Computer vision syndrome: 
new problem or conglomerate of old problems?

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INTRODUCTION
CVS – NEW CONGLOMERATE OF OLD PROBLEMS?
BINOCULAR & ACCOMMODATIVE CHALLENGES
VISUAL STRESS
SPECIFIC CHALLENGES WITH DISPLAYS
CONCLUSIONS

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OVERVIEW: CAVEAT

• Always look for pathology:
  • Neuro-optometric checks
    • Pupils, discs, fields, strabismus, incomitancy, accommodation
  • Check these things regularly

• Case study:
  • Px in early 20s: headaches with computer use
  • Saw 4 optoms, 7 physicians, 1 neurologist
  • Eventually, diagnosed with chronic intermittent angle-closure glaucoma, when it became acute
  • Patient then sued all healthcare practitioners

"I'm leaving you Mitchell. You've never had tunnel vision and you never will."
**Definition of CVS**
- "ocular complaints as a result of looking at a computer monitor"
- Blehm et al. (2005)
- "combination of eye & vision problems associated with the use of computers"
- Rosenfield (2011) from AOA
- "collection of visual, ocular and musculoskeletal (neck and shoulder pain) symptoms that result from prolonged computer use"
- Gowrisankaran & Sheedy (2015) from AOA

**Classification of CVS**
- Blehm et al. (2005)
- Rosenfield (2011):
  - Refractive error
  - Accommodation
  - Vergence
  - Dry eye
- Gowrisankaran & Sheedy (2015)

**Sheedy et al. (2003)**  No computers
- Is all asthenopia the same?
- 20 young adults with good vision
- Rated symptoms after:
  - Mixed astigmatism, close viewing distance, upward gaze, dry eyes, lens flipper, small font, glare, and flickering light (15Hz)
  - "at least 2 different afferent pathways for the symptoms of asthenopia"
- ESF: burning, irritation, tearing, and dryness
  - From: holding the eyelid open, glare, up gaze, small font, and flickering
  - "dry eye"
- ISF: ache, strain, and headache located behind the eyes
  - From: close viewing distance, lens flipper, and mixed astigmatism
  - "Accommodative/binocular stress"

**CVS case study**
- 52 year old design engineer
- Clinical findings
  - V (LogMAR): R 0.1 L 0.0 B-0.06
  - Subjective: R -0.50DS 6/5 L -0.25 6/5 Add: @38cm +1.75 @57cm +1.00
  - Other findings normal except NPC 11cm and N cover test & XP good recovery
- Visual requirements in different eras:
  - 1970s: SV NV spectacles & prism/VT
  - 1990s: IV/NV bifocals & CI exercises
  - 2017: no spectacles & no symptoms
The good old days (Duke-Elder, 1970)

- Duke-Elder (1970) on history of eye-strain
  - Eyes have not “evolved sufficiently to fulfil the exorbitant demands of unremitting close work imposed upon them by a highly complex and artificial civilisation”.
  - Asthenopia from Mackenzie (1843), treatment included abstention from near work, purgatives, tenotomy of medial recti, cauterization of urethra to stop spermatorrhoea or diminish masturbation, and “only very rarely in the aged convex lenses” or emigrate to “follow the pastoral pursuits of an Australian colonist”.
  - Donders (1864) said muscle strain, but Duke-Elder: “much of the symptom complex of eye-strain is probably due to tiring of higher perceptual processes”

The good old days (Duke-Elder, 1970)

- Duke-Elder (1970) on causes of eye-strain
  - Environmental factors:
    - Illumination (quantity, quality, distribution)
  - Ocular factors:
    - ametropia, accommodation, heterophoria, convergence, fusion inadequacy, aniseikonia (perhaps)
    - Gross visual errors affect function, minor ones cause eye-strain through continuous error to correct the defect
  - Constitutional factors:
    - Unfit, overwork, malnutrition, exhaustion, insufficient sleep, anxiety, emotional strain
  - Symptoms:
    - Eyes tired, hot, uncomfortable, watery, prone to infections;
    - Actual strain developing to pain;
    - Referred symptoms: headaches, vertigo, digestive
    - “Headache is the commonest symptom associated with eye-strain”…“occurs in almost every possible variety”

The good old days (Duke-Elder, 1970)

  - Environmental factors:
    - Notes need for adequate light, but not too much, similarly for contrast: “both brightness contrast and colour contrast should not be excessive”
    - Avoid flicker
    - Red & yellow light more likely to cause fatigue than blue & green
  - Ocular factors:
    - If vertigo consider cyclophoria
    - Correct Rx, consider eye exercises
    - For detailed work orthoscopic spectacles
  - Psychogenic factors:
    - Often have “a host of spectacles” which “make no difference”
    - “the real trouble is a pathological attitude of mind, none the less real”
Are computers the latest thing to be blamed for asthenopia?

