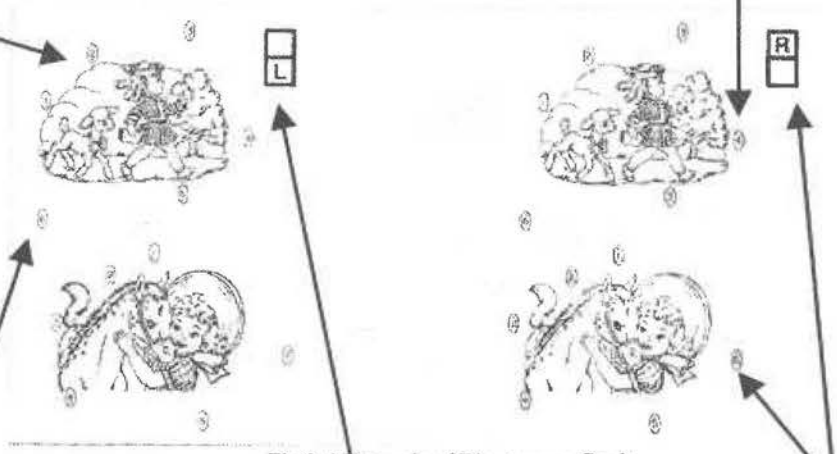


Fig 2-4 Example of Bioptogram Card:

Fixation disparity check is alignment of the dots inside the circles.

Suppression check is R/L in boxes and dots inside of the circles

Alignment of the R/L only related to the ortho position card.

Biopter

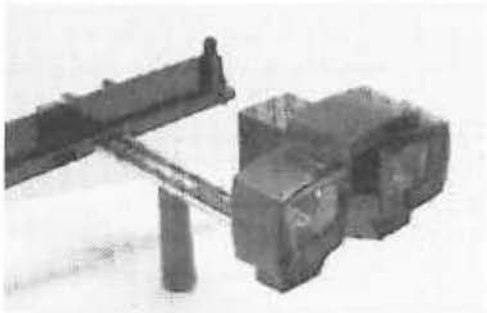


Fig 2-5 Biopter

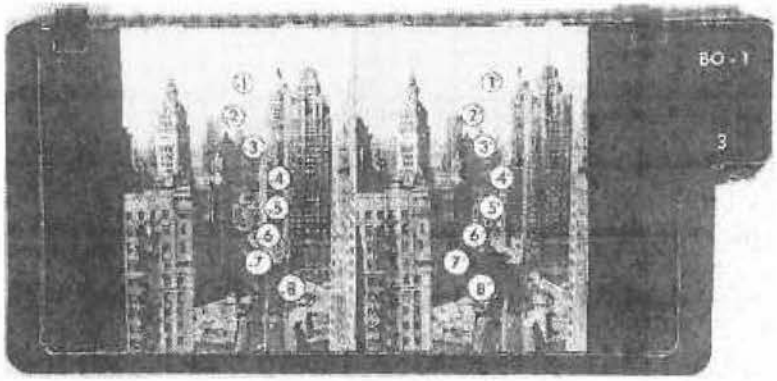


Fig 2-6 Bioptogram^{TM} Cards

Keystone Telebinocular

Optical center: = 95mm
Optical center of handheld = 85mm
Lens Power = +5 D

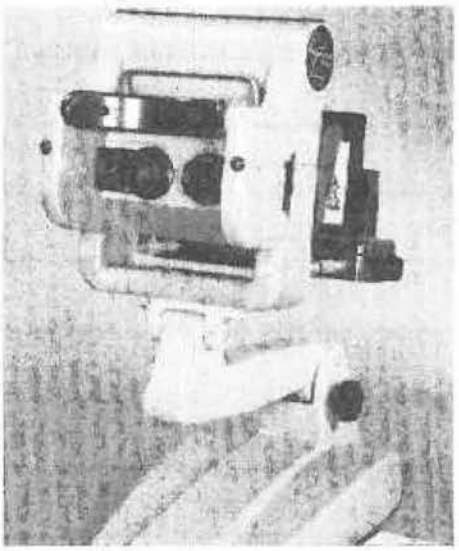


Fig 2-7 KeystoneTelebinocular Stereoscope

Keystone Cards Commonly Used Cards:
BU Series by Dr. Fredrick Brock
Purpose:

progression through binocular development

1-4	Luster targets
5-8	Normal retinal rivalry
9-15	Peripheral stereo with macular rivalry
16-38	Float is present, used to reduce phorias and establish fusional hold
9-20	Have peripheral stereo targets
21-34	Introduce linear stereo targets
35-38	Not designed for treatment, used to measure quality of stereopsis

AN Series by Ann Sutton Nichols
Purpose:

develop visual skills, including eye-hand coordination, fusional reserves, accommodation and stereopsis

Unit I 1-4
Version and suppression used for pointer training; stars have minimal fusion demand, 3 and 4 have stereopsis.

Unit II 5-10
Version and suppression, moderate BO

Unit III 11-18
Fusion amplitude, strong BO. Used with pointers. Alternate cards have BI and BO demand; odd numbers have intermediate, near range; even numbers have intermediate/far range.

Unit IV 19-32
Jump duction. Used for increasing stereoscopic projection; each pair has lower jump duction demands (2pd).

Unit V 33-46
Moderate/strong BI and BO jump ductions.

Unit VI 47-56
Farpoint stereopsis. Set card at infinity.

Unit VII 57-66
Intermediate point stereopsis

Unit VIII 67-76
Nearpoint stereopsis. Set card to 2.50

Unit IX 77-86
High BO and BI jump ductions (4-24pd)

Home Training Series (EC Cards)

designed for the hand-held telebinocular or correct-eye-scope (OC 85mm). Good for infinity, near or tromboning.

Includes:

Alpha for exophoria

Delta for high level exotropia
Gamma for children, exotropes
Eta for basic fusional skills
Beta for convergence excess
Gamma for esophoria in children, advanced esotropia training
Epsilon for fusion and stereo with esophores
Zeta. for mild esophoria
Theta supplements Beta Unit

Adult Eye Comfort Series

for home therapy to train CI and symptomatic presbyopes. Each card is 1pd more BO than the previous card. Designed for the hand-held stereoscope (OC 85mm). Top of card to bottom of card is difference of 4 pd BO.

Children's Stories

Two series of children's stories with 24 cards in each series (21pd BO-35pd BI)

BO Series:

Cinderella, The Three Billy Goats, Bobby's Christmas, and The Three Bears.

BI Series:

The Ugly Duckling, The First Thanksgiving, The Three Pigs, and Peter Rabbit.

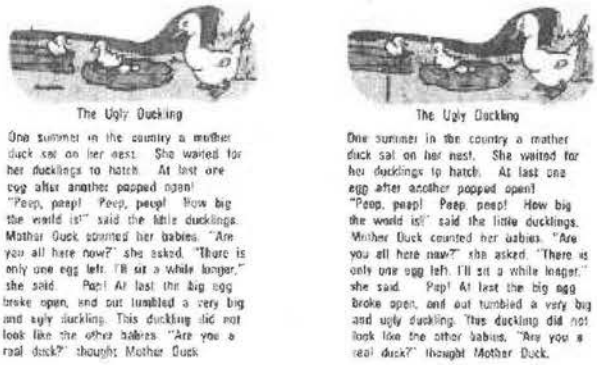


Fig 2-8 Children Stories Series

Other Types of Stereoscopes

Aperture-Rule Trainer

(Bernell)
by Vodnoy

Purpose:

Trains near vergence skill at a real 40 cm.

Advantages:

Dissociates accommodation and vergence to train relative fusional ranges.

Disadvantages:

Not good for training at optical infinity.

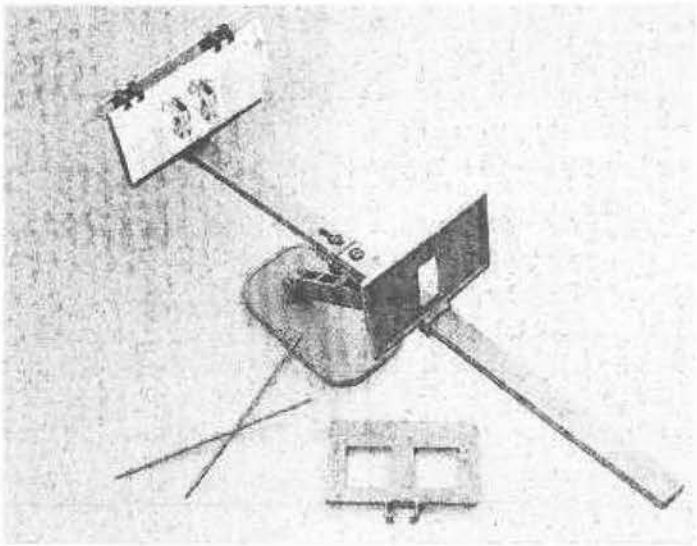
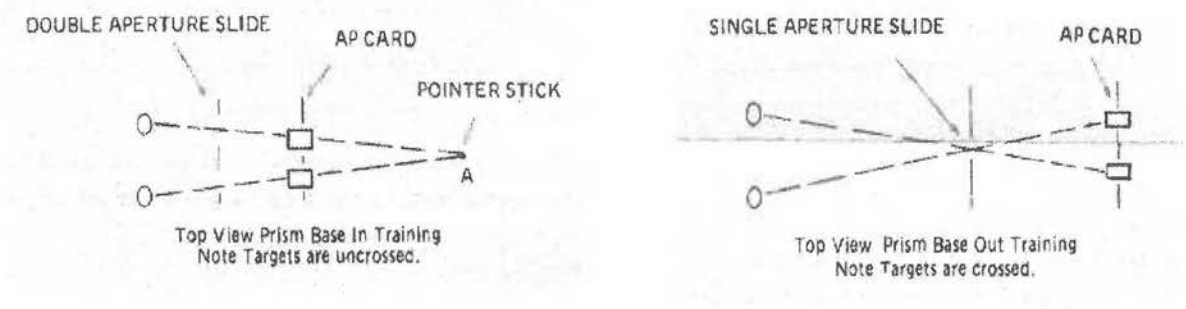


Fig 2-9 Aperature Rule

Optics:

No lenses. Aperture acts as dissociating septum. Single aperture makes visual axes cross in front of viewed target creating BO demand. Double aperture makes visual axes cross further behind the target, creating orthoptic or BI demand. Prismatic demand = card # x 2.5 pd



Double Aperature Rule

Single Aperature Rule

Fig 2-10 Optics of Aperture Rule

Use same stereocards for both BI and BO training. Goals: cards 1-12 for BO, and 1-7 for BI. Adjust aperature setting according to AP indicators on cards.

Each card increases in vergence by 2.5 pd.

Stereopsis check is pair of eccentric rings, inner floats backward with both single double apertures.

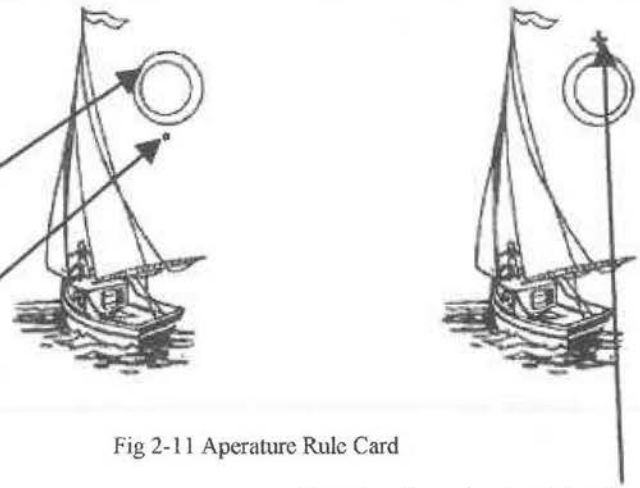


Fig 2-11 Aperature Rule Card

Suppression check is plus sign and dot.

Fixation disparity check is plus and dot alignment.

Box 2-1 Fixation Disparity Responses
Checking fixation disparity: with the **single aperture**, patient's right eye sees the left target. The left target is the "+". If patient reports the "+" to the left of the dot, the patient's nasal retina is projecting the target to the left. Patient is eso. If using the **double aperature**, an eso response will have the "+" reported to the right.

Single Oblique Mirrored Stereoscope (SOMS) a.k.a. Cheiroscope

Purpose:

to test superimposition (transfer), vertical and lateral phorias, stability of binocular posture, quality of binocular vision with manual system involvement; to train suppression, fusional ranges at near

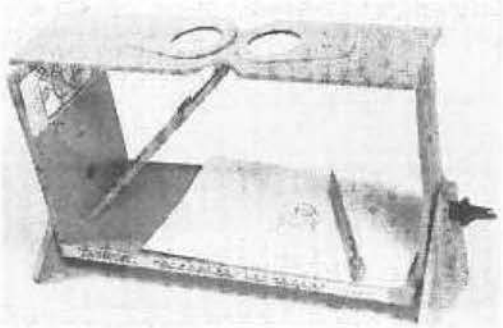


Fig 2-12 SOMS

Advantages:

Cheiroscopic drawing and other games hold children's interest; clear bottom available to train distant vergences for DI.

Clinical Pearl:

Methods used to train suppression: A picture viewed by one eye is projected cortically onto the SOMS table and only seen by the fellow eye. The target is traced or filled-in. Suppression control is tip of pencil.

Optics:

Two fields separated by oblique mirror. In order for targets to be fusable they must be mirror images. Viewing distance is16 cm to table so 1 pd =1.6mm. Increase BI demand by moving target on the table to the right (as viewed below). Increase BO demand by moving target to the left.

