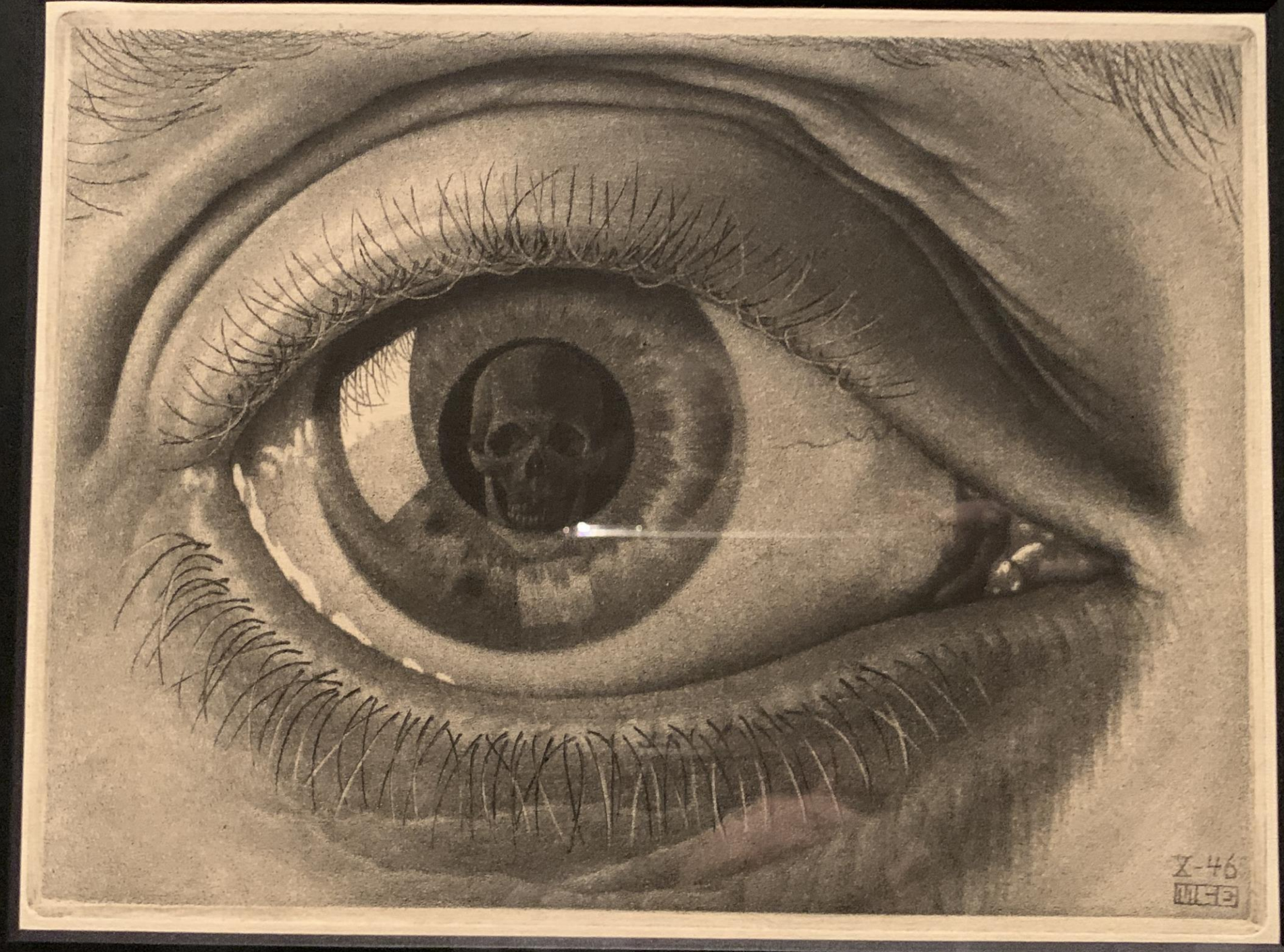
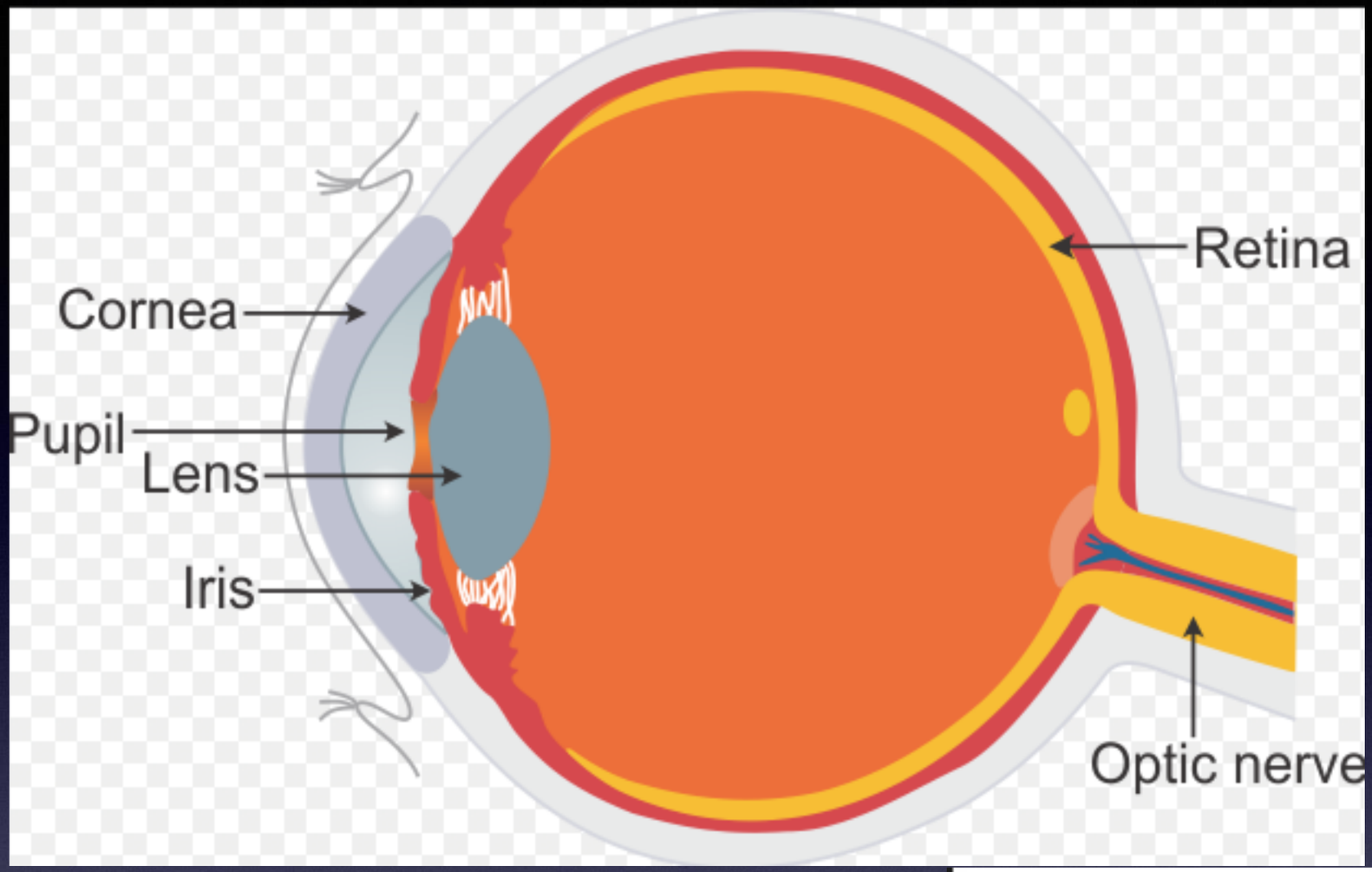
Functional Eye Capacity and Fitness for Work