Ocular motility problems
- Incomitancies are rare but A & V syndromes are common
- Workstation should avoid the px looking in problematic directions of gaze
  - Could potentially lead to decompensation
- Detect incomitancies
- Advice on workstation setup

Diagnosis of decompensated heterophoria & binocular instability

- 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 (Mallatt): 1.5Δ for under 40 years or 2.0Δ for over 40 years: -2
  - Aligning prism (Mallatt): +1Δ but unstable: -1
  - Forced suppression (Duplpin): +5Δ or diplopia during forced suppression test: -2

If score: <4: diagnose normal, ≥5: treat, 4-5 continue down table adding to score so far
- Sherrill’s criterion: failed: -2
- Psychokinesis: failed: -1
- Dissociated heterophoria: testable so that result is over +5Δ (i.e., phoria ≥5Δ): +1
- Fresnel amplitude: divergent break point - convergent break point x 105: < 205: +1

If total score: <6: diagnose normal, otherwise treat


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Treatment of decompensated heterophoria & binocular instability

- Refractive correction/modification
  - Under-used
  - Simple to prescribe with naturalistic FD test
- Prisms
  - Probably under-used
  - Simple to prescribe with naturalistic FD test or EyeGenius
- Eye exercises
  - Can be successful for motivated patients

Accommodative anomalies

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

Spectacles for mild accommodative anomalies: new developments

- Single vision lenses with accommodative support
- e.g., Hoya Nulux Active
  - Vertical aspheric design
  - No peripheral distortion, no defined reading zone, no corridor, no specific add
  - Wide, edge to edge, NV
  - 2 varieties, 5 (+0.53) and 8 (+0.88)
  - The lens is said to reduce asthenopia associated with use of the ciliary muscle
  - Also likely to be effective for correcting mild accommodative insufficiency
  - Regular checks of fit may be required

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Visual stress (PRVS; Mearles-Irlen syndrome)

PREVALENCE: 720% of people with dyslexia; 5% of normal readers also correlated with migraine, autism, epilepsy

AETIOLOGY: cortical hyperexcitability causing pattern glare from text

SYMPTOMS: asthenopia, headaches, perceptual distortions (words move)

SIGNS: diagnostic algorithm

TREATMENT: symptoms alleviated by
- Coloured filters
- Software
- Reducing contrast (including colour)
- Avoiding flicker & stripes

Evans, Allen, Wilkins (2016)

Specific problems with displays

- Maybe in wrong position
- Can flicker
  - Possibility of stroboscopic interaction with fluorescent lights
- Can be too bright
- Can achieve very high contrast
- Can have unnatural colour contrast

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Specific problems with displays

- 3-D displays dissociate convergence & accommodation
  - Loss of spatial resolution (may help) OR
  - Loss of temporal resolution
  - Unusual degrees of stereopsis
  - Possible mismatch between depth cues
- People with mild BV problems are more likely to have symptoms with 3-D displays
  - Lambooij, Fortuin, Ijsselsteijn, Evans, Heynderickx (2010)

Additional considerations

- Neurological basis for visual discomfort
  - Wilkins (1984) seminal paper on visual discomfort
  - Wilkins (2016): for scenes from nature their gross aspects have a higher contrast than the fine detail
  - The Fourier amplitude spectrum decreases approximately as the reciprocal of the spatial frequency, 1/f (Field, 1987).
  - The neural computation involved in sight is well-designed to take advantage of the 1/f characteristic (Field, 1987, 1994; Geisler, 2008).
  - Explains much discomfort from inside (Wilkins, 2016) and outside (Le et al., 2017) of buildings
  - Discomfort can be predicted from the unnatural statistical properties of the image.
  - The unnatural statistical properties are associated with inefficient neural processing and with a greater metabolic load in consequence.

Additional considerations

- Children may be more at risk
  - More prone to visual stress (Evans & Stevenson, 2008)
  - Winterbottom & Wilkins (2007)
    - 80% of schools have 100Hz flicker
    - Some desks at 1,000 lux
    - Interactive whiteboards often have uneven & excessive illumination
    - Pattern glare from window blinds

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- Like any tool, computers can be used to good or to bad effect
  - Asthenopia is the problem, not computers
- Find out about your patient’s workstation
- Detect and manage refractive error & BV/accommodative problems
- Abnormal eyes are likely to have problems
- Normal eyes may have problems in abnormal situations
- Flicker can be a problem even when not consciously perceived
- Visual stress from cortical hyperexcitability can cause symptoms sometimes blamed on BV/accommodative anomalies & vice-versa

Some famous people who were dyslexic:

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