Post-trauma vision syndrome: “myopia” AND accommodative insufficiency?

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Post-trauma vision syndrome

- Myopia
- Accommodative insufficiency
- Convergence insufficiency
- Possible exotropia, exophoria
- Photophobia
- Decreased blink rate
- Spatial disorientation
- Balance and postural difficulties

PTVS symptoms

- Diplopia
- Objects appear to move
- Visual memory problems
- Staring behaviour
- Poor tracking ability
- Asthenopic symptoms

Incidence

- In my experience:
  - Any traumatic closed head injury resulting in coma, with initial global effects on motor and cognitive function
  - Typically involves midbrain

Frequency (Kowal 161 pts)

- 16% poor accommodation
- 19% pseudomyopia (55% persisted)
- "4 had poor accommodation despite pseudomyopia"

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Differential

- Spasm of the near reflex
  - Accommodative excess
  - Miosis
  - Esophoria/tropia
- Accommodative spasm
  - Excessive accommodation tonus: should it be excessive when measured at distance and near?

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"Pseudomyopia"

- The excess accommodation disappears with cycloplegia, but commonly recurs as cycloplegia wears off (London, Kowal)
- Thus, it is excessive accommodation ie focusing closer than normal when tested at distance, but why?

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Treatment

- Atropinisation
  - "Treatments using cycloplegics with sunglasses and bifocals were.. uniformly rejected by patients... (Kowal)"
- Refractive correction, near addition
- Vision therapy: accommodative facility

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Neurological causation (London)

- "..shift secondary to an irritative lesion that affects the parasympathetic innervation, resulting in ciliary body contraction.."
- "secondary to neural irritation of the parasympathetic third nerve subnucleus, or possibly disinhibition of brain stem centres.."

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Control of accommodation

- Learned proximal information
- Blur
- Conscious/voluntary
- Convergence

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Accommodation... sensorimotor intelligence (Wachs)

- ..a self-directed, intrinsically constructed knowledge of body, physical world and practical use...(Wachs)

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Accommodation

- Identification of an object fixated in space along the third dimension of the learned visual space construct.
- The Z axis is constructed through experience of the baby and child through proprioceptive and kinaesthetic feedback of eye hand activities.
- Spatial construct to accurately localise the identification system in space.

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X and Y axes

- Given by the egocentric laterality of the body, and gravitational vertical of the body.
- Disturbances of the learned X and Y spatial coordinates (ambient system) eg by hemianopia, or midbrain/brainstem trauma, could disrupt the basis for the Z axis

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Dark focus

- Location of accommodation in space in the absence of visual information
- Young adults
  - Mean 1.6D (62.5 cms), range 0-4D
- Large variations in studies
- But individuals relatively stable
- Gradual changes due to continued close work

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Dark focus

- Changes with nervous system activity
- Measurement by laser optometer
- Clinically measured by a stigmatoscope ie light of a retinoscope in a dark room
- But results variable

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Concept of dark focus

- Resting point of accommodation
- We focus OUT for distance tasks
- And focus IN for near tasks

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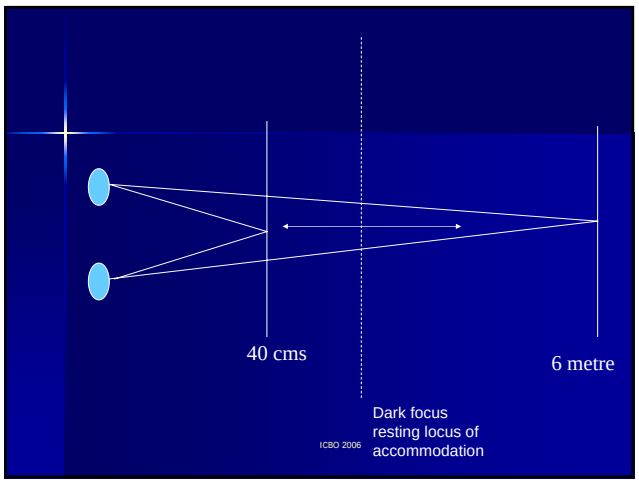

Mathematics!