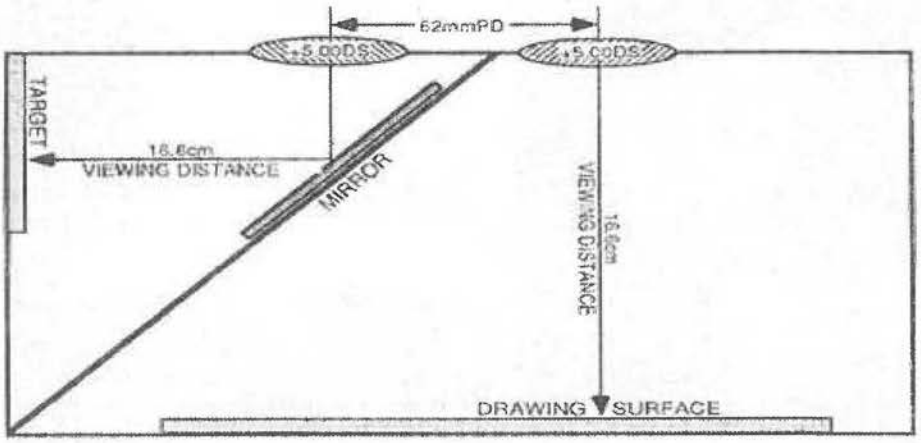
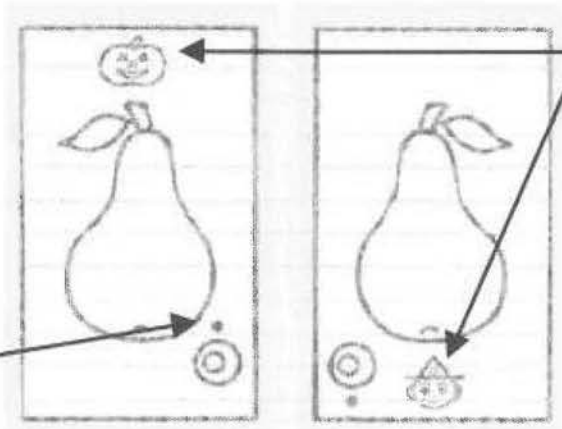


Fig 2-13 SOMS Schematic



Suppression control on each card.

If patient is eso and the left eye sees the top dot, top dot is projected from the nasal retina to the left.

Fig 2-14 Example of SOMS Card

Double Mirrored Stereoscope (Wheatstone)

a.k.a. Flying W

Fig 2-15 Wheatstone

Purpose:

Used at home for basic vergence training.

Advantages:

BI training, beginning at strabismic angle. Easily changed to a chieroscope for anti-suppression work if NRC exists..

Optics:

Fixation distance to targets is 33cm. Optical infinity can be created by using +3.00D lenses, important for DI and Basic Eso. Can be adapted as a chieroscope. Ranges are 40 pd BI to 50 pd BO. Scale is calibrated at bottom of instrument. Total demand given by adding both settings. Increasing the arms width increases BI demand

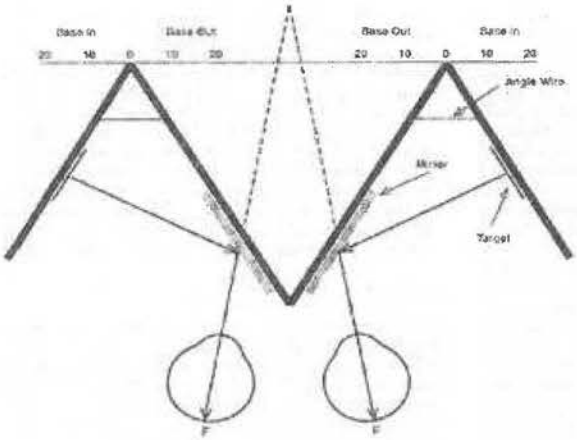


Fig 2-16 Wheatstone Schematics

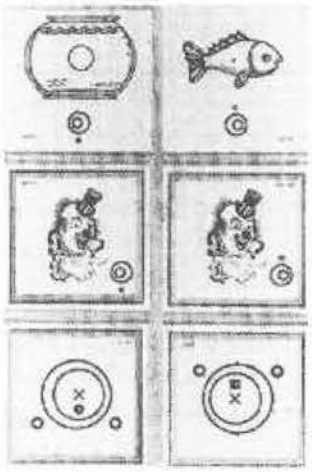


Fig 2-17 Wheatstone Targets

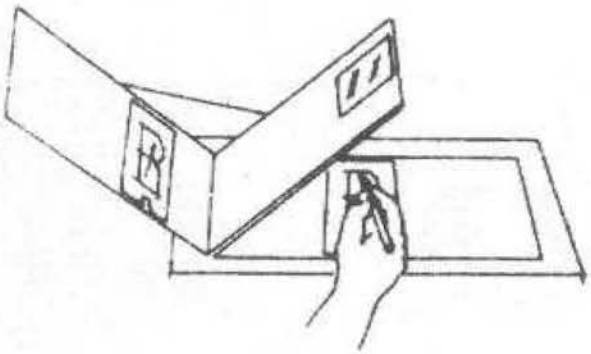


Fig 2-18 Cheiroscopic tracing using the Wheatstone stereoscope

Keystone Home Trainer

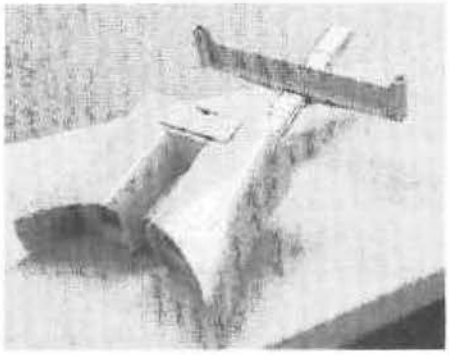


Fig 2-19 Keystone Home Trainer

Keystone View

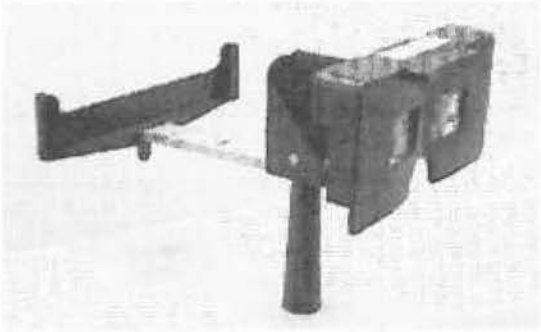


Fig 2-20 Keystone View

Sample Problems

Training at Optical Infinity

1. Willy has a PD of 50mm. Using a Bernelloscope, what should the target separation be to produce zero vergence demand at infinity (ortho)?

   90mm separation. Willy's PD is irrelevant.

2. How much should you move the target to get a 1pd vergence change?

   2mm (Bernelloscope has +5 lenses=20cm working distance.
   1pd=1/100th of 20cm = 2mm)

3. For 10pd of change?

   20mm

4. What target separation simulates 10BO demand?

   90mmTS(ortho) - 20mm (10pd of change) = 70mm target separation.

5. What TS for 10BI demand?

   90mm+20mm=110mm TS.

Training at Near.
Setting Near Accommodation and Vergence Demands.

1. Using a Bernelloscope, set up a 2.5 accommodation demand.

   xD + +5D(scope lens) = -2.5D (wanted)
   x = -7.5vergence
   1/7.5 = 13.3cm distance on the scope shaft will simulate 2.5 accommodation demand in real space.

2. What TS will create ortho (zero vergence) at the 2.5D accommodation demand?

   $$\frac{20\text{cm}}{90\text{mm}} = \frac{13.3\text{cm}}{x}$$

   x=60mm

3. What amount of separation would create a 1pd change at the 2.5D accommodation demand distance?

   1pd change = 1.33mm at a 13.3 cm shaft distance.

What You Need to Know About Stereoscopes

Three basic steps to stereoscope problems:

1. Define ortho (no vergence) simulating infinity for a given scope.

shaft setting = 1/power of the lenses
TS = same as optical center for scope

2. Then find ortho at any given new distance.

accomm demand = 1/new distance
to negate accommodation, find the new shaft setting:

$$\frac{1}{\text{new shaft setting}} - \text{lens power} = \text{accomm demand}$$

to negate vergence find new TS

$$\frac{\text{new shaft setting distance}}{\text{ortho TS at the new distance}} = \frac{\text{ortho shaft dx at infinity}}{\text{ortho TS at infinity}}$$

3. Figure a 1 pd change at that distance given by the accommodation demand.
1 pd = 1/100th of distance to target
= new shaft setting/100

Tromboning the slide forward, with a fixed TS, increases divergence demand and increases accommodation.

Vergence is dependent on the distance of the card from the eyes and the TS. This is why only accommodation is labeled on the shaft. To train strictly vergence, you must keep accomm steady (no change in shaft) and change only TS.

Relative BO demands will require decreased target separations; relative BI demands will require increased TS.

Target separation of ortho (zero vergence) demand get progressively smaller at closer shaft distances.

Adding plus lenses at near, relaxes accommodation, decreases accommodative vergence, increasing BI ranges.

Adding plus lenses at far, relaxes accommodation, increases convergence response, decreasing BI ranges.

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Sensory Fusion

Sensory Fusion

Key Terms

Sensory fusion AKA unification, binocular integration, stereo vision, stereo fusion (however, sensory fusion does not imply motor fusion.) There is a distinction between peripheral and central sensory fusion. For sensory fusion to occur, *a single target must stimulate homogenous points which occupies equal spatial position.*

> **Stereo fusion** is the crown jewel of sensory fusion. Stereopsis refers to the measurement of stereo fusion; a threshold stereo acuity.
>
> **Stereo localization** is how accurate the location is on the z axis.
>
> **Stereo mobilization** is the speed of the stereo response.

Theory of Summation: Visual unity is an additive process between the right and the left cortical images.

Theory of Localization: One image is really a projection of two identical images to the same position in space.

Correspondence: is a map for space including up, down, left, right and depth and code fusional movements. There are no retinal directional cells. Spatial values are learned.

Lateral Disparity: acts as a cue for binocular depth judgements. Vertical disparity gives no depth cues.

Single Binocular Vision: Morgan 1960 says we must have a good monocular motor system, simultaneous binocular vision, coordinated EOM, and a corresponding sensory system to give us sensory fusion.

First Degree Fusion

Definitions

first-degree fusion

a.k.a. simultaneous perception, Worth fusion level, requires non-fusable targets with no contours or with non similar contours seen with both eyes at the same time; first degree targets used to test and train vertical and lateral phorias, and suppression

contour rivalry

two different contours in the same visual space. Contours must be set at person's phoric posture or be a large target so that no matter where the eye points, there is a target.

Tests of First Degree Fusion

BU #1

Purpose:

Testing measures quality of luster, phorias, quality of macular transfer at infinity.

Indications:

Minimal fusion response suspected. No contour, no acuity demand (except dot)

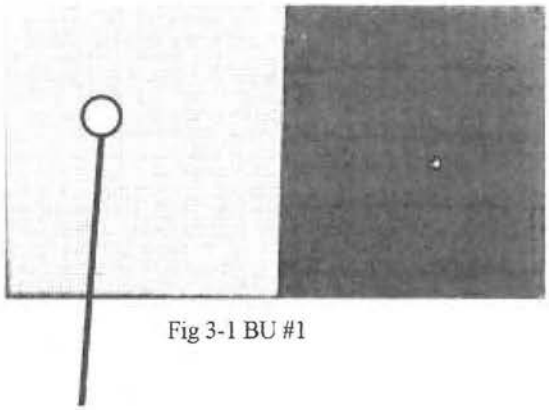


Fig 3-1 BU #1

Disadvantages:

Proximal convergence in scope.

Procedure:

Side with dot is placed opposite the hand holding the Russel ring. Targets are colors/loop and dot.

Interpretation:

- Fusion response is colored dot.
- Placement of the ring corresponds to where the fovea of the eye of the same side of ring is pointing.
- Ortho posture response is ring at the center of the card.

  Placing ring left and above of the center of card: patient is exophoric and hyperphoric (as seen above).

  Placing ring at the center of the card: patient is ortho.

  Placing ring to the right of center is eso.

  Color of field inside and outside of ring indicates amount and type of suppression.

Dog and Pig

Purpose:

tests lateral phoria.

Indications:

part of Keystone series.

Disadvantages:

proximal convergence in scope.

- Note: Different contours, not able to overlap dog and pig because of vertical separation.

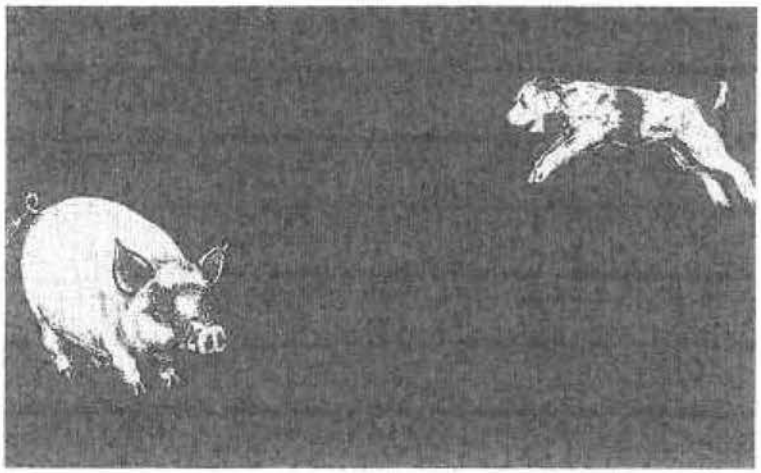


Fig 3-2 Dog and Pig

Cheiroscopic Tracings

Purpose:
Tests first degree fusion (or suppression), lateral and vertical phorias, stability of binocular posture, quality of binocular vision when manual system is involved at infinity.

Advantages:
more real life test of fusion.

Procedure:
Cheirogram is placed on side opposite the dominant hand. Patient draws with dominant hand. Then have patient trace again with non-dominant hand.

