

Clinical visual testing of patients with SpLD

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References

Pickwell's Binocular Vision Anomalies, 5th Edition, Elsevier, 2007
Eye Essentials: Binocular Vision, Elsevier, 2005

PLAN

SYMPTOMS

INVESTIGATION OF INCOMITANCY

INVESTIGATION OF HETEROPHORIA

INVESTIGATION OF HETEROTROPIA

TREATMENT

ACCOMMODATION

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DISCLOSURE

- * Books
- * Practice
- * Exercises



OVERVIEW: CAVEAT

- * Always look for pathology:
 - * Neuro-optometric checks
 - * Pupils, discs, fields, strabismus, incomitancy, accommodation
 - * Check these things regularly
- * Change management if not improving significantly
- * Refer if still not improving
- * Appropriate re-exam intervals (frequent)
- * Don't forget refraction



"I'm leaving you Mitchell. You've never had tunnel vision and you never will."

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Symptoms

- * Use a symptom questionnaire
- * Confirm key answers with the child
- * Are the parent(s):
 - * Ignoring
 - * Supporting
 - * Taking over
- * Link to the [questionnaire](#)
- * www.cmt-optometrists.co.uk/spldq.doc

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Incomitancies: conclusions

- ✿ Some incomitancies are difficult to detect
 - If you rely on motility alone you may miss some
 - If symptoms are suspicious, do cover testing in peripheral gaze
 - Testing for cyclo-deviations detects SO palsies
- ✿ Refer new or changing incomitancies
- ✿ In some long-standing cases, prescribing the prism required in the primary position may help

PLAN

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INVESTIGATION OF INCOMITANCY

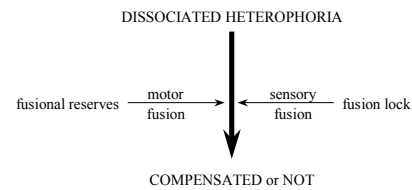
INVESTIGATION OF HETEROPHORIA

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SYMPTOMS OF DECOMP. PHORIA

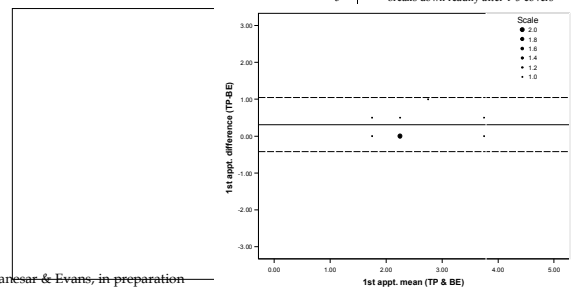
1. Blurred vision
2. Diplopia
3. Distorted vision
4. Difficulty with stereopsis
5. Monocular comfort
6. Difficulty changing focus
7. Headache
8. Aching eyes
9. Sore eyes
10. General irritation

KEY SIGNS OF DECOMP. PHORIA

▼ Symptoms

▼ Poor cover test recovery

Grade	Description
1	rapid and smooth
2	slightly slow/jerky
3	definitely slow/jerky but not breaking down
4	slow/jerky and breaks down with repeat covering, or only recovers after a blink
5	breaks down readily after 1-3 covers



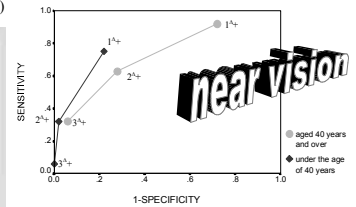
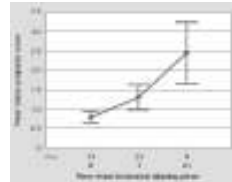
KEY SIGNS OF DECOMP. PHORIA

- ▼ Symptoms
- ▼ Poor cover test recovery
- ▼ Aligning prism
- ▼ Low fusional reserve opposing phoria
 - ▼ Sheard's criterion
 - ▼ Particularly useful for exophorias
- ▼ For esophorias, size and imbalanced fusional reserves are relevant
- ▼ For hyperphorias, size matters



