**Delphi stage 1**
symptoms, conventional optometry,
pattern glare

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**PLAN**

| Introduction | Symptoms | Basic optometry | Binocular vision | Accommodation | Pattern glare |

Based on published literature, it seems unlikely that a questionnaire alone can be used to reliably detect visual problems (Evans et al., 1993; Hollis & Allen, 2006)
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**Pathology & refractive errors**
- Serious pathology is rare & is not correlated with reading difficulty (RD)...BUT
- Reading difficulties, headaches, and perceptual distortions are all soft neurological signs
  - Ranges, will result from pathology
- Similarly, refractive errors are not especially common in RD, but can be present in any child
- So, any child who struggles at school should see an optometrist

**Case study G5781**
- 08-02: 29 yr old female adult student, referred by EP
  - Words blur & jump when tired, skips words, sore eyes with VDU
  - Ocular motor balance, pupils, ophthalmoscopy, fields all OK
  - Refraction: R=L=-0.25/-3.25x180=6/9

**BINOCULAR INSTABILITY: DIFFERENTIAL DIAGNOSIS**

<table>
<thead>
<tr>
<th>SYM</th>
<th>BINOCULAR INSTABILITY</th>
<th>DECOMP. PHORIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>phoria</td>
<td>may/may not be present</td>
<td>must be present</td>
</tr>
<tr>
<td>variableity of phoria</td>
<td>≥1.75x</td>
<td>&gt;1.75x</td>
</tr>
<tr>
<td>cover test recovery</td>
<td>may/may not be abnormal</td>
<td>usually slow &amp; hesitant</td>
</tr>
<tr>
<td>ocular reserves</td>
<td>convergent &amp; divergent disparity</td>
<td>low reserve opposing phoria</td>
</tr>
<tr>
<td>visual acuity</td>
<td>unstable FD, may be aligned</td>
<td>unaligned may not be unstable</td>
</tr>
<tr>
<td>alignment prism</td>
<td>unstable FD, may be aligned “on average”</td>
<td>may/may not be unstable</td>
</tr>
<tr>
<td>cover test</td>
<td>significant constant</td>
<td>insignificant constant</td>
</tr>
</tbody>
</table>
DISSOCIATED HETEROPHORIA

fusional reserves  →  motor fusion  →  sensory fusion  →  fusion lock

COMPENSATED  or  NOT COMPENSATED  or  BINOCULAR INSTABILITY

ALIGNING PRISM: Mallett Unit

- aligning prisms/spheres to eliminate FD
- good foveal and peripheral fusion lock
- question set is important
  - Karania & Evans (2006)
- for symptomatic phoria:
  - sensitivity 75%
  - specificity 78%

ALIGNING PRISM: Mallett Unit

- Maintain normal binocular vision
  - Increase lighting, full field of view
  - Use hand held loose prisms
  - Minimum prism for alignment
  - Re-normalise BV between prisms
  - Prism dioptrre steps: 0.5, 1.0, 2.0, 4.0

KEY SIGNS OF DECOMP. PHORIA

- 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

FUSIONAL RESERVES

- Can be measured with:
  - loose prisms
  - prism bar
  - rotary prisms
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**SUMMARY:** diagnosis of binocular instability & decompensated heterophoria
- Sheard’s criterion
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**SUMMARY:** diagnosis of binocular instability & decompensated heterophoria
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**MOTOR DEVIATION:**
**REFRACTIVE CORRECTION:**
- Mandatory in accommodative esotropia
- Also possible to treat convergence excess with multifocals & exo-deviations with negative lenses
- Limited by 4 factors
  - Angle of deviation
  - Refractive error
  - Accommodation
  - AC/A ratio

**MOTOR DEVIATION:**
**REFRACTIVE CORRECTION:**
- Determine sphere that
  - Eliminates strabismus (no diplopia)
  - Eliminates FO on Mallett Unit
- Prescribe, try to reduce approx. every 3-6/12
- Negative adds (Chen et al., 2016) 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

**MOTOR DEVIATION:**
**REFRACTIVE CORRECTION:**
- Case study: D1542
  - 11/5/96, female, age 8y, 1 headache a fortnight
  - Wearing full cycle plus (c. +2.00, R=L)
  - Cover test: D: 8a SOP N: 10a RSOT
  - With +2.00 add: N 4a RSOT
  - With +2.50 add: N ortho

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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

MOTOR DEVIATION:
PRISMATIC CORRECTION: 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
  – MKH Polatest method criticized for leading to "excessive amounts of prisms" (Lang, 1994)

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: 3 △ SOP , 2 △ L/R N: 3 △ XOP, 3 △ L/R
  – Align. prism: D: LE supp. N: 1 △ in, 1 △ up R
  – Rx: plano, 1 △ 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 eso-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
  – Cliftreda & Tannen (1956)
  – Scheiman & Gelazda (2011)

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 & patient enthusiasm
  – better to train convergence & accommodation separately rather than together
    – (Horwood & Toor, 2014)
• with a PC & printer anyone can design their own exercises

It was over. But the way the townsfolk called it, neither man was a winner.
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
  15min a day + 60min weekly > 15min a day