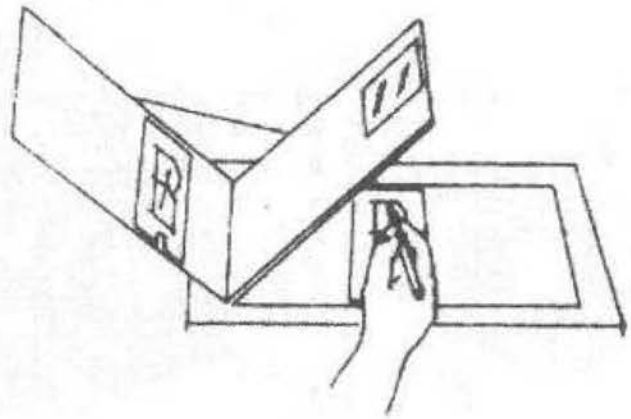


Fig 3-3 Cheiroscopic Tracing

Interpretation: (based on telebinocular at optical infinity, not a cheiroscope)

- Binocular posture is represented by the separation between a point on the cheirogram and that point on the tracing. 2mm = 1 pd.
- Ortho posture = 68 (+/-2mm).
- Eso posture separation of images drawn less than 68mm (+/-2mm)
- Exo posture separation more than 68(+/-2mm).
- Suppression chierogram not seen; no transfer of image, no first degree fusion. Eye suppressing is on the same side as cheirogram. Not seeing the pencil is suppression of the eye on the opposite side of the chierogram.
- Stability of binocular posture represented by reported or actual lateral shifts in tracing. With right hand, a shift to the right = exo posture. With left hand, a shift to the right = eso posture.
- Quality of first degree fusion represented by constant perception of pencil tip.

Van Orden Star

Purpose:

measures posture and stability of binocularity with bilateral manual involvement, quality of binocular vision/first degree fusion with bimanual involvement (suppression or not) measured at infinity.

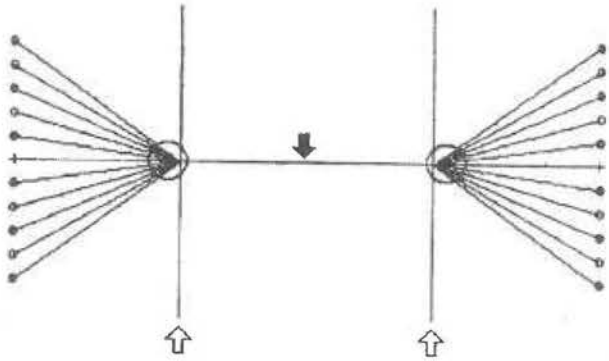


Fig 3-4 Van Orden Star

Procedure:

Patient must be able to identify middle of the paper before test can continue. One pencil in each hand. Patient looks at center and draws simultaneously from each diagonally opposite point until pencils meet in perceived center.

Interpretation:

- 2mm = 1 pd
- Ortho posture = 68mm(+/-2).
- Exo> 68mm(+/-2)or outside lines AA.
- Hyper projection Apex higher than the other represents (above line BB) of eye on that same side.

Box 3-1 First-Degree Fusion Levels According to Worth

→BU #1 (color targets only)
→Color + contour
→Contour + contour
→Contour with rivalry

Sample Problem

Example of measuring lateral and vertical phoria with first degree fusion

1. The optical centers of a +5 lens stereoscope are 85mm. 5 dots are aligned vertically in front of left eye. The patient with a marker in right hand, places dots where dots appear to be. Assume the patient is using fovea of left eye to see dot. The patient marks dot at 65mm in the right field. What is the patient's phoria if measured at the infinity shaft setting?

85mm (ortho) -65mm = 20mm
If 2mm = 1pd, then 20mm = 10pd Exo

Box 3-2 What ocular conditions can cause difficulty with sensory fusion?

anisekonia
anisometropia
muscle palsies
cataracts
strabismus

Second Degree Fusion

Definitions

Second-degree fusion

requires fusable targets/within the range of motor ability, similar contours and same lateral separation

Tests of Second Degree Fusion

Keystone 4-ball fusion card

Interpretation:

- 4 balls-not fusing
- 3 balls-fused
- 2 balls-suppression
- 3 balls with top to the right-eso

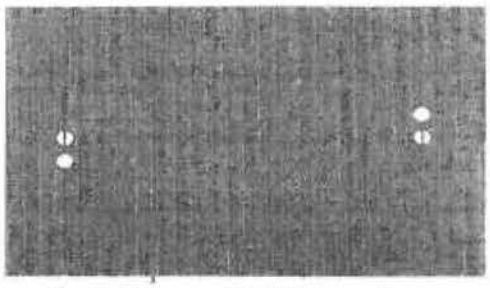


Fig 3-5 Keystone 4 ball fusion card

AN #1 Card

Purpose:

measures second degree fusion, fixation disparity, quality of binocular vision when manual system involved.

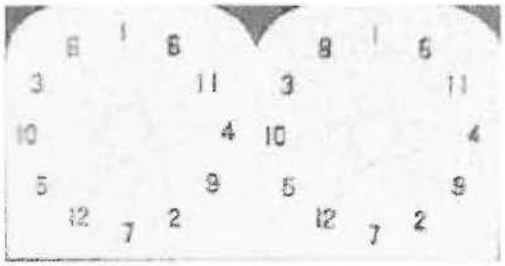


Fig 3-6 AN #1 Card

AN #2 card

Purpose:

measures fixation disparity and at least second degree fusion because of similar targets.

Procedure:

two pick up sticks, one for each hand are used to point to numbers around the star.

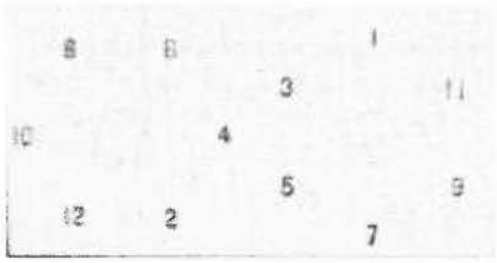


Fig 3-7 AN #2 Card

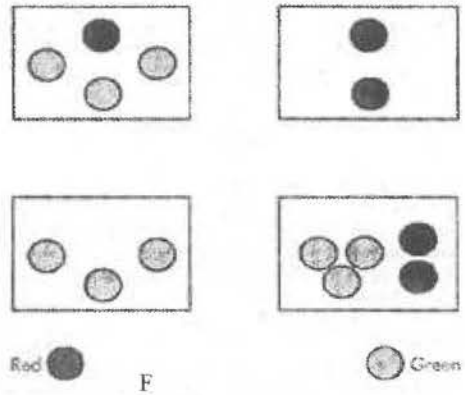
Interpretation:

- Every common point has same separation (definition of flat fusion target) of 78mm.Odd numbers only seen by one eye, even numbers by the other.
- Suppression: numbers missing
- Fixation disparity determined by position of the sticks relative to star point.
- Stick pointed nasal and superior to the star tip represents eso fixation disparity and hyper (of eye corresponding to that stick) fixation disparity.
- The appearance of the tips (macular) or shaft (paramacular) of the sticks determines quality of binocular vision.

Worth Dot

Interpretation:

- Red eye sees illuminated red dots
- 2 dots: green eye suppressing
- 3 dots: red eye suppressing
- 4 dots: normal
- 5 dots: diplopic



F

Fig 3-8 Worth Dot

Third Degree Fusion

Definitions

third-degree fusion
a.k.a. stereoscopic fusion, binocular depth perception, requires binocular vision to perceive float, or ability to interpret monocular cues such as parallax, texture, overlap, shadowing, and velocity, which also give depth perception.

stereothreshold
the minimum distance you can tell it's at a different position. Vertical disparity does not cause depth awareness.

reduced volume of field
converging and diverging equal amounts without the perception of equal amounts of float. Can be helped by replacing opaque backgrounds with clear backgrounds for uncrossed targets.

contracted volume of field
float perceived less than the mathematical expected.

global stereopsis
requires higher perception, believed to be learned/developed. Rare to train a strab to perceive unless had experience prior to strabismus. Ex: Butterfly, magic eye

local stereopsis
simple contour, single item. Can train strab to achieve. Ex: Wirt circles.

spatial summation
more looks lead to increased depth perception

temporal summation
longer looks lead to increase in depth perception

SILO
Float follows the rules of **SILO**. With BO/crossed targets, as you increase BO demand, target appears to get **smaller**, move **in** and shows **with** motion (paradoxical parallax). For BI/uncrossed targets, as you increase BI demand, target appears to get **larger**, move **out** and shows **against** motion

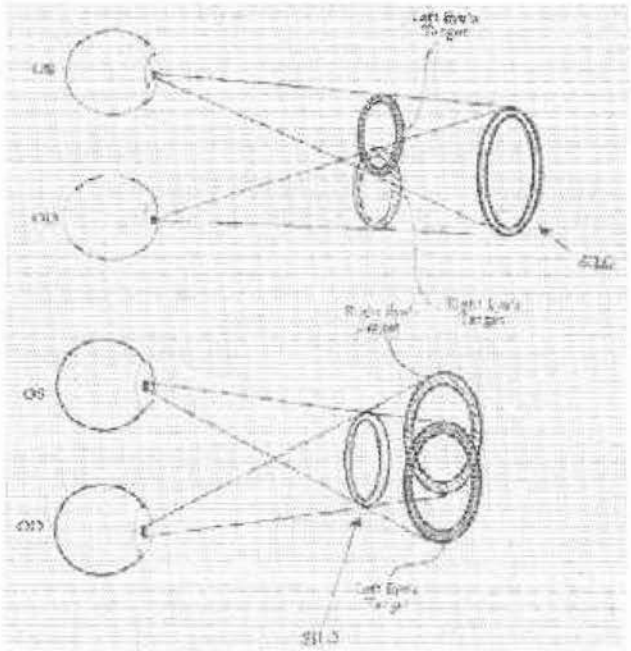


Fig 3-9 SILO

BOX 3-3

Study of size cues, speed cues and change in disparity cues (binocular cues)

Three scenarios:

- airplane to: Target: a big runway from far away distance. Given 1 sec to look judge depth

  Change in size is 67x more effective in judging depth than disparity.

- cricketball: 2 1/2 inches distance of 50 feet, velocity 90mi/h . Given .25 second to look

  Change in disparity is 2.4x more effective than size.

- fly: .2cm target, velocity 5cm/sec at 50cm distance.

  Change in disparity is 72x more effective than size cells.

Summary: Given three factors: dx, size and speed, change in disparity is most useful for small, fast, close objects.

Tests of Third Degree Fusion

Vectographic Tests of Stereoacuity

Contoured

Stereofly
Purpose:
nearpoint testing, measures local stereopsis

Procedure:
Use glasses to detect presence of float. Turn the fly upside down and left eye sees left target (uncrossed) and the fly is seen as floating behind the plane.

Interpretation:
- + or – float
- **Fly** 2000 arc seconds
- **Animals** 400, 200 and 100" Good for 2-3 years
- **4-ball Wirt** 800" to 40"

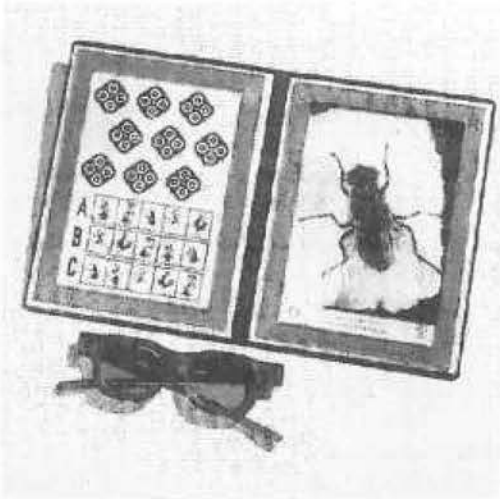


Fig 3-10 Stereofly

Stereo Reindeer
Purpose:
near test

Advantages:
comes with contour circles on opposite page which is better than 4-ball because you only have a 1/6 chance of getting it right.

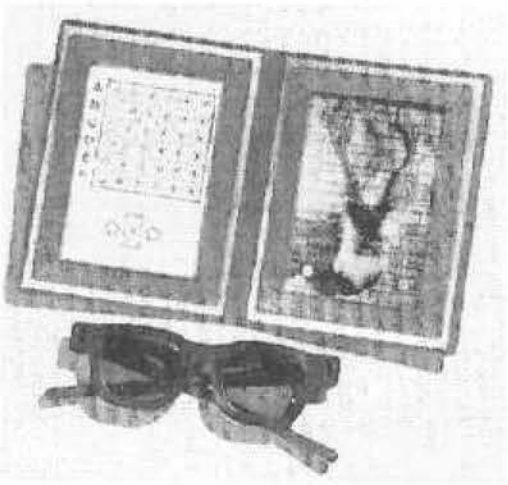


Fig 3-11 Stereo Reindeer

AO Vectographic Slide
Purpose: farpoint testing

See Antisuppression section for details.

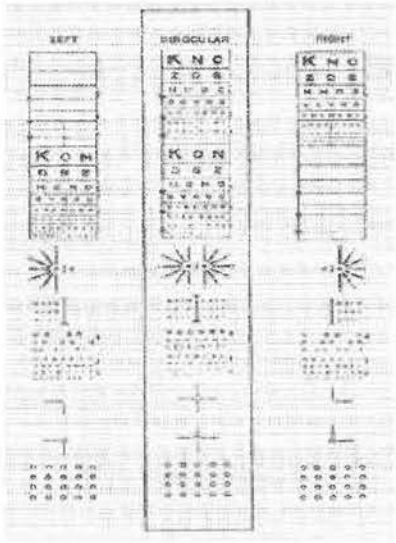


Figure 3-12 AO Vectographic Slide

Non Contoured/Global

Randot Stereo Test
Purpose:

nearpoint testing, measures both global and local stereopsis

Procedure:

targets generated with computer.

Interpretation: Test includes:

- randot forms gross test: 600" at 16 inches.
- randot forms graded (animals): 400", 200" and 100" at 16 inches.
- randot circles: 8 grades from 400" to 20" at 16 inches.
- Circles and animals are not random dot stereograms

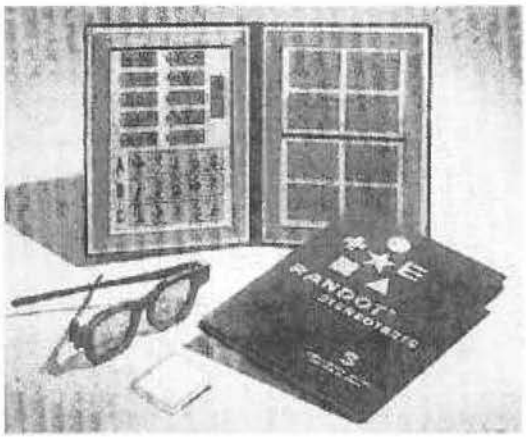


Fig 3-13 Randot Stereo Test

Random Dot E Stereo Test
Purpose:

near and far testing, measures global stereopsis

Procedure:

comes with blank control card. Single element display crossed and uncrossed E. Can test at any distance, a chart is provided to help you figure demands. Test threshold by backing up. **Need 3 trials at each distance**. Test OK for 4 year old. Need to know E laterality.