ALIGNING PRISM: Mallet Unit

- aligning prisms/spheres to eliminate FD
- good foveal and peripheral fusion lock
- question set is important
 - ask if a line ever moves



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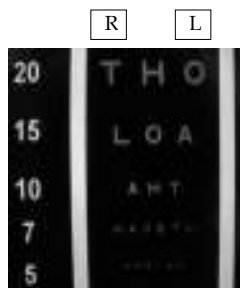


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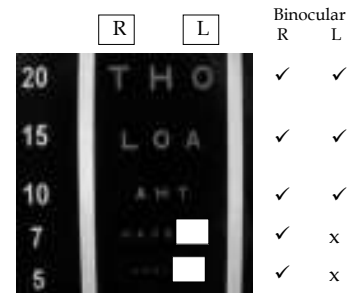


FOVEAL SUPPRESSION TEST



1. Only show patient test with visor on
2. Have patient read down test binocularly
3. You are assessing monocular acuities under binocular conditions

FOVEAL SUPPRESSION TEST



1. RE reads to 5 mins of arc, LE only to 10 mins of arc
2. Is the reason for the poor acuity in the LE foveal suppression or poor VA?
3. To find out, keep visor in place and occlude RE, re-measuring LE

FOVEAL SUPPRESSION TEST

	R	L	Binocular		Occluded R
			R	L	L
20		H O	✓	✓	✓
15		G A	✓	✓	✓
10		H T	✓	✓	✓
7			✓	x	✓
5			✓	x	x

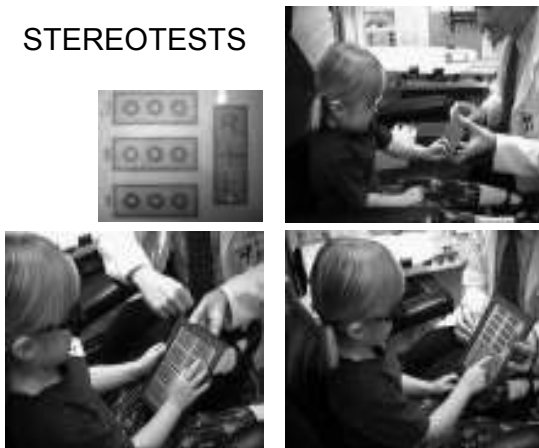
1. RE near VA 5 mins arc
2. LE near VA 7 mins arc
3. Under binocular viewing conditions, LE has 3 min arc foveal suppression

FOVEAL SUPPRESSION TEST: norms



For 95% of the population, the VAs under binocular viewing conditions should be within one line of the VAs obtained under monocular viewing conditions Tang & Evans (2007)

STEREOTESTS



BINOCULAR INSTABILITY: DIFFERENTIAL DIAGNOSIS

<i>SIGN</i>	<i>B.I.</i>	<i>DECOMP. PHORIA</i>
phoria	may/may not be present	must be present
variability of phoria	$> \pm 1.75 \Delta$	$< \pm 1.75 \Delta$
cover test recovery	may/may not be abnormal	usually slow & hesitant
fusional reserves	convergent & divergent usually low, worse as tires	low reserve opposing phoria
aligning prism	unstable FD, may be aligned "on average"	misaligned, may/may not be unstable
dyslexia	significant correlate	non-significant correlate

CONVENTIONAL ANALYSIS

- * If: P = size of phoria, V = opposing fusional reserve, N is the normal value of fusional reserves:
- * method of comparing with norms:
 $V > N$
- * method of Sheard's criterion:
 $V > 2P$

ALTERNATIVE HYPOTHESIS

- * If: P = size of phoria, V = opposing fusional reserve, N is the normal value of fusional reserves:
- * vergence errors during saccades of $> 20'$
- * SO, will need some reserve just to overcome vergence errors
- * hence: $V > MP + C$ (M=multiplier, C=constant)
- * formula to be applied to the opposing reserve
- * the non-opposing fusional reserve would simply need to exceed C

BINOCULAR INSTABILITY: MANAGEMENT

- * treat any sensory factors interfering with fusion.
- * train the fusional reserves.
- * if temporary poor health, can use prisms or spheres to correct any aligning prism.

