The Institute of Optometry is unique in being an independent self-financing charity dedicated to the promotion of clinical excellence, research, and education in optometry.

Roberson (1989)

Treating orthoptic anomalies in optometric practice

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WHEN TO TREAT AMBLYOPIA: conclusions of literature review

- Most results are of passive occlusion
- For strabismic amblyopes:
  - Age matters
  - No sharp cut-off, best to treat before 7-12 yrs
  - For best results, treat as early as possible
- For anisometropic amblyopes:
  - Age does not matter
  - Try with Rx first, ideally CL, patch if necessary


WHO SHOULD TREAT AMBLYOPIA: differential diagnosis

- optic nerve hypoplasia
- retinal pathology
- neural pathology

WHO SHOULD TREAT AMBLYOPIA: general principle

- Orthoptic treatment is within the scope of optometry
- Only treat a condition if you have appropriate skills
  - If you lack appropriate skills, refer to an appropriately skilled optometrist or to HES

WHO SHOULD TREAT AMBLYOPIA: differential diagnosis

- Look for negative sign:
  - no abnormalities of optic nerve, fundus, pupils
- Look for positive sign:
  - Strabismus
  - Anisometropia
  - An optometrist or ophthalmologist MUST be involved
- Treat decisively
  - Refer soon if unsuccessful
  - Monitor ocular health at every visit
TREATMENT OF AMBLYOPIA (a)
- Flow chart based on review of recent RCTs in Evans et al. (2011; OPO)
- Many cases of amblyopia can be cured by refractive correction alone;
  - 20% don’t need occlusion (Gibson, 1955; Pickwell, 1984; Stewart et al., 2004; West & Williams, 2011)
  - Contact lenses are likely to be best (Evans, 2006)
- Many cases never require full-time occlusion
  - If 6/9 to 6/25, 2h occl.
  - If 6/30, 6h > 2h
- Avoid full time occlusion for orthotropic anisometropia
- Timings approximate
  - See patients frequently during the treatment of amblyopia, to begin with every 4-6 weeks

TREATMENT OF AMBLYOPIA (b)
- RCTs show that occlusion is unsuccessful in 17-37% (Simons, 2005)
- If treatment fails, re-evaluate your diagnosis (Evans, 2007)
- Treated amblyopic eyes on average 2 lines below fellow (Repka et al., 2005)
- Remember that the child may be partially sighted during occlusion
  - It is not always better to do something than nothing at all (Jennings, 2005)
- Penalisation is a viable alternative to occlusion
  - West & Williams (2011)
- There is a dose-response relationship in patching (Stewart et al, 2004)
- Eye patch is best but compliance poor & they will cheat!

ACTIVE AMBLYOPIA THERAPY
- Active treatment for brief periods of occlusion in adults (Mallett, 1977; Campbell, 1978)
- RCT of IPS show 1 line improvement for adults, but recidivism (Evans et al., 2011)
- Perceptual learning methods look promising, but needs major RCT (Polat, 2008; Levi & Li, 2009; Evans et al. 2011; Astle et al., 2011)
- PEDIG group pilot study of vision therapy for amblyopia is promising (Lyon et al., 2013)
- Virtual reality methods may make treatment more engaging (Eastgate et al., 2006)

TREATMENT OF MOTOR DEVIATION
- Motor deviation
  - Refractive correction / modification
  - Prisms
  - Eye exercises
- Binocular sensory adaptations
  - Phoria: foveal suppression is rare
  - Strabismus: consider both sensory & motor

OVERVIEW: SEQUENCE OF TREATMENT
- in heterophoria:
  - if significant motor deviation treat first, usually any foveal suppression (rare) is eliminated
  - if (rarely) no significant motor deviation but only foveal suppression, then treat this

OVERVIEW: SEQUENCE OF TREATMENT
- in strabismus:
  - only treat motor or sensory if you are sure that both can be corrected
  - if can correct refractively / prismatically
    - easy to check that Rx will not cause intractable diplopia
    - usually sensory factors eliminated with Rx
  - if treat sensory factors before motor deviation corrected then will need occlusion
  - if good sensory adaptations then treatment usually inappropriate
MOTOR DEVIATION: REFRACTIVE CORRECTION: OVERVIEW

• Mandatory in accommodative esotropia
• Also possible to treat exo-deviations with negative lenses & convergence excess with multifocals
• 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; Paula et al., 2009)
• patient likely to 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
  – BF don’t reduce amplitude of accommodation (Fresina et al, 2010)
• 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: 8
  Δ
  SOP N: 10
  Δ
  RSOT
  – with +2.00 add: N ortho