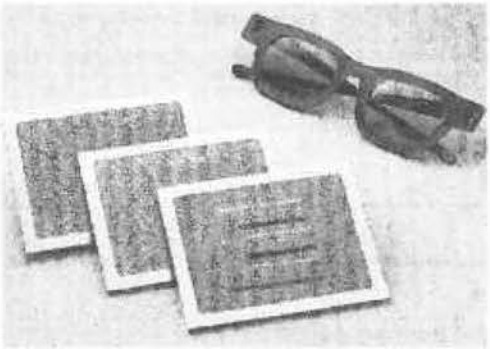


Fig 3-14 Random Dot E Stereo Test

Disadvantages:

for myopes because VA decreases with distance.

Advantage:

a performance test: gives good information about Rx.

Stereo Butterfly

Purpose:

near testing, measures local and global stereopsis

Interpretation:

- global stereopsis with 3 levels of float:
- upper wing 2000",
- bottom wings 1150"
- tip of abdomen 700".
- animals and circles similar to Stereo Fly

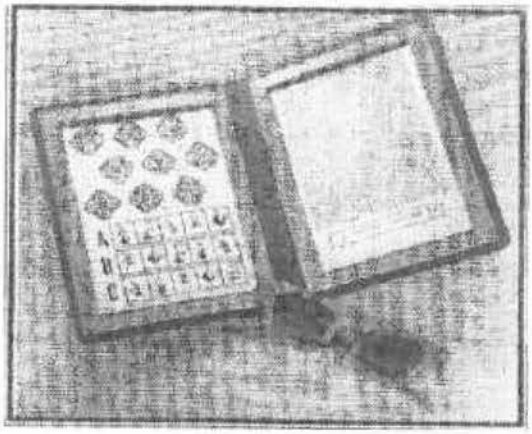


Fig 3-15 Stereo Butterfly

Non Vectographic Tests of Stereoacuity

Frisby Stereo Test
Purpose:
nearpoint test based on Random Dot design. Real space, no glasses needed.
Interpretation:
- measures 20-880"

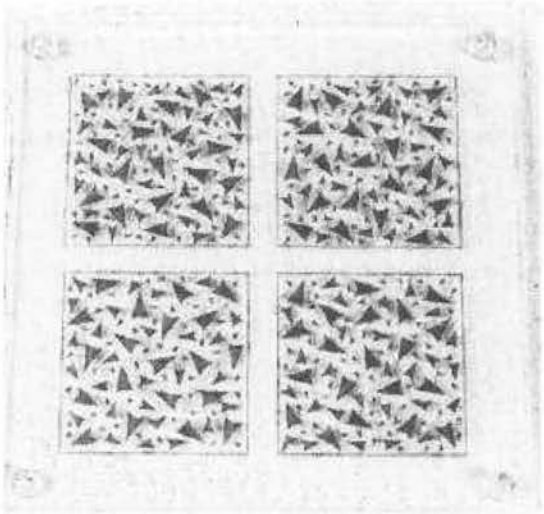


Fig 3-16 Frisby Stereo Test

Lang
Purpose:
nearpoint test

Advantage:
A randot stereogram/global. **Highest fail rate for small angle strabs.** Easy to use with kids and does not need glasses.

Disadvantage:
Patient must be directly centered with no target movement.

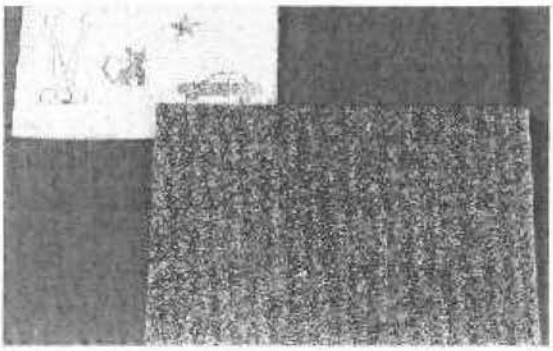


Fig 3-17 Lang Stereo Test

Optics: multiple cylindrical prism overlay separates eyes at set angle.

Synthetic Optics Viewer-Free Stereo Test
Purpose:
nearpoint test copied Wirt circles, animals and butterfly with similar prism overlay as above. Measures global and local stereopsis.

Disadvantage:
Patient must be directly centered with no target movement. The cylindrical prisms cause an "in" then "out" effect as the stereo target is moved right or left of straight ahead alignment.

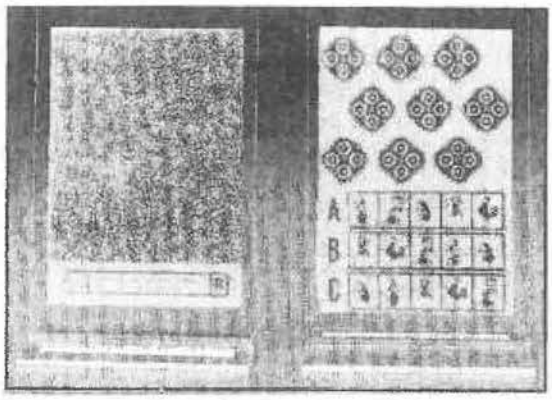


Fig 3-18 Synthetic Optics Viewer-Free Random Dot Test

Keystone Aviator Series
Purpose:
farpoint testing in stereoscope

Advantage:
test measures different stereoacuities at different visual acuities. **Monocular cues confusing**. Bigger and darker letters are perceived as closer.
Measures to 10 arcseconds. Each card measures one level of stereopsis.

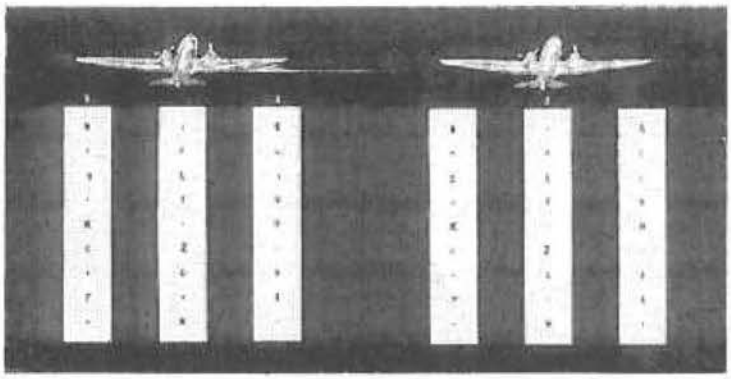


Fig 3-19 Keystone Aviator Series

Procedure:
20 cards. Test every other card until you get a miss, then test one card above and below. Two thirds correct needed on each card.

BVAT
Purpose:
farpoint test

Procedure:
time shuttered glasses

Advantage:
tests crossed disparity at a distance
alignment is not critical

Disadvantage:
Expensive
can cause seizures

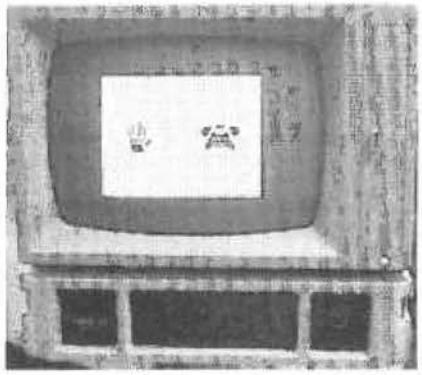


Fig 3-20 BVAT

Multi-stereo Test
Purpose:
farpoint stereo test.

Interpretation:
each line has different disparity Down to 11'.

Howard-Dolman
Purpose:
farpoint testing.

Advantage:
stereoacuity in real space.

Procedure:
patient moves rod by way of strings until it appears in the same plane as a fixed rod.

Sample Problems

1. Given amount of convergence, figure total prism diopter for patient's pd and convert to meter angle. Target separation is 12mm, tested at 40cm distance. Patient's pd is 60cm. Where is the float?

   At 40cm, 4mm = 1pd, so 12mm =3pd
   xMA x pd demand = 6cm (patient's pd)
   MA = 3/6
   MA = .5

   2.5 MA (at 40 cm) + .5MA = 3.0MA
   1/3MA = 33 cm from eye or 7 cm from plane

2. Target separation for the right eye and left eye wings are 7mm. Testing distance is 40 cm. Patient's pd is 60cm.. Where should the float be perceived?

   $$\frac{400mm-x}{60} = \frac{x}{7}$$

   x = 42mm = 4.2cm = 1 1/2 inches from the plane

3. If at 50cm, you measure 504", what is the disparity at 200cm?

   Use linear stereoacuity. Answer: 126"

   $$\frac{200}{50} = 4 \qquad \frac{504}{4} = 126"$$

Antisuppression

Two of the most common causes of suppression in non-strabismics are:

1. anisometropia
2. anisekonia (5% of anisekonics suppress)

Reasons for suppression include:

to relieve double vision (#1 reason)
to relieve inequality in images
to eliminate difficulty fusing

Suppression does not necessarily imply misalignment.

Suppression is non-pathological. It happens only under binocular conditions.

Describing Suppression

Zone/Degree of field	foveal (<1°) central (>1° but <5°) peripheral total/partial
Distance	
Field of view involved	
Frequency (Example: 3/4 times at near, permanent/temporary)	
Intensity shallow or deep. Related to naturalness of environment. Shallow to deep tests:	

Physiological Diplopia, Penlight, pola-mirror, Vis a Vis, Vecto, Bar Reader, Brewster, Wheatstone, Red Lens Test, Worth Dot

Other Terms Used to Describe Suppression

•gross	20-30° of field suppressed-total field
•absolute	all distances
•non-absolute	certain distances
•complete	all distances
•non-complete	certain distances
•total	whole eye
•partial	part of the eye

70-Year History of Binocular Refraction

Turville

use of septum to separate OD and OS images.

Humphress Infinity Balance

could suspend central vision by using plus to blur out. Adds +0.75 over one eye to allow peripheral fusion. Not monocular acuity under binocular conditions.

Grolman

AO Vectographic Slide

gives a binocular refraction. Both eyes are open during most of the exam.
Advantages include:

1. cyclophoria eliminated giving more control over cylinder axis
2. accommodative control under associated conditions to give more accurate sphere
3. constant pupil size
4. confirm malingering
5. controls convergence
6. better spherical balance

Disadvantages:

1. alignment can prove difficult

AO Vectographic Slide

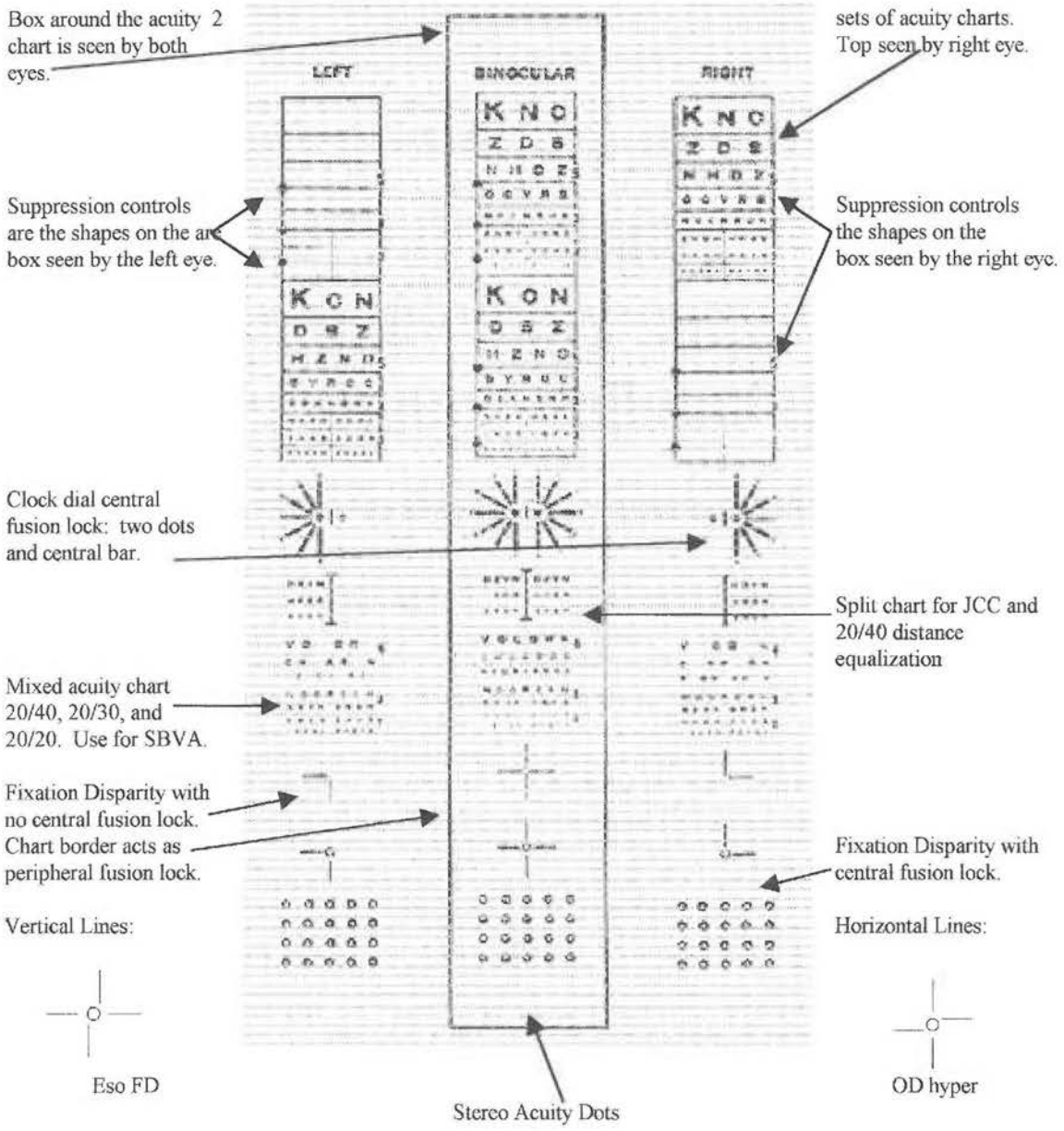


Fig3-21 AO Vectographic Slide

If patient breaks fusion and overlaps charts, compensate by adding vertical prism and increasing room lighting.