Differential diagnosis: *Binocular Instability or Meares-Irlen Syndrome*

- * Similar symptoms & often co-exist
- * Which is chicken and which is egg?

Evans (2001) *Dyslexia & Vision*, Whurr, London

Differential diagnosis: *Binocular Instability or Meares-Irlen Syndrome*

Sign	Binocular vision anomaly	Meares-Irlen Syndrome
Significant phoria	May be present (not if binocular instability)	Unlikely
Low fusional reserves	Present	May be present
Symptoms alleviated by occlusion	Yes	Unlikely
Pattern glare	Unlikely	Present
Photophobia	Yes, but not colour specific	Yes, colour specific
Symptoms alleviated by coloured filters	Unlikely	Yes

Evans (2001) *Dyslexia & Vision*, Whurr, London

SUMMARY: DIAGNOSIS

Sign or symptom	score
one or more of the symptoms of decompensated heterophoria	+3
cover test: heterophoria detected	+1
cover test: absence of rapid and smooth recovery (+1 if quality of recovery 'border-line')	+2
aligning prism (Mallett): 1Δ+ for under 40 years or 2Δ+ for over 40 years	+2
aligning prism (Mallett): <1Δ but unstable	+1
foveal suppression (Mallett) >3° or diplopia during foveal suppression test	+2
<i>If score: -4 diagnose normal, +3 treat, 4-5 continue down table adding to score so far</i>	
Sheard's criterion: failed	+2
Percival's criterion: failed	+1
dissociated heterophoria unstable so that result is over a range 3Δ (i.e., phoria ±2Δ)	+1
fusional amplitude (divergent break point - convergent break point) < 20Δ	+1
<i>If total score: -6 diagnose normal, otherwise treat</i>	

CONVERGENCE INSUFFICIENCY: INTRODUCTION

- * "An inability to obtain or to maintain sufficient convergence for comfortable binocular vision at near"
- * can be conceptualized as a decompensated exophoria at an usually close working distance
- * c.f., convergence weakness exophoria

CONVERGENCE INSUFFICIENCY: AETIOLOGY (a)

- * disuse of accommodative convergence
 - e.g., uncorrected myopes
- * anatomical factors
- * developmental (or phylogenetic) factors
- * disuse of an eye (e.g., amblyopia, blur)
- * vertical heterophoria

CONVERGENCE INSUFFICIENCY: AETIOLOGY (b)

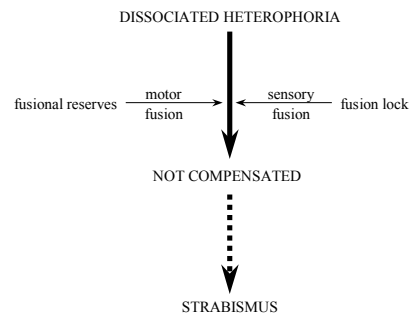
- * general debility
 - e.g., Moebius' sign in thyrotoxicosis
- * medication
- * paralysis of convergence
 - can rarely occur in conditions affecting the brain-stem, in disseminated sclerosis, tabes dorsalis and in some traumatic conditions.

CONVERGENCE INSUFFICIENCY: INVESTIGATION: outline

- * symptoms
- * convergence tests
 - near point of convergence, $\sim > 8$ cm
 - jump convergence (see next slide)
- * heterophoria tests for near vision
- * fixation disparity tests at reduced distance.
- * amplitude of accommodation

CONVERGENCE INSUFFICIENCY: MANAGEMENT

- * 1. removal of cause of decompensation
- * 2. refractive correction
- * 3. orthoptic treatment
- * 4. relieving prisms
- * 5. referral (rarely)