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

MOTOR DEVIATION: PRISMATIC CORRECTION: SPECIFICS

• determine prism that
  – eliminates strabismus (no diplopia)
  – eliminates FD on Mallett Unit
• unlikely to adapt to prism if abnormal BV (North & Henson, 1985)
• But can check (2 mins) don’t adapt (North & Henson, 1985)
MOTOR DEVIATION: PRISMATIC CORRECTION

**EVIDENCE**
- Small RCT (mostly esophoria) shows Mallett prism is preferred to no prism
  - "Based on our results, one would not expect to find a significant preference for prism prescribed according to Sheard’s criterion."
    - (Payne et al., 1974)
- Prism prescribed using Sheard’s criterion is no better than placebo for children with CI
  - (Scheiman et al., 2005)
- RCT shows Mallett prism improves reading speed
  - (O’Leary & Evans, 2006)
- Presbyopes with CI have less symptoms with BI prism
  - (Teitelbaum et al., 2009)
- Prismatic glasses (8BI) as effective as computer orthoptics at improving reading
  - (Dusek et al., 2011)

**MYTH**
- patient might “eat up prisms”
  - prism adaptation usually abnormal in orthoptic anomalies
    - (North & Henson, 1981)
  - exceptions can occur
  - e.g., myopes with decompensated esophoria

**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: 3 Δ SOP, 2Δ L/R N: 3Δ XOP, 3Δ L/R
  - Align. prism: D: LE suppl. 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
  - Work well in those aged 11-19y, even if strabismic (Pickwell & Jenkins, 1982)
  - 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)
    - Scheiman & Gwiazda (2011)

FUSIONAL RESERVE EXERCISES: EVIDENCE IN THE LAST 10 YEARS - RCTs
- In-office VT better than placebo or home pencil push-ups (Scheiman et al., 2005; CITT, 2008)
  - [15min a day + 60min weekly > 15min a day]
- Systematic review supports VT for CI; lack of evidence for other disorders
  - (Cacho Martinez et al., 2009)
- Treatment for 12+ weeks may be optimal
  - (Scheiman et al., 2010)
  - But did not control for treatment dose
- Systematic review suggests in-office VT better than at home
  - (Scheiman & Gwiazda, 2011)
  - But don’t seem to have controlled for treatment dose

FUSIONAL RESERVE EXERCISES: EVIDENCE IN THE LAST 10 YEARS - RCTs
- Seems to be better to exercise convergence and accommodation independently of one another than together (Harwood & Toor, 2014)
  - But this study looked only at normals
- Other studies (not listed) have not included a matched treatment for the control group
**Fusional Reserve Exercises:** Evidence in the last 10 years—objective measures

- Small trial indicates VT for CI improves convergence, phoria, peak velocity convergence, and fMRI measures (Alvarez et al., 2010)
- Children with vergence insufficiency & vertigo show improved vergence response with training (Jainta et al., 2011)
  - It is the transient (open-loop) phase of vergence that changes, not the tonic (closed-loop)

**Motor Deviation:**

- **Fusional Reserve Exercises:**
  - Specifics
    - Haploscopic instruments / anaglyphs / vectograms / free-space methods
      - Feedback helps, as in computer-orthoptics
      - Varying targets & conditions helps
      - A key factor is practitioner enthusiasm
      - With a PC & printer anyone can design their own exercises

**Orthoptic Exercises:** The elderly

- Retrospective study of 161 presbyopes with asthenopia and convergence insufficiency/decomp. phoria
- Most needed <10/52 of therapy, max. 15/52
- 97% had symptoms cured, 92% + improved optometric status
- After 3/12, 77 needed further VT

**Convergence Insufficiency:**

- Overview
  - An exophoria/tropia at a close viewing distance
  - Exercises to extend the binocular range into the monocular range
  - Often need brief top-up (maintaining) exercises
  - RCTs support training of positive fusional reserves

**Convergence Insufficiency:** Specifics

- Treatments (in order of increasing complexity)
  - Simple push up (bead on string if very remote)
  - Jump convergence
  - Push up with physiological diplopia
  - Jump convergence with physiological diplopia
  - Free-space stereograms
- RCT shows intensive programme of exercises better than home push-up
  - 15 min a day + 60 min weekly > 15 min a day
- "Whether synoptophore or jump vergence stereocards are used, the critical variable is the length of time it is maintained" (Vaegan, 1979)
- "Convergence exercises independent of accommodation were the most effective treatment" (Horwood & Toor, 2014)

**Bead-on-string exercises**

- Patient holds card, C, close to nose
- Bead, B, is on string tied to card
- Patient fixes bead, sees card in crossed physiological diplopia
- String appears as X
  - In suppression, part of X is missing
- This approach does not exercise relative accommodation or relative convergence
FUSIONAL RESERVE EXERCISES:
COMPUTER ORTHOPTICS

- HTS
  - Wide range of vision therapy
  - For fusional reserves, amblyopia & much more (if wanted)
  - In-office
  - At-home