Polarized glasses give better alignment than the phoropter's polarized lenses.

Antisuppression Testing

Worth Dot

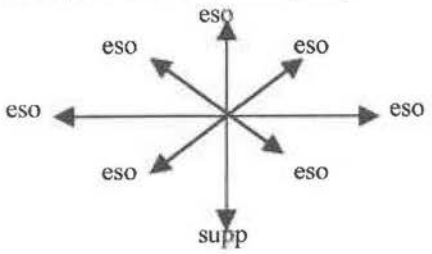
Purpose:

tests fusion at 6any distance.

Recording:

Done in all fields of gaze. Record speed of response and phoric posture or suppression behavior:

Example: Red Lens at far (20ft)



Interpretation:

- 2 red dots — green filtered eye suppressing
- 3 green dots — red filtered eye suppressing
- 4 dots — second degree fusion
- switching between 2 and 3 lights — alternate suppresser
- 5 dots — diplopia, no suppression

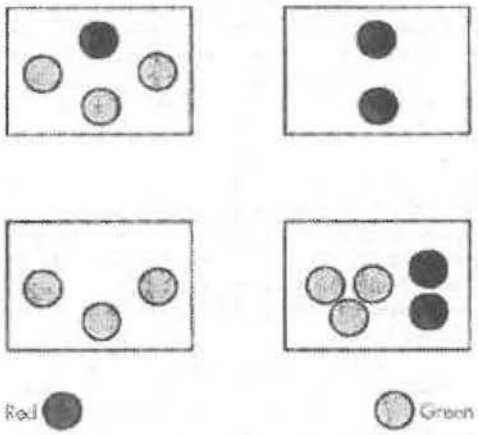


Fig 3-22 Worth Dot Test

Red Lens Test

Purpose:

Patient views a fixation light with a red lens in front of fixating eye.

Recording:

distance, field of gaze, phoric posture if not fused.

Interpretation

- two lights — diplopic, no suppression
- one red light — suppression
- one white light — suppression
- one pink light — fusion, no suppression

  - Note: Depth of suppression is assessed by adding other red lenses to fixating eye until diplopia elicited. The more filters needed to elicit diplopia, the deeper the suppression.

Brock String

Purpose:

trains physiological diplopia, smooth and jump vergences, pursuits, and suppression with red/green glasses and red/green beads on white string.

Fig 3-23 Brock String in use

Interpretation:

- patient sees single bead with double string crossing at bead: normal
- focused bead single, other two beads double: physiological diplopia. normal
- only one string or portion missing: pathological suppression
- string crossing in front of bead: over convergence
- string crossing behind bead: under convergence

Fig 3-24 Normal response

Fig 3-25 Eso response

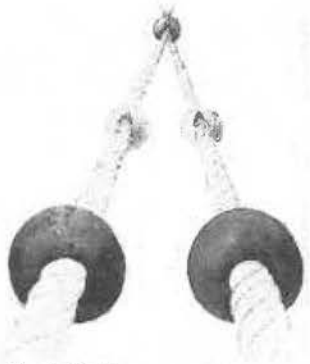


Fig 3-26 Exo response

- Note: minus lenses make string cross in front; if using R/G glasses, put green lens over suppressing eye. The red lens blocks out more light and could cause suppression easier. String appears crossed with the red string coming from the green eye. Record the effect of +/- lenses.

Pola Mirror Test

Purpose:

suppression test. Patient looks at self while wearing polarized lenses. The patient's right eye will see itself projected directly in the mirror. If the patient sees both eyes, they are not suppressing.

Advantage:

great for kids.

Vis-a-Vis

Purpose:

suppression test. Partners wearing polarized lenses and view each other. Use the wink game. Polarized lenses are set at 45° and 135°. The right eye of one person sees the left eye of the other. Ask patient *Which eye am I winking?*

Bar Reader

May be R/G or polarized. An overlay for reading material.

Purpose:

antisuppression

Advantage:

patient able to use own reading material

- Notes: large and small sizes; minus makes the green bar easier; small polaroid bars do not polarize reading material when strip of polaroid is against the page.

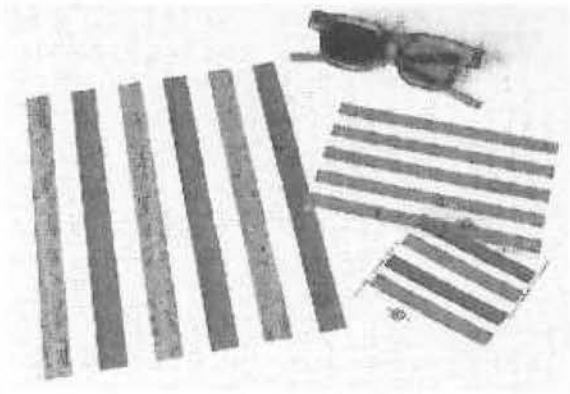


Fig 3-27 Filtered Bar Readers

AO Vectograph
see diagram

Mallot Box

Borish Nearpoint Card

Vectograms

Tranaglyphs

Physiological Diplopia

(Also Van Order Star, AN Star, Dog and Pig, 4-ball fusion, major amblyoscope targets, color luster, anything that presents two different targets to the eyes separately with septum)

Antisuppression Training

Induced Diplopia

with prism
physiological diplopia with Brock string or just using two objects at near and far distances
free fusion thumbs
with handheld mirror as a septum while superimposing objects or being aware of objects in front of left and right eyes

Illumination

Neutral density filter in front of good eye
increase light on suppressing eye's target

Translid Binocular Interaction Trainer (TBI)

Purpose:

breaking suppression, using alternately flashing light

Disadvantage:

may cause seizures and may not be used with epileptic patients.

Techniques with this instrument:

alternately flashing light bulbs placed directly on closed eyelids or in front of open eyes. Can be clipped to separated fusion targets.

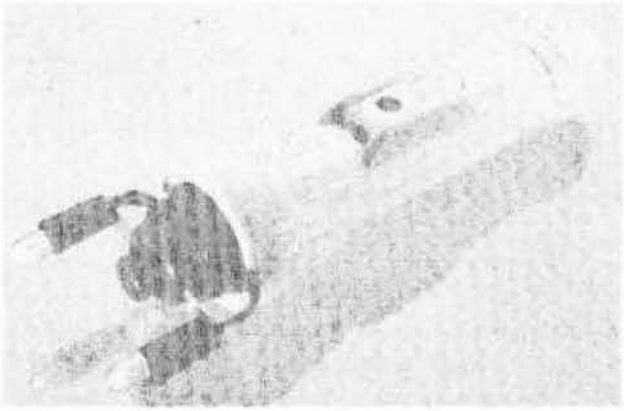


Fig 3-28 Translid Binocular Interaction Trainer

- Note: The Bartley phenomena technique uses 6-10 cycles/second flashing unilaterally or binocularly.

Occlusion

Patching direct technique penalizes the good eye and forces suppressing eye to stay on.
Indirect technique patches the suppressing eye and allows the patient the chance to find normal correspondence.
Fogging good eye.

Movement

intermittent stimulation by finger flash in front of suppressing eye
wiggling mirror in amblyoscope
tactile rubbing target
vibrating pen, tracing in cheiroscope
fusion aider

Split Fields

TV Trainer
Purpose:
antisuppression training

Advantage:
excellent compliance, R/G or polarized

Disadvantage:
not for deep suppression or constant strabs

Vectograms

Tranaglyphs

Bar readers

Sherman Cards
Purpose:
antisuppression

- Note: Green lens sees red numbers and symbols. Red lens sees black letters and symbols.

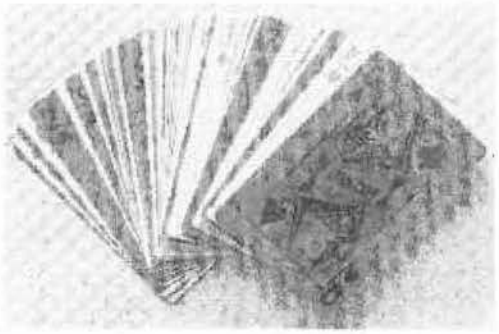


Fig 3-29 Sherman Playing Cards

Naturalness of environment

From in instrument to free space:
Amblyoscope - Brewster - Aperture Rule - Vectographs - Tranaglyphs - Brock String

Other Antisuppression Training Tips

Make sure RE is corrected.

Address pathology concerns that could be creating unequal images.

Start with big targets.

Peripheral targets before central.

More detail is easier. (Not to Kohl)

More interesting.

Vectograms before tranaglyphs.

Multiple looks to few looks.

Longer looks to short looks.

Stationary to moving targets.

Work "unreal" space to real.

Start dissociated to fused.

Use real colors to unnatural colors.

Start penalizing good eye with plus or filters and work towards equally balanced.

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Laxer M, Cohen J, Press LJ. An expanded guide to the keystone stereogram cards. J Behav Opt. 1991;2, no 3:59-66.

McMahon A, The Van Orden Star. College of Optometry Pacific University Thesis: May 1993.

Visual Science Dictionary

Motor Fusion

Motor Fusion

Convergence Training Variables

1. Tonic vs. phasic

Easier ↓ Harder

Slow change in disparity in BO direction (note break and recovery)
Slow change in disparity in BI direction (note break and recovery)
Jump vergence vectograms between high/low BO
Jump vergence vectograms between high/low BI
Random jump vergence vectograms
Jump vergence through cover/uncover and look-aways

2. In instrument vs. out of instrument

3. Target size big vs. small
   Quoits to Clown to Mother Goose to Spirangle to Chicago to Skyline

4. Distance dependent

5. Smooth vs. jumps

6. Static vs. dynamic targets

7. Gross motor action body to head to eyes

8. BIM-BOP Training
   BIM/BOP with vectograms or tranaglyphs
   Disparate to limits of BI while looking through -1.00
   Disparate to limits of BO while looking though +1.00
   Disparate to letter C (BI) while looking through -1.00; flip to +1.00
   Disparate to no. 3 (BO) while looking through +1.00; flip to -1.00
   Repeat in 3 PD steps to limit of BI and BO
   Increase power of flipper up to +/- 2.50 repeating steps above

Divergence is the Hardest to Train

1. Set up conditions that promote far-away feeling

2. Visualization techniques/ deep breathing

3. Rebound (BO first to relax into BI)

4. BOM / BIP

5. As little proximal effect as possible: clear lifesaver, clear SOMS bottom, big sloppy targets with little detail, free space, lower lights, distance

Brock String
See suppression training

Tranaglyphs and Vectograms
See vectogram and tranaglyph training

Rotoscope

Fig 5-1 Rotoscope

Troposcope

Fig 5-2 Troposcope

Loose prisms

Aperture Rule
See stereoscopes

Life Saver Cards
Purpose:
convergence, divergence training

- Note: Available in clear or opaque background. No glasses required. Demand for both BI and BO increases as you try to fuse wider separated targets or move the card closer. Clear card best for BI and best at end of training. Patient should see three lifesavers when fused. Suppression control is luster, float, and complete letters in words. Stereopsis is noted by the middle circle being perceived closer for BO and further away for BI

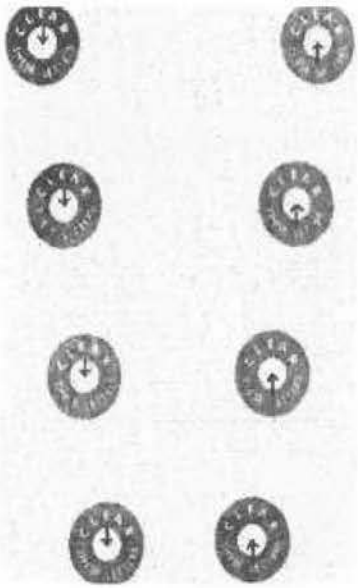


Fig 5-3: Lifesaver Card

Eccentric Circles

Purpose:

Free space convergence

- Note: Inner circle floats in front when diverged. And floats behind when converged

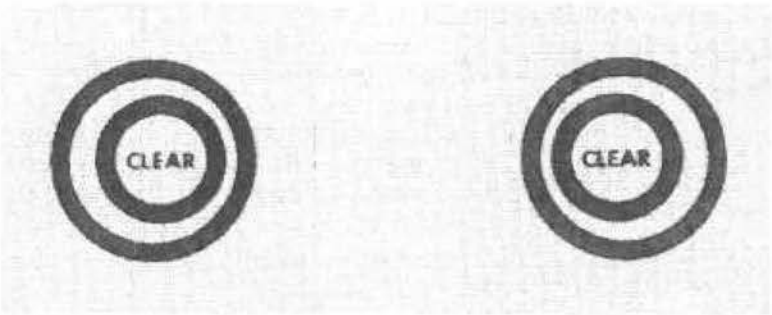


Fig 5-4: Keystone Eccentric Circles

3-Dot Card

Purpose:

trains convergence at near.

- Note: One side has red dots. The other side has green/blue dots. Suppression control: fused dots appear as a blended color/luster.

Fig 5-5: 3-Barrel Card

Stereograms

Binaco Cards

AN jumps

Vectogram Training

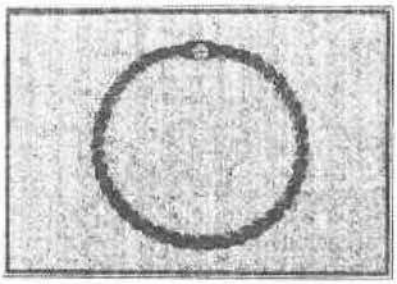
Vectograms are polarized stereograms viewed through polarized glasses at right angles of 45 and 135 degrees. They are used for patients with normal sensory fusion who need training in fusional vergence amplitude and facility. They provide the advantage of free space training.

The stereo optical set contains 11 polarized vectograms: 8 variable/split and 3 fixed. Variable vectograms discussed in class in order of difficulty include: Quoits, Clown (Topper), Mother Goose, Spirangle, and Chicago Skyline. Figure 8 is a non-variable vectogram used to specifically train stereopsis. Letters indicate BI demand. Numbers indicate BO demand.