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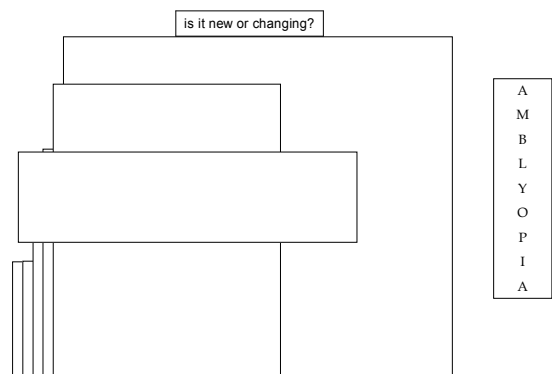
INVESTIGATION OF HETEROTROPIA

TREATMENT

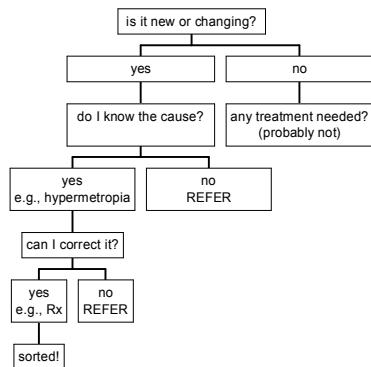
ACCOMMODATION

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Strabismus: the bottom line for the busy optometrist



Strabismus: the bottom line for the busy optometrist



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MOTOR DEVIATION: REFRACTIVE CORRECTION: OVERVIEW

- preferred treatment for many horizontal deviations
- limited by 4 factors
 - angle of deviation
 - refractive error
 - accommodation
 - AC/A ratio



MOTOR DEVIATION: REFRACTIVE CORRECTION: SPECIFICS

- determine sphere that
 - eliminates strabismus (no diplopia)
 - eliminates FD on Mallett Unit
- Can check (2 mins) don't adapt (North & Henson, 1985)
- prescribe, try to reduce approx. every 3-6/12
- negative adds and bifocals/varifocals can work well



MOTOR DEVIATION: REFRACTIVE CORRECTION: MYTHS

- negative adds might cause myopia
 - “overminus lenses do not induce clinically significant myopic changes” (Rutstein et al., 1989)
- patient might adapt to the over-correction
 - if abnormal BV, tend not to adapt (North & Henson, 1985)
- bifocals might reduce children's ability to accommodate
 - smooth muscle; 14D-3D=11D
- accommodative (hyperopic) esotropia will not need glasses in later life
 - after 10 yrs, 97% still need Rx (Rutstein & Marsh-Tootle, 1998)

MOTOR DEVIATION: REFRACTIVE CORRECTION: CASE STUDY: D1542

- 11/5/96, female, age 8y, 1 headache a fortnight
 - wearing full cyclo plus (c. +2.00, R=L)
 - cover test: D: 8Δ SOP N: 10Δ RSOT
 - with +2.00 add: N 4Δ RSOT with +2.50 add: N ortho

Date	May 96	July 96	Mar 97	Jun 97	Sep 97	Jan 98	Apr 98	Jun 98	Sep 98
Add	+2.50	+3.00	+2.50	+2.00	+1.75	+1.50	+1.00	+0.50	None

**MOTOR DEVIATION:
PRISMATIC CORRECTION: OVERVIEW**

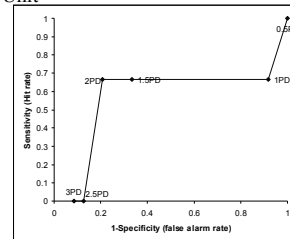
- preferred treatment in small/moderate vertical deviations
- may also help in small/moderate horizontal deviations if not amenable to refractive modification or exercises
- limited by angle of deviation / cosmesis of prism



"There I was, asleep in this little cave here, when suddenly I was attacked by this hideous thing with five heads!"