Stephen J Best
Ophthalmologist, Auckland


X-46

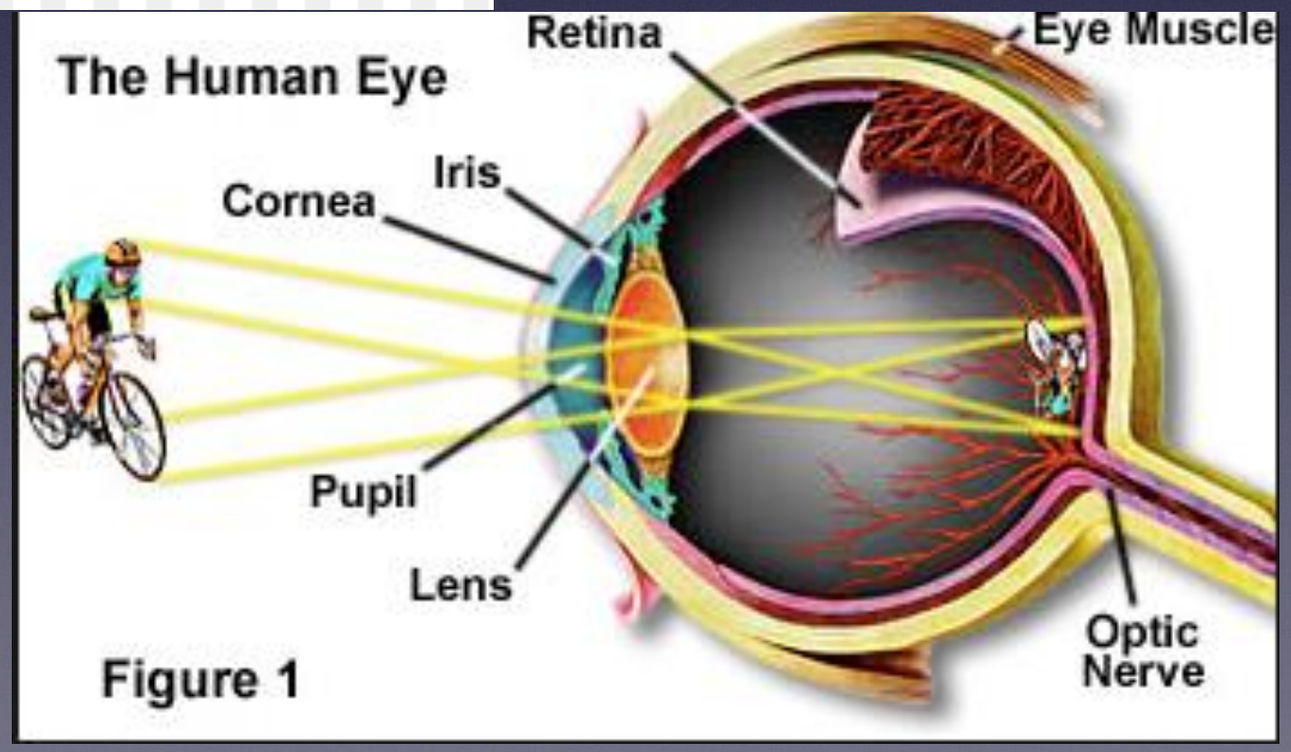
The Eye

- Very small but very important sensory organs
- Highly organised neuro-physiology
- Occipital lobes primary visual cortex but ~ 51% of entire brain associated with visual processing!
- Primate evolution upright posture
- Binocular perception….2 eyes!!!…Stereopsis
- Colour perception mediated via cone photoreceptors
- Extensive visual fields ~ 210 degrees….movement detection mediated via rod photoreceptors
- Dark adaptation cf daylight (rod photoreceptors)



Anatomy

Optics



Boney Orbit

- Mechanical protection but orbital walls with thin bones cf orbital rim bones
- Ocular adenexa in particular extra ocular muscles
- Vascular supply and innervation

Boney Anatomy

Fig 1 – The anterior and lateral views of the bony orbit.