QUOITS

Trains peripheral stereopsis at near and far if projected. Evaluates float, localization, SILO and parallax motion. Trains vergences with large, easily fusible targets.

Suppression control: cross at top of ring



Calculating Float

Problem: Patient PD is 48pd. Vecto demand set at 6BOwhen using at 40cm. At what distance from the vecto should the patient report the float?

MA demand of testing distance + demand for patient's PD = total near meter angles

2.5MA + 6BO/4.8cm=3.75MA
1/3.75MA=26.7cm from patient
40cm-26.7cm=13.3cm from the vectogram

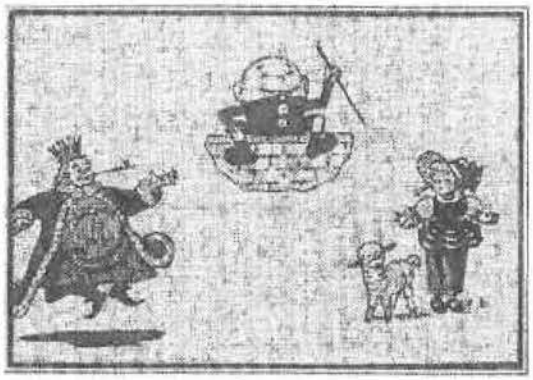
CLOWN

Trains near and far stereopsis. Letters on blocks require fine visual acuity. Trains vergence ranges.

Suppression control: R/L box on right-hand side

MOTHER GOOSE

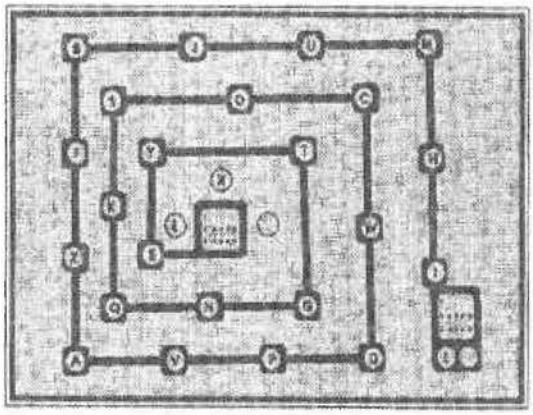
Trains near stereopsis and vergence ranges. Contains 3 vergence demands. When at the 0pd indicator, Bo Peep is at the plane, Humpty Dumpty is always 2pd BI and Old King Cole is 2pd BO relative to Bo Peep. This allows for more advanced jump ductions.



Suppression controls: king's pipe/bowl, Humpty's hat/cane, and Bo Peep's sheep/staff.

SPIRANGLE

Trains near stereopsis. The vergence demand increases from the center to the outside by 6pdBO. This remains true for BI and BO settings. Therefore, the outer spiral will always appear closer to the patient. Requires fine visual acuity. Letters also contain different disparities and appear to float in comparison to the borders of the boxes.



Suppression control: R and L, letters within box in the middle and at the end of the spiral are seen separately by OD and OS

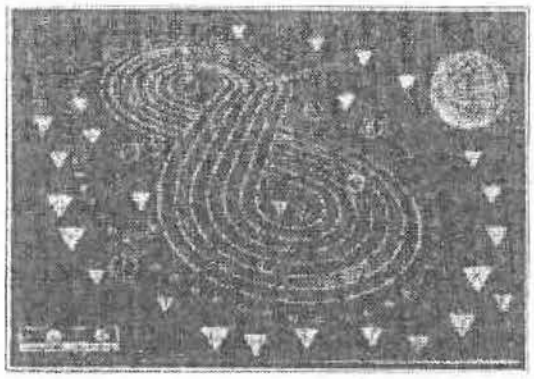
CHICAGO SKYLINE

Trains near stereopsis and vergence ranges. The plane and skyline have opposite vergence demands. If the plane is BO, then the skyline is BI. This allows jump ductions between the plane and the skyline.

Suppression control: R and L

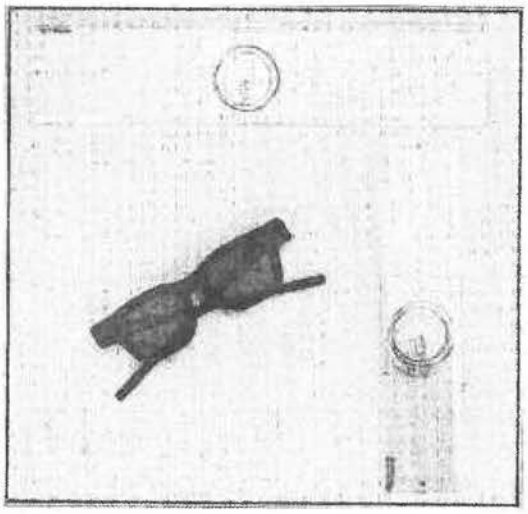
FIGURE 8

Non-variable. Trains depth perception.



RANDOM DOT VARIABLE BUTTERFLY
Very difficult to perform cover/uncover/recover training method because of no contours. Requires polarized glasses at 90 and 180 degrees.

VERTICAL MINI VECTO BC 216
HORIZONTAL MINI VECTO BC 275
Contains 3 acuity controls: 2 monocular and 1 binocular



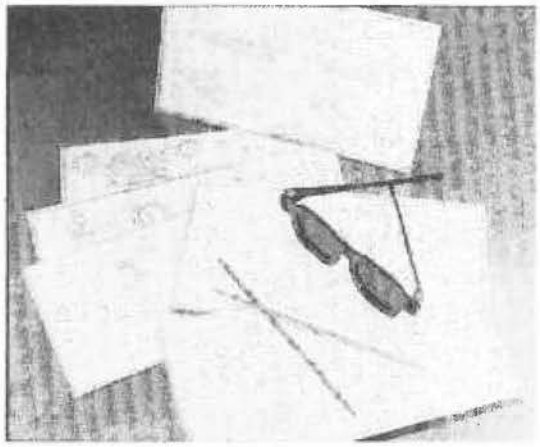
Anaglyphs

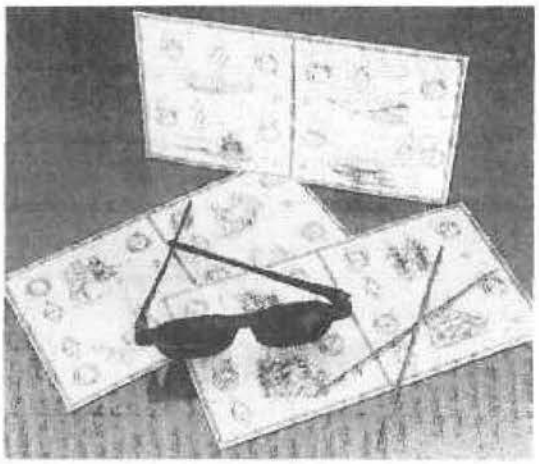
Tranaglyphs are a tradename of Bernell. They are more difficult to use than vectograms because of a chromatic difference between the R/G targets. They require R/G glasses and work to eliminate suppression while enhancing fusion and stereopsis. The Bernell tranaglyph series includes:

BC 50 Series

Non variable. Build horizontal fusional convergence and divergence. 2pd increments from ortho to 30pd as progress through the 6 frosted slides. Opaque background makes BI training harder. BI and BO trained separately as flip over slide or reverse R/G lenses.

BC51 Bike, Bowler 1-3pd
BC52 Horse 4-10 pd
BC53 Bowler 1-3pd
BC54 Football, Skier 20-22 pd
BC55 Football, Baseball 24-26pd
BC56 Race Car, Snowmobile 28-30pd





BC 70 Series

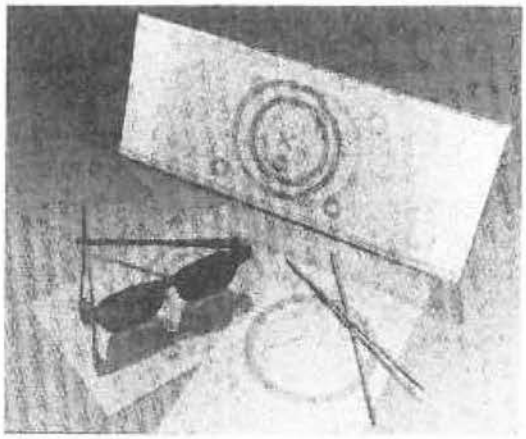
Non-variable. Trains vertical fusional reserve. Frosted slides .25-3.0 pd in .25 D increments. BU and BD trained by flipping slides or reversing R/G glasses. Float achieved by small amount of lateral separation.

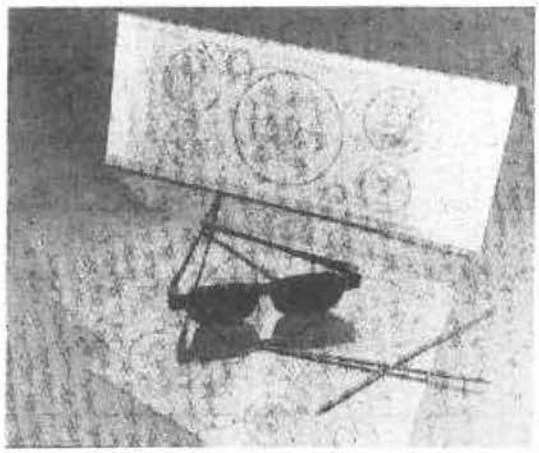
BC 71
BC 72

BC 500 Tranaglyph Kit

Variable. Train initial reserves through peripheral and central fusion as well as stereopsis. Included 3 variable slide pairs; single ring, double ring, double ring with suppression control.

BC 510 Peripheral Fusion
BC 515 Peripheral Stereopsis
BC 520 Peripheral & Central





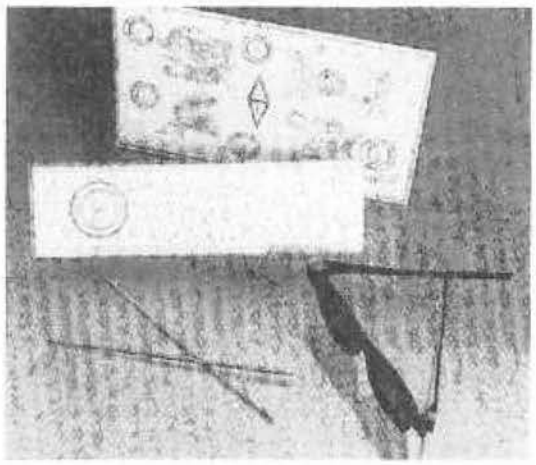
BC 600 Tranaglyph Kit

Variable. Included 5 pairs of slides, which can change ortho to 30pd for BI/BO fusional vergence training. Multiple disparity targets within each slide. These lines are very thin and make fusion more difficult.

BC 601 Bunny
BC 605 Spiral
BC 606 Clown
BC 607 Airport
BC Sports

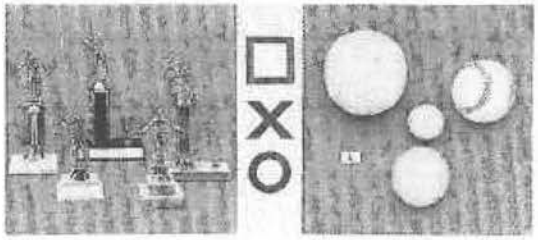
BC 920 Tranaglyph Trainer

Variable. Hand-held slider with horizontal range of 36pd BI/BO. Comes with diffuser, suppression control, and accommodation demand. BC 925 Tranaglyph Kit includes a +/- 5D vertical scale and a BC 51 slide.



BC 801 Slide Set

Combines both vertical and horizontal targets. Variable fusional training for horizontal or vertical by rotating the targets and 550 holder 90 degrees. Box-X-O anti-suppression included.



BC 802 Slide Set

Has two horizontal targets with differing stereoscope demands and also has monocular clues.

Polachrome Trainer

Purpose:

Provides coherent lit background and holder for vectograms and tranaglyphs. Allows for easier BI float.

Training Tips for Tranaglyphs

Put demand within patient's range of motoric fusion

Use Polachrome trainer as a holder

Use a target (i.e. a piece of tape or a coin) to act as a comparison to floating target

Start with single and move to multiple targets

Give "guided tours" through multiple target tranaglyphs

Use thick-lined targets first

Show crossed and uncrossed demand within the patient's range and compare back and forth. Use multiple disparity targets for this to increase their sensitivity to disparity.

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Bernell: A division of vision training products, Inc. 1998-99.

Griffin JR. Binocular anomalies. 3rd ed. Boston: Butterworth-Heinmann; 1995.

Kohl P. Optometry 720 Lecture. Fall 1997.

Accommodation

Accommodation

Accommodation training is used to treat

asthenopia

blur

enhancement for athletes

strabismics, amblyopes

reading problems

AC/A disorders

high exo

CI

eso

3 Aspects of Accommodation

Amplitude
Train to norms for relaxation and stimulation of accommodation.

Facility
Train to physiological maximum and age norm for
distance rocks and lens rocks.

Posture
Relates to hypo and hyper accommodation
More difficult to train.

Accommodative Tests

Amplitude

Acuities

Near point of accommodation. Do binocular first. If there is a problem do monocular. Apply Donders. Monocular should equal binocular otherwise there may be an accommodative/convergence problem.

Far point of accommodation (7,7a, Red/Green)

#19

#20 PRA Tests relative amplitude: accommodation freed from vergence. Similar to #17 BI.