**MOTOR DEVIATION:
PRISMATIC CORRECTION: SPECIFICS**

- determine prism that
 - eliminates strabismus (no diplopia)
 - eliminates FD on Mallett Unit
- check (2 mins) don't adapt (North & Henson, 1985)



O'Leary and Evans (2006)

**MOTOR DEVIATION:
PRISMATIC CORRECTION: MYTH**

- patient might "eat up prisms"
 - prism adaptation usually abnormal in orthoptic anomalies (North & Henson, 1981)

**MOTOR DEVIATION:
PRISMATIC CORRECTION: CASE STUDY: F6123**

- 8/4/97, male, age 6y, ? dyslexia
 - symptoms: words move, sore and tired eyes
 - motility full, +0.50DS BE, cover test ortho., D=N, NPC=nose
 - Dissoc. tests: D: 3Δ SOP, 2Δ L/R N: 3Δ XOP, 3Δ L/R
 - Align. prism: D: LE supp. N: 1Δ in, 1Δ up R
 - Rx: plano, 1Δ up R
- 5/7/97
 - symptoms: with Rx no eyes hurting, D & N clearer
 - no slip with glasses, other findings as above

**MOTOR DEVIATION:
FUSIONAL RESERVE EXERCISES:
OVERVIEW**

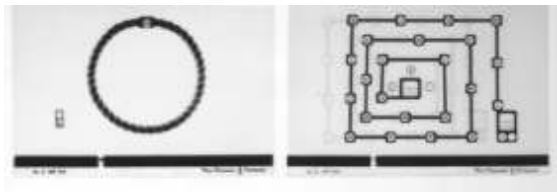
- preferred treatment in small/moderate horizontal deviations, if px co-operative
- in exo-deviations improve ability to converge
- in eso-deviations improve ability to diverge
- try to assess progress using a method different to the treatment technique
- there is some supporting evidence from RCTs
 - Ciuffreda & Tannen (1995)



It was over. But the way the townfolk called it, neither man was a winner.

**MOTOR DEVIATION:
FUSIONAL RESERVE EXERCISES:
SPECIFICS**

- haploscopic instruments / anaglyphs / vectograms / free-space methods
 - feedback helps, as in computer-orthoptics
 - varying targets & conditions helps
 - probably, the most important factor is practitioner enthusiasm
 - with a PC & printer anyone can design their own exercises



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Polarised vectograms are manufactured by Stereo Optical Company and are available from Vision Training Products, Inc.

FUSIONAL RESERVE EXERCISES: COMPUTER ORTHOPTICS

- * HTS
 - ◆ Standard program uses red/green
 - ◆ Also available with LCD shutters
 - ◆ Can give patient floppy disc with exercises to do at home
 - ◆ Also includes "behavioral optometry" components (e.g., perceptual training)
 - ◆ Available from Keith Holland
- * Orthoweb
 - ◆ Patient "visits" web site to do exercises
 - ◆ <http://www.academy.org.uk>
 - ◆ Designed by Andrew Field



APERTURE RULE TRAINER

- ◆ Single aperture to train convergent reserves
- ◆ Double aperture to train divergent reserves

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DEVELOPMENT OF IFS: Primary goal

- To maintain the patient in an over-converged posture for 10-20 mins a day without them becoming bored
- To provide a variety of stimuli to help any benefit translate into everyday life



DEVELOPMENT OF IFS: Details

Goal	Design feature
Affordable	Printed home exercises
Easy to understand	Comprehensive instructions
Fun to do	Novel 3-D images Varied tasks
Motivating	Encourage parent/child team One or two 10' sessions daily Check in 3-4 weeks
Checks on progress	10 self-test questions
Variety of stimuli	18 targets with step and ramp Different size stimuli Different shape stimuli Vergence angles: 3-30Δ
Control/treat suppression	Physiological diplopic images Monocular markers stereopsis

IFS EXERCISES: BLURB

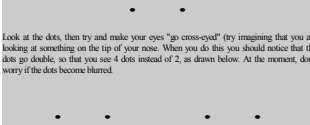
- IFS exercises can be used to treat:
 - decompensated exophoria at near
 - binocular instability
 - convergence insufficiency
 - intermittent exotropia at near
- experienced practitioners can also use the exercises to treat constant comitant exotropia at near, usually as part of a more detailed treatment regimen.