- Myopia is a relative posturing of the identification system closer in space than the demand (zero at 6 metres)
- Myopia of 1 dioptre means the identification system is localising at 1 metre from the individual
- Myopia of 2 D means it is at 50 cms
- Etc

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Accommodative insufficiency

- A lag of accommodation measured by near retinoscopy at 40 cms is a measure of less response than the demand of 2.5 D
- A lag of 1 D means a response of 1.5 D (2.5-1.0), and identification is localising at 67 cms
- A lag of 2 D indicates a spatial value of 2metres etc

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Pattern of PTVS

- Moderate degree of myopia, and moderate to severe degree of accommodative insufficiency
- It is not accommodative spasm in the true sense, since there is excessive focus at distance but insufficient focus at near
- Patterns (London)
  - Transient case which resolves
  - Commonly chronic but stable mild myopia
  - Less commonly, progressive myopia

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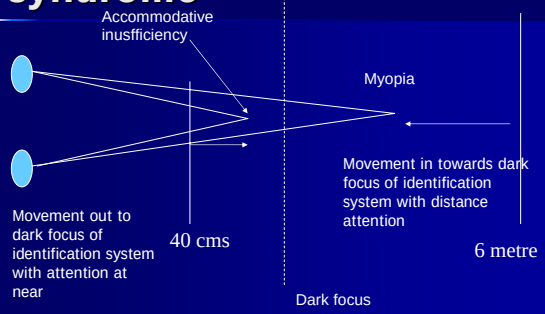
Post trauma vision syndrome

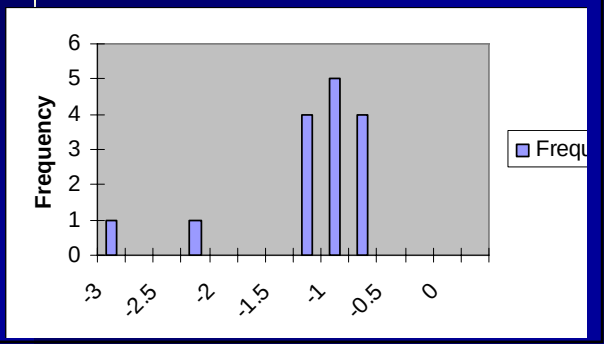


Study data

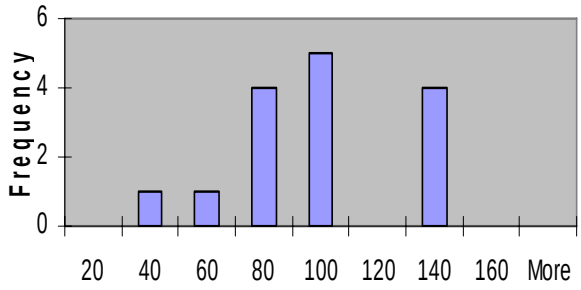
- Randomly selected 15 records from TBI patient population with:
  - History of traumatic head injury
  - Post-traumatic myopia
  - No pre-existing myopia
  - No ocular pathology (other than possible common mild optic atrophy)
  - Age range 21-43
  - 13 males, 2 females, long term problems.

Age	RE sph	RE spatial	LE sph	LE spatial	MEM lag	MEM spatial	Differences
23	-0.75	133	-1	100	2	200	67
41	-1	100	-1.25	80	1.5	100	0
45	-1	100	-1.25	80	1	67	-33
33	-1	100	-1	100	1.5	100	0
38	-1.25	80	-1.25	80	1.5	100	20
21	-2.25	44	-2.25	44	1.25	80	36
24	-3	33	-3.5	29	0.5	50	17
24	-0.75	133	-1.25	80	1.25	80	-53
23	-1	100	-1	100	1.5	100	0
33	-1	100	-1.25	80	1.75	133	33
22	-0.75	133	-1	100	1.75	133	0
28	-1.25	80	-1.25	80	1.25	80	0
30	-1.25	80	-1.5	67	1.25	80	0
28	-0.75	133	-1	100	-0.25	36	-97
30	-1.25	80	-1.25	80	0.5	50	-30

RE myopia



RE spatial locus of "myopia" (cms)



Summary

- The majority of post-traumatic myopia is -1.00 to -1.25 sphere, with minimal or no cylinder
- The visual systems, when asked to attend at 6m, localise around 1 metre