#21 NRA Again testing binocular first and compare to monocular. Should be equal or have A/V problem

Posture/Accuracy

MEM

Bell

Book

#14a, #14b

#5

Facility

Distance rock

Lens rock

Accommodative Training

Train monocular to biocular to binocular

Monocular Training

1. Start with patching the worst eye and rock with plus lenses
2. Then patch the good eye and start with the bad eye rocking with plus lenses
3. Good eye begins with minus rocks
4. Bad eye begins with minus rocks
5. Rock minus to plus with flippers help straight up, changing occluder eye to eye

Norm for Lens Rock 12-15 cpm

Monocular Fixation in Binocular Field (MFBF)

- Overlays and filtered glasses
- Reading material with MKM Reading Test
- Half a Vectogram
- +/- flips in stereoscopes

Before Training Binocular

1. must be age expecteds
2. OD = OS in facility and amplitude

Binocular Training Targets

- Brock string with letter demand
- Vectograms
  - Spirangle because of acuity demand
  - Clown lettered blocks
  - Aperture Rule

Dissociative Training

(disagreement if before or after binocular training)
Split vectograms
Prism dissociation

BIM/BOP Training

- BI trained through minus. Helps with #17 on 21-point exam.
  BIM training on double aperture rule with flips
- BO trained through plus. #16
  Aperture rule
  CI/Accommodative Insufficiency BIM double aperture with flips
  Vectogram
  Stereoscope tromboning. Converge while relaxing accommodation, diverge while stimulating accommodation

Symptomatic VDT/Computer Users

Predictive tests

MEM

Accommodative Rock

Problems

1. Target is poor quality. Too much flickering.
2. Glare from image of convex screen and from light colored clothing
3. Don't blink

Types of Accommodation Dysfunction

Accommodative Excess	#7 more minus then #4; over-convergence on Brock, VO No plus acceptance on MEM, #14b, #5 Treat by eliminating cause, VT and Rx to reduce accomm
Accommodative Insuff.	Fail both monocular and binocular accommodative rocks and amplitudes True accommodative insufficiency is failure of monocular flips. Plus lenses first then VT
Accommodative Infacility	Fail both monocular and binocular rocks, but amplitudes are normal Treat with VT then plus lenses
Ill-sustained Accom.	Increasing difficulty with -2.00 flippers Treat with VT (use lenses only as crutch)

Accommodative Convergence Imbalance

REFERENCES

Kohl, P. Optometry 720 Lecture, Fall 1997.

Eye Movements

Eye Movements

Eye movements and Reading

- Sherman study
  Done on 40 children, 7-11 yo with known reading disabilities. Found that ocular motor pursuits and saccades were the worst skills.

- SUNY study
  Done on 10th graders to college age who were poor readers. Using the Eye-Trac, they tested using material that required higher comprehension abilities with 5th grade reading material. If the patients had only perceptual problems, they should score well on the 5th grade reading material.. These kids didn't have a difference in scores between the two levels of reading. Therefore these students were poor readers because of poor skill levels. VT improved reading to college level in 6 to 8 weeks.

- As a child develops over a period of time, a natural increase in all abilities occurs. Studies have shown that there is a supralinear relationship in vision training and performance, showing that VT is helping above the expected development that happens out of normal maturation.

- To be a good learner, we must be strong visually. Reading difficulties can be due to perceptual problems or skills problems (being either decoding or oculomotor movements). Perceptual problems are not a quick fix.

Physiology of Eye Movements

- 500-1050g of muscles around the eyes
- 10g of movement required for pursuits
- sustainability, speed, and accuracy all require additional energy
- between 10-12 degrees for most eye movements
- we use head movements if we look outside this range
- saccade latency .12-.16 sec
- saccades 600 degrees/sec
- pursuits 30 degrees/sec
- head movements 8 degrees/second
- vergence 10 degrees/sec
- cyclo <7 degrees/sec
- pursuits used in the act of learning to do visually-directed fine motor tasks like sewing
- highest form of fine motor skill is handwriting

Signs and Symptoms of Oculomotor Problems

read and lose place
using one eye
re-reading
HA's
fatigue
poor in sports
doesn't like reading
poor penmanship
don't like to watch spectator sports
may be developmentally delayed
reading disorder
strabismus

Saccadic Testing

Percon

Problems: Test didn't relate to reading

Pierce

Problems: Tests only really big eye movements

King Devick

A separate score for errors and time.

Consists of:

I Demo- numbers spaced with directional arrows

II Subtest with lines

III Subtest without lines

IV Subtest with stimuli more crowded but same number of elements

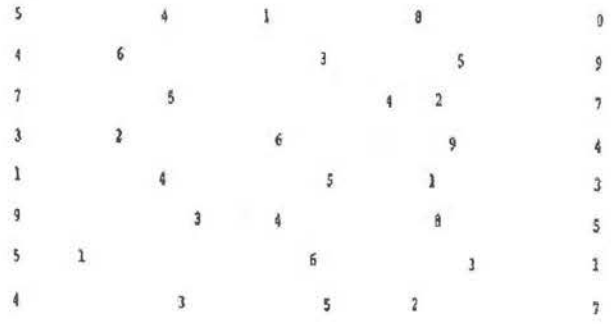

Fig 6-1 King-Devick Subtest III

Normed on 10,000 kids and became part of the New York Vision Testing Battery. Could be administered by a teacher. Normed for errors, age and by subtests.

Problems: you had to know your numbers and be able to say them quickly and no prescreening.

DEM

Normed on 6-14 yo
Pretest administered to <6 yo and anyone of concern. Screens out language problems.
Relate scores to age and grade by month in school.
Allows you to see if patient is working at appropriate age level and to pinpoint problems to eye movement and/or automaticity problems.
A+B have the same amount of numbers as in Test C.

Vertical Test A and B

Instructions: *Read the numbers down the columns as quickly as you can(finger motion down columns). Do not use you finger, only your eyes.*
Vertical test tells about **automaticity** because oculomotor skills required here are very easy, just one fixation per line. It's a baseline performance.
Vertical score is determined by adding the time to complete both A and B.
No errors are taken into account.

Vertical time = A+B

Horizontal Test C

Tests "sophisticated" **oculomotor ability** to saccade. Horizontal score must be compensated for if errors occur.

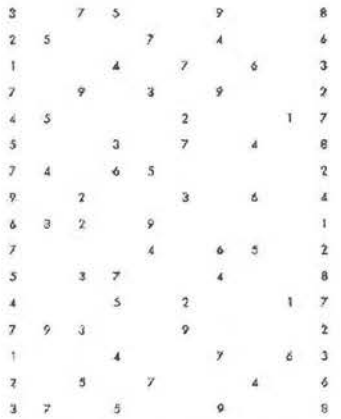

Fig 6-2 DEM Horizontal Subtest

Horizontal Time = Test C x [80/(80 - o + a)]
where o = omissions and a = additions(numbers repeated or added)

Other Calculations

Ratio = horizontal time/ vertical time

Total Error Score = (s + o + a + t) errors
where t = transposition errors

Percentile is figured for the vertical time, horizontal time, the number of errors and the ratio scores.

Age equivalent is whatever age would at least give the child a 50th percentile score.

Faults of the DEM:

The standard deviation is so high that you can't really say an above or below score is significant.
Test-retest problem between the 1st and 2nd tests.

Advantages of the DEM:

Normed on a wider age span that King Devick.
It has more numbers and they are placed more appropriately for actual saccade sizes in reading with large and small saccades.
Prescreens for language problems.

Clinical Application	
Type I Behavior	**normal** in horizontal, vertical and ratio
Type II Behavior	high ratio (horizontal more difficult); represents **oculomotor problem**
Type III Behavior	normal ratio but abnormally high horizontal and vertical; horizontal time has been influenced by poor automaticity tested in the vertical test; represents **deficient automaticity** in number-calling skills.
Type IV Behavior	high ratio with high horizontal and vertical test times; represents **oculomotor and automaticity problems**.

Ober 2

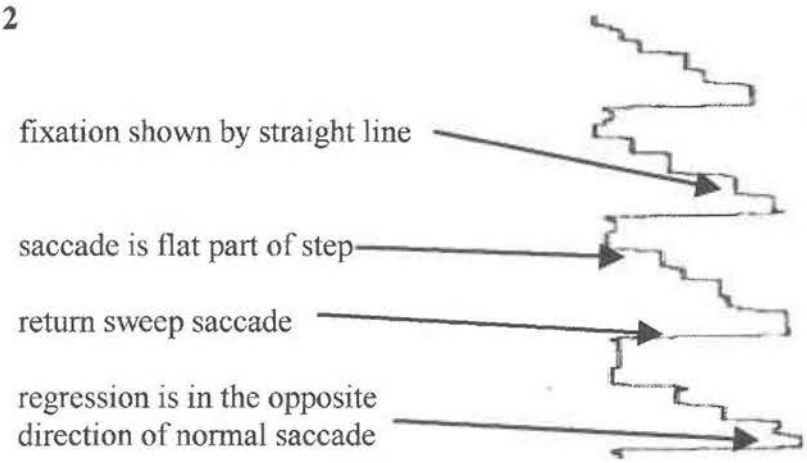

Fig 6-3 Ober Printout

This Ober test result shows poor eye movements:

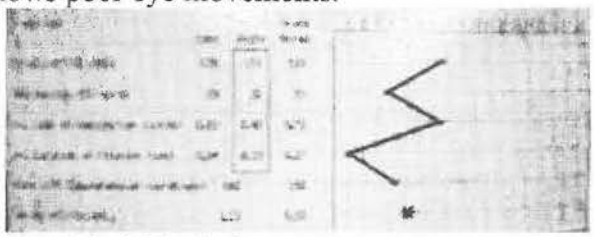

Fig 6-4 Results due to poor eye movements

This Ober test result shows poor fixation ability that might be found on an ESL patient.

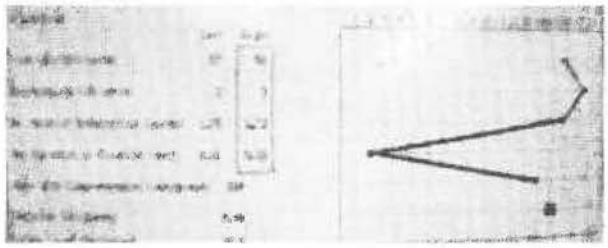

Fig 6-5 Results due to English as a second language

In normal eye movements, the length of fixation is approximately equal to the saccade movement.

	College level	1st grader
fixation/words	1 fix/2 words	1fix/.5 word
regression/words	1 regress/10words	1 regress/2 words
avg. span of recognition	2 words/fixation	
duration of fixation	.3 sec/fixation	.2sec/word

Saccadic Training

Visually-Directed Counting

Wayne Saccadic Fixator

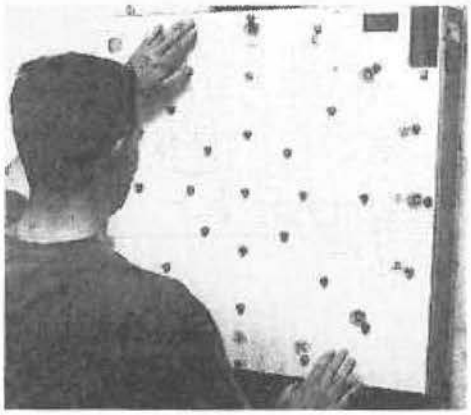

Fig 6-6 Wayne Saccadic Fixator

Saccadic Fixations

Fig 6-7 Column Saccades

Michigan Tracking

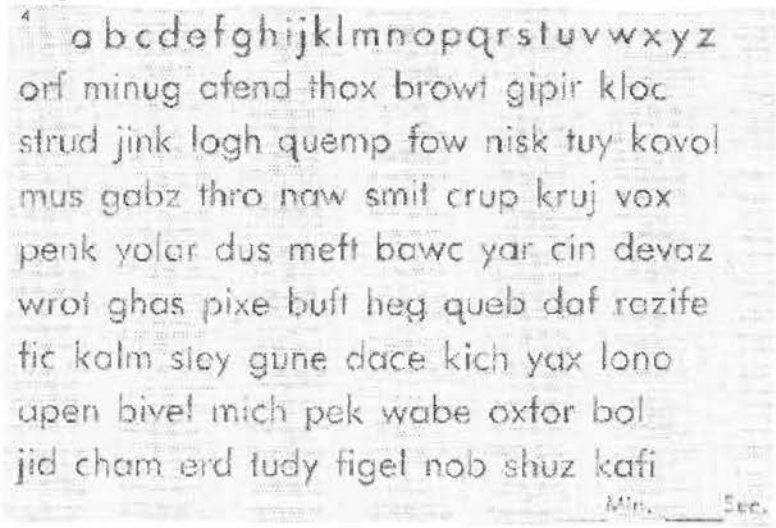

Fig 6-8 Michigan Tracking

Pursuit Testing

Bead Skills

Bead skills are the only time you assess eye movements in the standard 21 point exam, so do it well!

Levels of Eye Movements by SUNY

Stage I	Stage II	Stage III	Stage IV
M	**M**v	**V**m	**V**
motor stage	motor-visual	visual-motor	purely visual
	3.5 yo	5.5 yo	7 yo

Ocular Dexterity

Level IV	accurate and smooth all the time
Level III	small midline jump; rotations are clipped off/squared
Level II	no pursuits; look like saccades
Level I	patient's eye don't follow bead

OD=OS=OU

Level IV	equal ability in all meridians
Level III	lead eye; monocular > binocular
Level II	monocular much better than binocular but no clear dominant eye

Meridional Differences

Sequence of increasing difficulty; horizontal to oblique to vertical

Level IV	vertical, horizontal, oblique all smooth and equal
Level III	vertical most difficult, midline jump
Level II	oblique and vertical difficult

Sustaining Ability

Level IV	rotations smoothly without losing place
Level III	5 rotations smoothly without losing place
Level II	2 rotations smoothly without losing place

Motor Reinforcement

Behavior that reinforces the activity but at a lower developmental level; results in inefficiency. Examples: pointing, touching the bead.

Motor Overflow

Indicative of stress, no help. Examples: tapping foot, head movements.

Level IV	no motor overflow; purely responsive
Level III	motor overflow and motor reinforcement but easily squelched
Level II	expect motor overflow and motor reinforcement

Adding Cognitive Demand

5 yo What's your name?
7 yo Count 1-10.
9 yo Count backwards from 10.
11 yo Count backwards from 100.
13 yo Count backwards from 100 by 2's.
High school Count backwards from 100 by 3's.

- Note: Arnie Sherman adds motor activity to increase the demand. Kohl believes that adding the thinking element to the eye movement is more reflective of reading demands.

Groffman Visual Tracing Test
An error-corrected score
Normed for 7-12 yo
Purpose:
tests pursuit ability as well as figure ground.

Directions:
The patients starts at "A", pursuits to a number. You record the time. Repeat until all letters have been completed. A correct answer gets scored. Points are awarded for time completed using the scoring scale. Total points are related to a rating given by an age norm.