DEVELOPMENT OF IFS: Card 1

- Teaches physiological diplopia & introduces 3-D perception

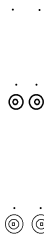
Card 1: Learning How to Use Double Vision to Develop 3-D Vision
On the "Card 1" that accompanies these notes there are three "exercise pictures". These pictures look very simple. But don't be fooled! As you will come to realise, these exercises will involve you doing some very clever things with your eyes.

Card 1: First Exercise: Dots
Stage 1: Seeing Four Dots
The first of the three exercises on Card 1 consists of two dots, about 1.5 cm apart. The aim of these dots is to teach you how to use double vision to improve your control over your eyes. These dots are like those drawn below.



Look at the dots, then try and make your eyes "go cross-eyed" (try imagining that you are looking at something on the tip of your nose). When you do this you should notice that the dots go double, so that you see 4 dots instead of 2, as drawn below. At the moment, don't worry if the dots become blurred.

FREE SPACE STEREOGRAMS
Card 1: Learning to Use Double Vision to Develop 3-D Vision



DEVELOPMENT OF IFS: Card 2

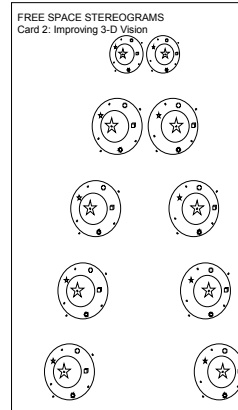
- Builds fusional reserves (step & ramp)
- Controls for & treats suppression

Card 2: Improving 3-D Vision: Mega 3-D!
After completing card 1 you will not be surprised by the pictures on card 2. What you can see is 5 pairs of targets, each target is made up of 2 rings, with other shapes as well. Before long these shapes will be floating off the page towards you, in a type of "virtual reality". The smaller targets are at the top of the page, and the targets become further apart towards the bottom of the page. Surprisingly, the smaller top two targets are actually easier to do than the larger ones. So start with the smaller targets.

Stage 1: The Smallest Targets
For now, try to ignore the larger targets and just concentrate on the smallest size at the top of the page. Don't think about the shapes: at this stage just concentrate on the rings. The procedure is exactly the same as for the circles on Card 1. However, there are no dots so you have to make your eyes go cross-eyed without using the dots.

As before, make your eyes go cross-eyed (you can use a pencil if you have to) until you see 4 blurred targets instead of 2. Then, change how cross-eyed you are until you see 3 targets. The inner rings on the central target should look like they are closer to you than the outer ones. **IF THE INNER RING SEEMS FURTHER AWAY THEN STOP DOING THE EXERCISES AND TELL YOUR EYE CARE PRACTITIONER.**

Practice keeping these targets instead of two or four. You may need to twist the page to keep the targets level. Try to keep the targets as clear as possible. When you can see 3 targets and keep them clear for most of the time then go on to Stage 2.



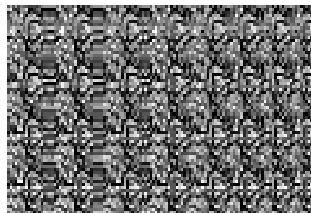
DEVELOPMENT OF IFS: Card 3

Card 3: Now to Magic!
Unlike Cards 1 and 2, Card 3 should be turned on its side to be viewed, so the heading is at the top. When you look at Card 3 you will probably not be able to see a lot, except for a few eyes looking out at you from near the top of the picture. Believe it or not, when you can do this exercise you will be able to clearly see letters on this sheet. What's more, these letters will appear in 3-D.

The type of picture on Cards 3 and 4 is called an autostereogram. Recently, the autostereogram method of seeing 3-D images has become very popular, and you have probably seen posters, postcards, books, and even videos using this type of picture. It may be that you have already experimented with these images, and you may or may not have managed to see them in 3-D.