- 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

Reproduced with permission from Vision Training Products, Inc. (Bernell Division)

PHYSIOLOGICAL DIPLOPIA

- Patient looks at A
  - B is seen in crossed physiological diplopia
- Patient looks at B
  - A is seen in uncrossed physiological diplopia

INSTITUTE FREE-SPACE STEREOGrams (IFS)

A new version of an old approach

Bruce Evans
Director of Research, Institute of Optometry

Acknowledgment: Anita Lightstone entered 5 patients into trial
Colleagues at the Institute for comments on early versions

DECLARATION OF INTEREST

- Institute of Optometry is a registered charity
- IOO Marketing raises funds for Institute of Optometry
  - Markets equipment
  - Pays an incentive to staff to invent equipment
- Bruce Evans receives 0.85p for each set of exercises sold
**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
- Declaration of interest

**IFS EXERCISES: USES**

- 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: Details**

<table>
<thead>
<tr>
<th>Goal</th>
<th>Design feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card 1: First Exercise: Dots</td>
<td></td>
</tr>
<tr>
<td>Stage 1: Seeing Four Dots</td>
<td></td>
</tr>
<tr>
<td>Stage 2: Improving 3-D Vision: Mega 3-D!</td>
<td></td>
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<tr>
<td>Stage 3: Now to Magic!</td>
<td></td>
</tr>
<tr>
<td>Stage 4: Finding Your Eyes</td>
<td></td>
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</tbody>
</table>

**FREE SPACE STEREOSCOPIC IMAGES**

Card 1: Improving 3-D Vision

- 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 develop 3-D vision.

**DEVELOPMENT OF IFS: Card 1**

- Teaches physiological diplopia & introduces 3-D perception

**DEVELOPMENT OF IFS: Card 3**

- 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 ($p=0.015$).

![Graph showing changes in fusional reserves and NPC](image)

*Evans (2000)*

**Conclusions about orthoptic exercises**

- Decompensated exophoria and convergence insufficiency are readily treatable in optometric practice.
  - Treatment does not need to take up a lot of “chair time”.
  - Treatment improves MRI measures (Alvarez et al., 2010).
- Treatment with orthoptic exercises is appropriate for optometric practice.
- Strabismus can also be treated with exercises (Pickwell & Jenkins, 1982).
- Treating strabismus with exercises seems less common now (Piano & O’Connor, 2011) than Pickwell might have wished...

**A sceptical view of Behavioral Optometry**

- Non-standardised
- "no randomised controlled trials" *(Jennings, 2000)*
- "a large majority of behavioral management therapies are not evidence-based" *(Barrett, 2008)*

 Validated
- Yoked prisms in neurological patients
- Visual rehabilitation after brain disease/injury

*Voltaire: “Practical therapeutics is the art of keeping the patient entertained until nature effects a cure”*

**Controversy: training saccades in dyslexia**

- Saccades are not unique to reading.
- Abnormal saccades when reading more likely to be a consequence than a cause of dyslexia.
- The DEM is not an eye movement test:
  - DEM test has no correlation with objective eye movements measures *(Ayton et al., 2009)*
  - Abnormal DEM ratio is an effect not a cause of reading difficulties *(Medland et al., 2010)*
  - the DEM is not a measure of saccadic eye movements *(Webber et al., 2011)*
- Attention deficit disorder (ADD) is an important confounding variable.

**3-D displays are popular but unnatural**

- Vergence changes but accommodation does not
- Loss of spatial resolution (but may help) OR Loss of temporal resolution
- Unusual degrees of stereopsis
- Possible mismatch between various depth cues

*Howarth (2011)*
How many people will not perceive 3-D content?

- Strabismus 2.5-4%
- Uncorrected anisometropia 0.5-1.5%
- Monovision 0.4%*
- Stereo-blind <0.1%*
- Poor or distorted vision in one eye v rare in young*
- Total 3.5-8%

*more common in older people

Could be reduced with better eyecare

How many people may have discomfort with 3-D?

- Under-corrected refractive error 11-30%*
- Decompensated heterophoria possibly, 1-10%*

*more common in older people

CONCLUSIONS

- Always be on the lookout for pathology
  - refer if no significant improvement
- BUT pathology is very rare
- It is possible to treat amblyopia in optometric practice
  - patients will need good instructions & regular checks
- Many comitant ocular motor anomalies are treatable
  - plus for eso and minus for exo are under-used treatments
- Vision therapy for convergence insufficiency is evidence-based, but there is a need for more research for other forms of vision therapy

Occ. Fingers, between the columns of the Irish (who forgett ‘The Odyssey’ and ‘The Rain’); what’s the average height of the Irishman?”

Handout from www.bruce-evans.co.uk for regular tweets on optometric research

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