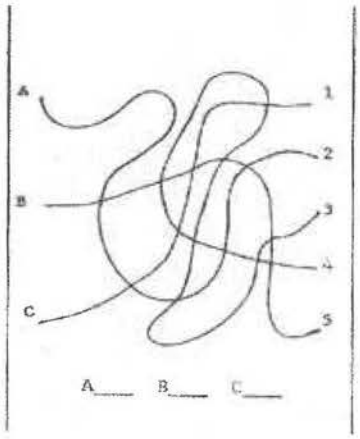

Fig 6-9 Groffman Visual Tracing

If a child does poorly, Kohl suggests throwing it away and repeating with another form of the test. This time tell the child that accuracy is important. You want to see if the child is capable of doing the test at all. If not, then you know the child really has a problem.

If you think the child has a binocular problem, then do the test monocularly, especially for intermittent strabs.

Pursuit Training

Two main training goals are:

1. rid the child of using motor support
2. provide the child with the ability to do ocular motilities without head movements

Approach	Examples
Steady position maintenance of stationary targets	Attention helps maintain. Try contrast, dx, size, touching targets
Voluntary to reflexive responses	
Eye-hand coordination to no eye-hand support	Touch, intermittent touch, pointing, flashlight pointing
Small to large excursions	
Slow to fast speed of pursuits	
Jerky to smooth	
Head movement to no head movement	Sand bag. Progress from eye movements laying down to sitting to standing to walking
Unequalness to equalness of OD or OS	Train monoc. first. Right side should be able to cross over to left side of body to train midline jumps.
Monocular to binocular	
Sitting to standing	
No vergence demand to prismatic demands	Marsden ball progression: hanging straight down, holding in hand and swinging, swinging by itself, swinging around the body, 2 balls at once.
Simple to complex cognitive demand	Use multiple targets, increase cognitive demand with questions and motor tasks. This ensures automaticity of eye movements.
Combinations of less stress to more stress	

Examples of pursuit activities:

Mazes
Tracing
Cutting with scissors
Marsden Ball

- Note: Once some fixation ability is accomplished in the child, concentrate on increasing the ability to take in quantities of information with a tachistoscope, for example.

In-office Pursuit Training

Sports Disc Rotators
Purpose:
pursuit training

- Note: have stereo targets that provide float out to no float to float in as they rotate.

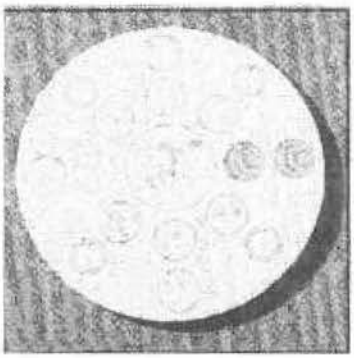

Fig 6-10 Sports Training Disc

Keystone Rotators
Purpose:
pursuits with first degree fusion

- Note: do monocularly, slow speed, finger or hold penlight on it; use record player at home and track object rotating

Most training done at home

Paper and Pencil
Groffman
Eye-Hand control pursuits

Marsden Ball
Purpose:
pursuits in multi directions
Advantage:
fun and easy to vary task

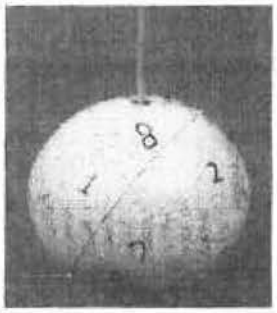

Fig 6-11 Marsden Ball

Tachistoscope

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Study Questions

Study Questions

Stages of Learning in Training

1. During the post performance part of a training session

   a) the patient should describe what they did
   b) the doctor should describe the task
   c) the patient performs the task
   d) the doctor watches the performance

2. If a training procedure is too hard for your compliant patient,

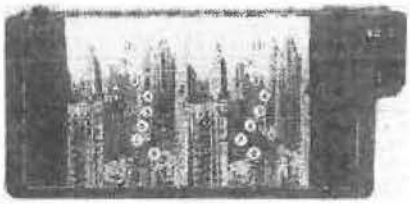
   a) scream at them
   b) bribe them with candy
   c) make them work harder
   d) change or modify the procedure

Stereoscopes

1. This is a

   a) Aperture rule
   b) SOMS
   c) Wheatstone
   d) Bernelloscope

2. Fusion of this targets would produce this degree of fusion:



   a) first
   b) second
   c) third

3. When moving the Wheatstone wings together, what demand is increasing?

   a) BO
   b) BI

4. Moving the bottom SOMS target further out increases what demand?

   a) BO
   b) BI

5. What happens to the accommodation stimulus as you move the SOMS target out?

   a) increases
   b) decreases
   c) remains the same

6. Using the single aperture on the aperture rule creates what demand?

   a) BO
   b) BI

7. How can the accommodation stimulus be changed on the aperture rule?

   a) changing the aperture position
   b) changing the card
   c) moving the targets back
   d) none of the above are correct

8. With the single aperture on the aperture rule, fusion of the eccentric circles creates float in the inner circle

   a) closer
   b) further
   c) same distance

9. When tromboning the stereocard toward the patient in a Biopter, what happens to the BO demand?

   a) increases
   b) decreases
   c) remains the same

10. What happens to the accommodation demand?

    a) increases
    b) decreases
    c) remains the same

11. The aperture rule with a single aperture, using plus flippers is appropriate to train

    a) convergence excess
    b) convergence insufficiency
    c) divergence insufficiency
    d) basic esophore

12. At optical infinity setting of a +5.00 stereoscope with 90mm OC separation, a stereogram, with a separation of 130mm. has a convergence demand of

    a) 10 pd BO
    b) 10pdBI
    c) 20pd BO
    d) 20pd BI

Sensory Fusion

1. When using the russel ring with this card, the patient report the inside of the loop is black. This response represents

a) OD central suppression
b) OS central suppression
c) OD peripheral suppression
d) OS peripheral suppression

2. The AN-2 card can be used to assess all except:

    a) suppression
    b) second degree fusion
    c) amount of phoria
    d) direction of fixation disparity

3. With a green lens on the right eye, a red lens on the left, the patient reports 2 dots on the Worth 4-Dot test. This represents

    a) OD suppression
    b) OS suppression
    c) monocular diplopia

4. A patient with red/green glasses (red on right), reports 2 green dots and below that 3 red dots. This patient has a

    a) left hypo
    b) left hyper

5. To neutralize the patient in the above problem, use right eye base

   a) up
   b) down
   c) in
   d) out

6. When turning the Synthetic Butterfly upside down, what happens to the float?

   floats in front
   floats behind the card
   will not float

7. For which one of these is straight on alignment critical?

   a) Stereo Fly
   b) Random Dot E
   c) Stereo Reindeer

8. In a Randot E, the patient is wearing habitual distance Rx. At 1 meter, the patient gets 500". What do you predict the stereopsis will be a 4 meters?

   a) 2000"
   b) 1000"
   c) 250"
   d) 125"

9. In the aviator series, how many levels of stereoacuity are measured on a given card?

   a) 1
   b) 2
   c) 3

10. Comparing the actual float perceived by a patient to the predicted mathematical float is a measurement of

    stereoacuity
    stereolocalization
    stereomobilization
    proximalization

11. Which one of the following is the worst for catching small angle strabismics?

    a) Stereo Fly
    b) Stereo Butterfly
    c) Random Dot E
    d) Synthetic Optics Butterfly

12. Binocular depth cues are most important at

    a) near distances with large moving targets
    b) near distances with fast moving targets
    c) near distances with stationary targets
    d) far distances with stationary targets

Motor Fusion

1. The Figure 8 vectogram is used to train

    a) first degree fusion
    b) BO ranges
    c) BI ranges
    d) stereopsis
    e) all the above

2. Quoits vectogram is used to train

    a) stereopsis
    b) vergence ranges
    c) stereolocalization
    d) all the above

3. What is the relationship between Bo Peep, Old King Cole and Humpty Dumpty in the Mother Goose vectogram?

    a) changes depending on the disparity
    b) stays the same
    c) reverses with BO
    d) reverses with base in

4. When sequentially fusing the lifesaver cards, which circles are seen as closer?

    a) top
    b) middle
    c) bottom
    d) all are at the same distance

5. With a Quoits vectogram at a 6_ BO demand, parallax motion should be

   a) with
   b) against
   c) it should not move

6. With the same set up as above, increasing the demand would make the inner target appear

   a) smaller
   b) larger
   c) stay the same size

7. Using the horizontal mini tranaglyph in a vertical manner, do you expect float?

   a) yes
   b) no

8. The demand of the Spirangle becomes more __ as you move towards the inner box

   a) BO
   b) BI
   c) cannot be determined

9. With the Chicago Skyline vectogram, increasing the BO demand of the airplane, makes the city become more

   a) BI
   b) BO
   c) does not change

10. If you put the Chicago Skyline at demand "H", as you move away the airplane vergence demand becomes

    a) smaller
    b) larger
    c) remains the same

11. Which lifesaver card is appropriate for BI training?

    a) clear card
    b) opaque card
    c) both will be equally successful

12. As you fuse (crossed) from bottom to top of the lifesaver card, BO demand

    a) increase
    b) decreases
    c) remains the same

13. The BI demand in the above example

    a) increase
    b) decreases
    c) remains the same

14. With the lifesaver, you are first crossed and move card towards you, BO demand_____. Then you uncross and again move the card towards you. The BI demand____.

    a) increases-increases
    b) decreases-decreases
    c) increases-decreases
    d) decreases-increases
    e) both remain the same

15. In the BC 500 series, the opaque backgrounds are used for

    a) BI
    b) BO
    c) Trains both BI and BO equally well

16. The Brock rod trains

    a) BO
    b) BI
    c) Trains both BI and BO

17. Which order ranks the following techniques from easy to hard?

    1. Clown-increasing BO and BI ranges with smooth vergences
    2. Clown-cover, uncover, recover with a moving target
    3. Clown-jump vergences
    4. Clown-fuse with touch

    a) 1,2,3,4
    b) 4,1,2,3
    c) 4,1,3,2
    d) 1,4,3,2

18. Which is better for training DI?

    a) SOMS with a clear base
    b) aperture rule
    c) 3 dot card
    d) Brock string

19. Using the 3-dot card, the patient is asked to converge and overlap the dots. Which is not true?

    a) the patient has feedback whether they're over or under converging
    b) this is best for training BI
    c) this patient knows if they're suppressing
    d) this is good to improve NPC

20. Using the variable Random Dot E, the lowest finding is usually

    a) blur
    b) break
    c) recovery

21. Arrange in order of easy to hard.

    a) Quoits, Clown, Mother Goose, Chicago skyline
    b) Clown, Quoits, Mother Goose, Chicago Skyline
    c) Quoits, Clown, Chicago Skyline, Mother Goose
    d) Quoits, Mother Goose, Clown, Chicago Skyline

22. When crossing to see the lifesaver card, how many circles does the patient see?

    a) 1
    b) 2
    c) 3
    d) 4

Accommodation

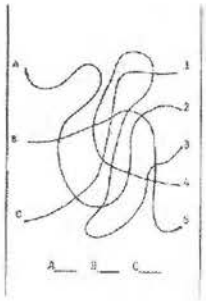
1. The following +/-2.00 flipper findings are indicative of

OU 9cpm
OD 15cpm
OS 16cpm
OU 8cpm

a) amblyopia
b) accommodative insufficiency
c) accommodative excess
d) accom/verg problems

Eye Movements

1. What is this?



a) Groffman
b) DEM
c) Ober
d) King Devick

2. To perform well on the test above, you need

a) good saccades
b) good pursuits
c) good figure-ground
d) B and C only

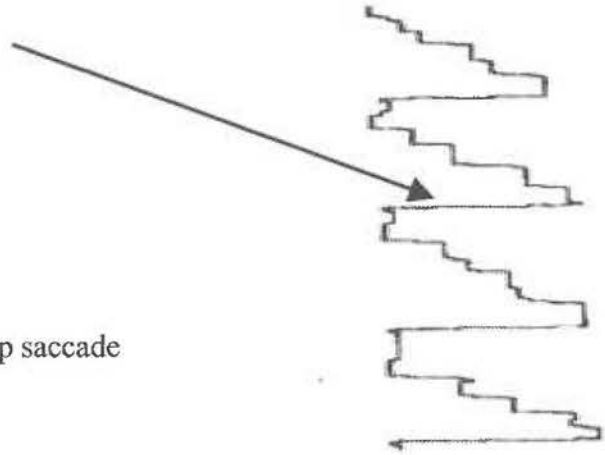
3. Vertical and horizontal subtests are parts of which test?

a) Groffman
b) DEM
c) King Devick
d) Pierce

4. What is the vertical subtest mentioned above assess?

a) vertical eye movements
b) horizontal eye movements
c) automaticity of letter naming
d) assess pursuit ability

5. This shows a



a) regression
b) saccade
c) fixation
d) return sweep saccade

6. Eye movements should start to supersede head movements in pursuits by age

a) 5
b) 7
c) 9
d) 11

7. Using a finger under words to guide the eyes is an example of

a) motor overflow
b) motor reinforcement
c) motor hysteresis
d) motor generalization

8. Using scissors to cut out along a line is used to train

a) saccades
b) pursuits
c) accommodative facility
d) duration of fixation

9. Tachistoscope presentations train

a) excessive regression
b) too many saccades
c) too long fixations
d) return sweep accuracy

10. Concerning the Ober 2, which finding showed the least percent difference in comparing 1st graders to college-aged students?

    a) fixations/100 words
    b) regression/100 words
    c) duration of fixation
    d) span of recognition

11. A "hiccup" in the eyes during a pursuit movement crossing the midline is an aberrant finding in

    a) 3 yo
    b) 5 yo
    c) 6 yo
    d) 8yo
    e) all but "a" are correct

12. Order the following techniques for training with Groffman visual tracings easy to hard:

    1. pointing
    2. touching
    3. ocular with target movement
    4. ocular with stationary target

    a) 1,2,3,4
    b) 2,1,3,4
    c) 2,1,4,3
    d) 1,2,4,3

Further Readings

Further Readings

Sensory Fusion

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