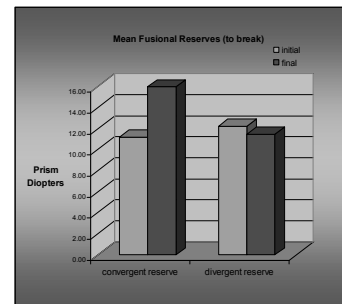
With this type of picture there are in fact 2 ways of seeing the image in 3-D. The way most people use is to under-converge the eyes. Because your eyes naturally under-converge, this method will be easiest for you. If you can already see 3-D images in this type of picture then it is almost certainly because you use the under-convergence method. However, the under-convergence method will not help your eye problem. The stages described below will teach you a new way to see the 3-D images, by over-convergence. This method is similar to that used on sheets 1 and 2 and will help your eyes to become better at working together.

- Builds fusional reserves
- Controls for suppression
- Card 4 similar, but different autostereogram



OPEN TRIAL: Fusional reserves & NPC (N=20)

- Divergent reserves (control) did not change significantly ($p=0.6$)
- Convergent reserves improved significantly ($p=0.004$)
- Mean NPC improved from 6 to 4 cm ($p=0.015$)



Evans (2000)

OPEN TRIAL: Effect of treatment on compensation

Criterion	Before	After	Chi-sqar.	Wilcoxon
Mallett	8 passed	14 passed	0.006	0.035
Sheard	7 passed	14 passed	0.001	0.025

Evans (2000)



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Accommodative dysfunction: confounding factors

- * refractive error
- * pharmacological agents
- * alcohol
- * neurologic anomalies
 - e.g., degenerative diseases, Adies syndrome, food poisoning, trauma, diabetes, subclinical viral encephalopathies; febrile illnesses
- * AC/A related (e.g., high AC/A & eso)



Accommodative anomalies

- * Accommodative paralysis
- * Accommodative insufficiency
- * Accommodative fatigue
- * Accommodative infacility (inertia)
- * Accommodative spasm (excess)

Accommodative amplitude

- * especially important in
 - esophores
 - symptomatic patients
 - measure monocularly and binocularly
- * repeat to check for fatigue
- * Norms (Hofstetter): (D)
 - Minimum amplitude = $15.0 - (0.25 \times \text{age in years})$
 - Probable amplitude = $18.5 - (0.3 \times \text{age in years})$



Accommodative facility

- * tested by flip lenses
 - +2.00D/-2.00D
 - Use letter or word target
 - can monitor suppression with vertical OXO
 - should be clear, single, both Nonius strips present
- * Also available in other powers
 - Norms will be different



Accommodative facility

- * Norms:
 - typical pre-presbyopic patients consulting an optometrist
 - 7.5 cycles per minute +/- SD 4.5
- * NB can also be measured by alternating fixation from near to far



Accommodative lag (MEM)

- measured by MEM retinoscopy
- px binocularly fixes target on retinoscope at normal reading distance
- practitioner monocularly rapidly interposes lenses to neutralise reflex
- lenses should only be present for 0.5 second

Accommodative lag (MEM)

- * Monocular estimate method (MEM)
 - norm is small with-movement neutralised by low sphere +0.25 to +0.75D
- * mean +/- 1 SD quoted as plano to +0.75
- * If negative lenses required then accommodative spasm



Management of accommodative anomalies

- Look for plus (cyclo)
- Treatment approaches are refractive or eye exercises
- combined accommodative & convergence insufficiency is difficult to treat
 - *Sometimes responds to exercises, sometimes needs plus lenses with base in prism*

Are accommodative exercises effective?

- Randomised controlled trials show that accommodation can be trained
 - **Cooper et al. (1987)**
 - **Stern et al. (2001)**

Exercises for accommodative anomalies: general principles

- Push up training (amplitude)
- Gradually increasing -ve lenses
- Near-far accommodative facility
- Flipper accommodative facility

- All of these can be carried out binocularly or monocularly

- Need px compliance
 - *If not, try plus lenses*



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