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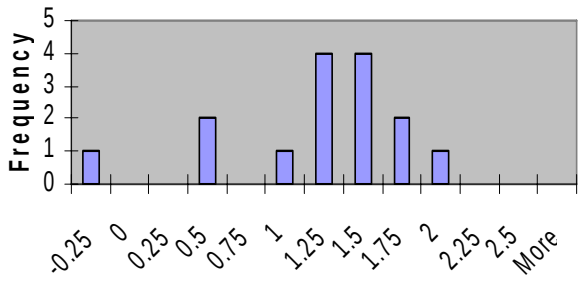
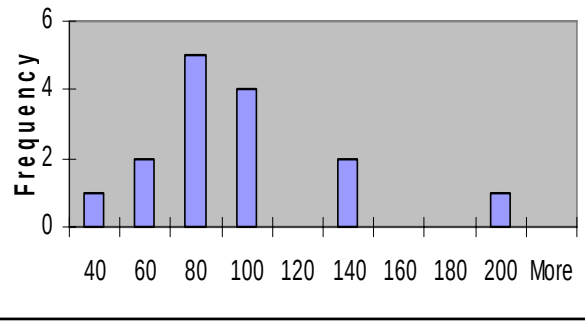
MEM lag (D)



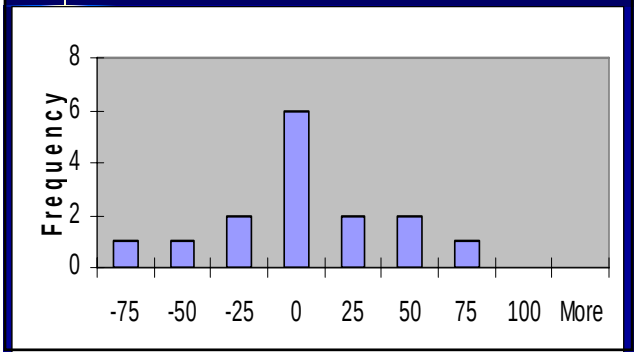
Accommodative near locus (cms)



Summary

- The majority of near accommodative response is to localise between 60 and 100 cms from the patient

Difference between near and distance loci (cms)



Summary

- The most common response (6/15) of the identification systems in this study, when tested at distance and near, is to localise in the same place in space at about 1 metre from the patient.

And.....

- Is this contiguous with the dark focus?
- Dark focus varies individually, and can change gradually over time; we do not know their pre-trauma dark focus
- We are in the process of re-examining these patients for dark focus and trends over time
- I now routinely measure dark focus on all TBI patients

Implications

- London describes three patterns of post-trauma myopia
  - 1 Transient cases which resolve
  - 2 Chronic but stable, most common
  - 3 Progressive myopia, less common

In my experience...

- The cases studied are all long term, chronic problems. The transient cases may not present as much for care, as their neurological recovery takes precedence over transient visual needs.
- Treatment involves??
- The majority of these chronic cases studied show stable myopia and accommodative function over time.

Hypothesis

- Brain trauma can disrupt a person's ability to access learned Z-axis sensorimotor control of accommodation in visual space
- The system loses its ability to know and respond to changes in task distance

Hypothesis

- The accommodation system essentially localises at its resting tonus ie dark focus
- Testing at distance shows myopia
- Testing at near shows accommodative lag
- Long term, the system builds in this new "learned" space, unless the system is retrained at an early, plastic stage

Using the model outlined:

- An acute case of post-traumatic myopia should be managed by aggressive vision therapy of accommodation, emphasising change in space supported by proprioceptive involvement; together with sufficient plus at near to minimise near visual stress.
- It may be possible to relearn the visual-spatial skill of focusing

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Chronic but stable…

- A chronic but stable case of post-traumatic pseudomyopia should be managed by:
  - Minus at distance if indicated
  - Plus at near
  - Annual reassessment
- The patient has essentially rebuilt their visual space around the adaptation, and cannot access the lost knowledge of how to operate identification in space

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Progressive pseudomyopia..

- Post-traumatic progressive pseudomyopia and accommodative insufficiency should be managed by:
  - Minus at distance combined with plus at near
- The patient's adaptation of visual space is not "working" for them, so it continues to build as in a progressive myope, increasing apparent myopia and reducing accommodative lag to an eventual lead of accommodation.

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Ambient visual function

- Many severe traumatic brain injuries involve the midbrain, where peripheral retinal input is integrated with proprioceptive and vestibular information
- "the ambient visual process must let you know where you are in space and essentially where you are looking before you process information about what you are looking at" (Padula & Argyris)

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- Disruption of the ambient visual process disrupts the construct and stability of space so that the Z-axis loses reference.
- The disruptions directly and indirectly cause:
  - Spatial disorientation
  - Balance and postural difficulties
  - Objects appear to move
  - Floor tilting etc

Conclusion

- Measure near function in TBI patients and relate it to far function
- Does patient touch change near function (proximal information)?
- Use lenses, prisms, and VT to re-develop, or at least to stabilise adapted visual spatial judgment.