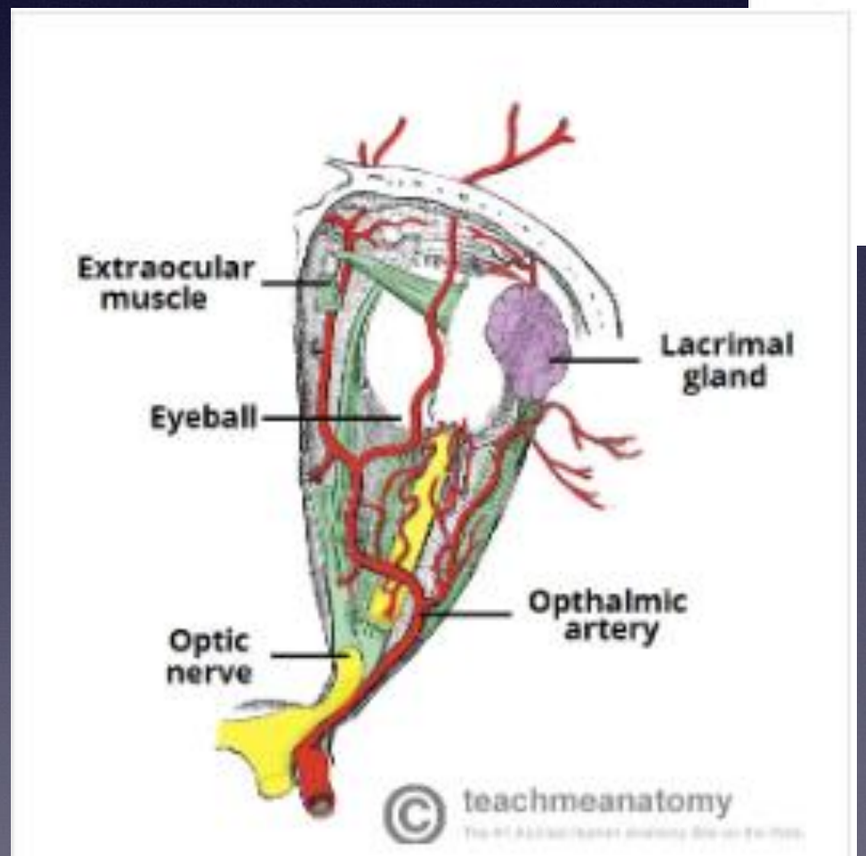


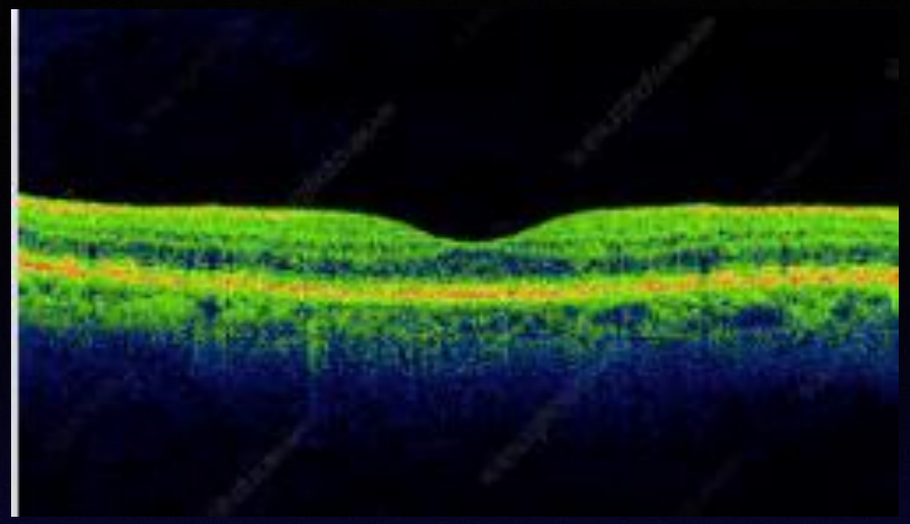
Fig 1.1 – Diagram of the arterial supply to the eye.