- "Whether synoptophore or jump vergence stereocards are used...the critical variable is the length of time it is maintained" Vinger (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 fixates 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

APERTURE RULE TRAINER

- Simple aperture to train convergent reserves
- Double aperture to train divergent reserves

PHYSIOLOGICAL DIPLOPIA

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

- Cats at arms length: patient fixates pencil
- Pencil position adjusted until middle two cats fused
- Patient asked to see cats clearly: exerting negative relative accommodation

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:
  - decompressed 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

DEVELOPMENT OF IFS: Card 2

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

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)

Evans (2000)

Case study
- 07-97: 10 yr old boy with suspected SpLD
  - Reading: blurs, changes size, doubles.
  - Sore & tired eyes, 2 headaches a month
  - Convergence insufficiency
  - Given eye exercises
- 08-97: exercises done, "easy"
  - No blurring or doubling now, no headaches
  - Convergence & convergent fusional reserves improved
- 03-98: no symptoms
  - Reading and maths now average. Spelling still slightly behind, not a problem
  - Clinical tests all normal

Handout from www.bruce-evans.co.uk

Case study
- 09-97: 12 yr old girl with suspected SpLD
  - Reading: hard to focus & eyes water
  - Decompensated exophoria at near
  - Given IFS exercises
- 03-98: motivation poor, exercises not done
  - Findings similar to above
  - Given spectacles (+ve add) to correct esophoria
- 07-98: glasses used in class & reading
  - “Glasses make eyes work harder so less blurring”
  - Heterophoria compensated when glasses worn
  - Still SpLD, but reading less strained
  - Prescription reduced over next 2 yrs to nil

Accommodative amplitude
- E.g., RAF rule
  - read smallest line they can see
  - move target in and watch for saccades to make sure they are accommodating on the target
  - at first blur, move back until clear
  - end-point is halfway between blur and clear points
  - 1 D/s
  - Can also test with negative lenses

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 Norius 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 (Zellers et al., 1984)
  - NB can also be measured by alternating fixation from near to far

**Accommodative lag (MEM)**

- measured by MEM retinoscopy
- px binocularly fixates 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

**PLAN**

- Introduction
- Symptoms
- Basic optometry
- Binocular vision
- Accommodation
- Pattern glare

**Representation of colour in macaque area V2**

- Used optical recording & confirmed with electrode recording
- Identified “colour-preferring” modules
- Did not overlap with “orientation-preferring modules”
- Each contour illustrates the cortical region giving the maximal response to each tested colour
  - But different colours produce different response magnitudes
**Pattern glare**

- High prevalence in:
  - Sensory visual stress
  - Migraine
  - Photosensitive epilepsy
  - Autism

**Pattern glare test**

- Background:
  - Wilkins et al. (1984)
  - Evans et al. (1994)
  - Conlon et al. (2001)
- Pattern 1 (coarse) is control
- Pattern 2 (medium) should maximally elicit pattern glare
  - Neurological origin
- Pattern 3 (fine) is another control
  - Optical rather than neurological
  - People with low visual discomfort may get more illusions with 3 than with 2

**Stevenson & Evans Study 1 results: norms**

- Is there a gender effect?
  - Removed people with frequent headaches
  - Matched for age
  - 33 females & 34 males
  - Did not differ significantly for each grating or 3-12cpd

**Stevenson & Evans Study 1 results: age**

- Gender matched 38 oldest with 38 youngest participants
- Similar prevalence of migraine in both groups
- Groups differ sig. at 3cpd and 12cpd, but not at 3-12
Stevenson & Evans Study 3 results: migraine

- 30 new participants:
  - Medical diagnosis of migraine
  - Age- and gender-matched to study 1
- Difference between groups for each grating not statistically significant
- More pattern glare in migraine group at mid-SF relative to high-SF (p=0.041)
- If mid-high>1 is abnormal:
  - 17% of migraine
  - 1.7% of controls

Stevenson & Evans: conclusions

- Norms:
  - For medium grating, 95% of typical optometric population have score less than 4
  - For medium-high, 95% score less than 2
- Pattern glare is similar in males & females
- Pattern glare decreases with age
- Pattern glare is higher than usual in migraine, and the medium-high measure best correlates with migraine
- The test seems useful for:
  - Measuring pattern glare in clinical practice
  - Indicating who may benefit from coloured filters

Differential diagnosis in the consulting room: what to do if the patient has BI/AI & MISVIS?

- Listen to the symptoms (if you hear hoofs...)
- Are the problems only with text?
- Are there pathologic symptoms like “rivers”?
- Look at the signs
- Is any BV anomaly motor or sensory in origin?
- Is there pattern glare?
- 55% of patients receiving gold standard vision therapy are still symptomatic after 12 weeks of treatment
- Scheiman et al (2005)
- Investigate different interventions on text:
  - Coloured filters
  - Spheres
  - Prisms
  - Occlusion

CONCLUSIONS

- People with RD need an eye exam
- The exam should be more comprehensive than a normal eye exam, including:
  - Detailed symptomatology
  - Extra binocular vision tests
  - Extra accommodative tests
  - Testing for sensory visual stress
- Most patients will be OK
- BUT some will need treatment