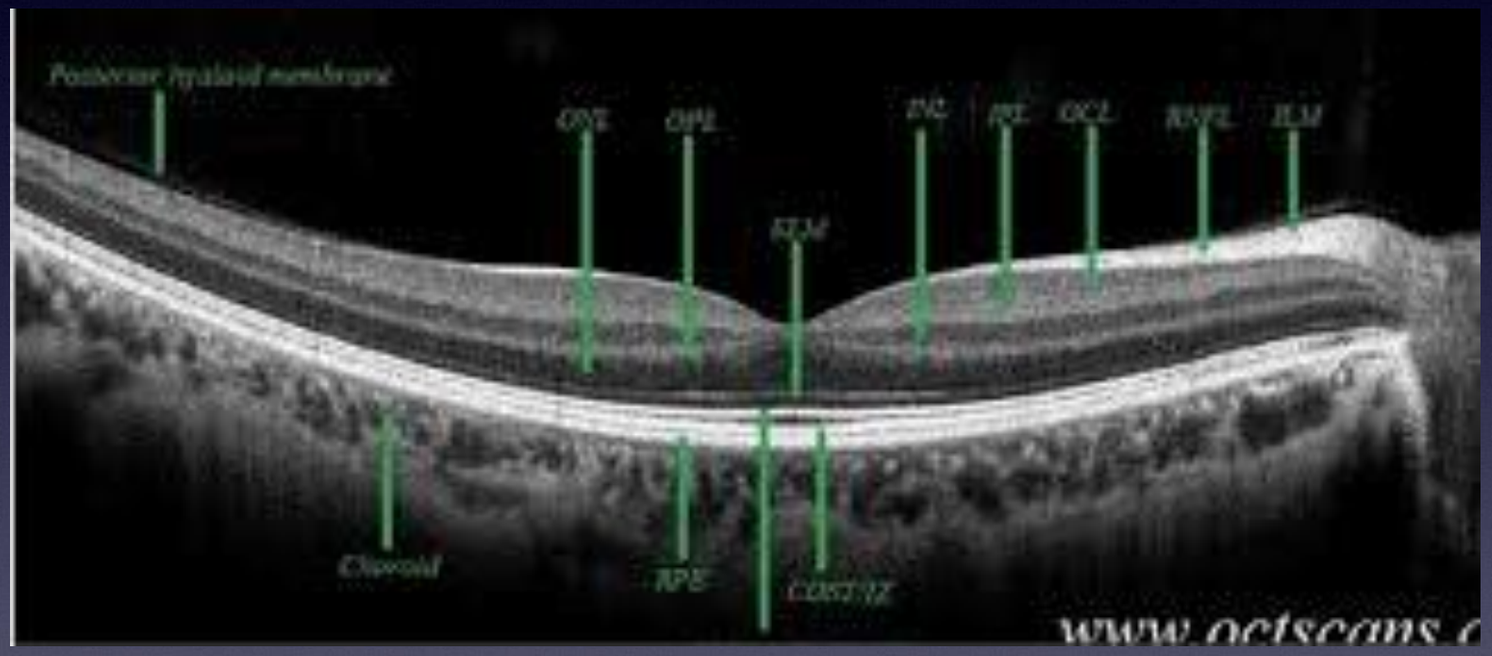
Orbital Contents

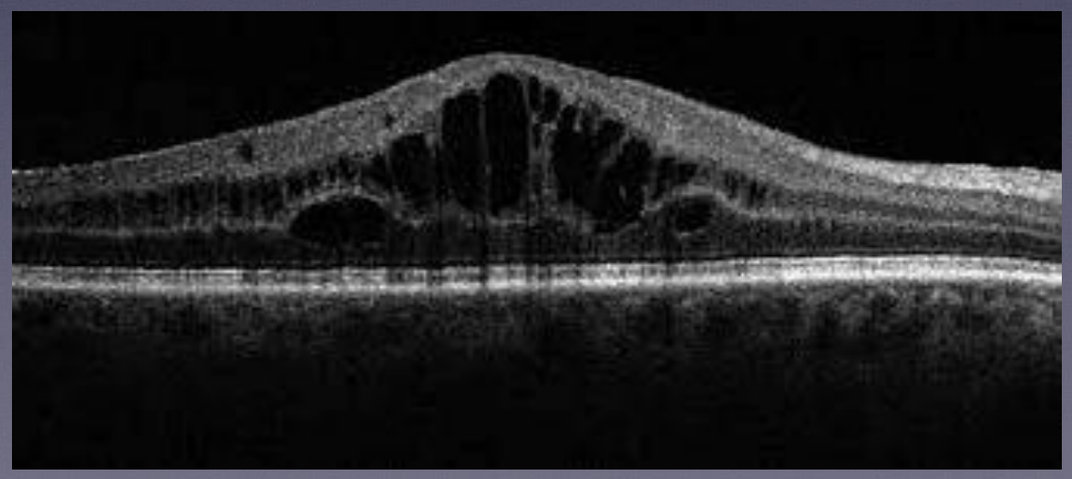
Visual Acuity

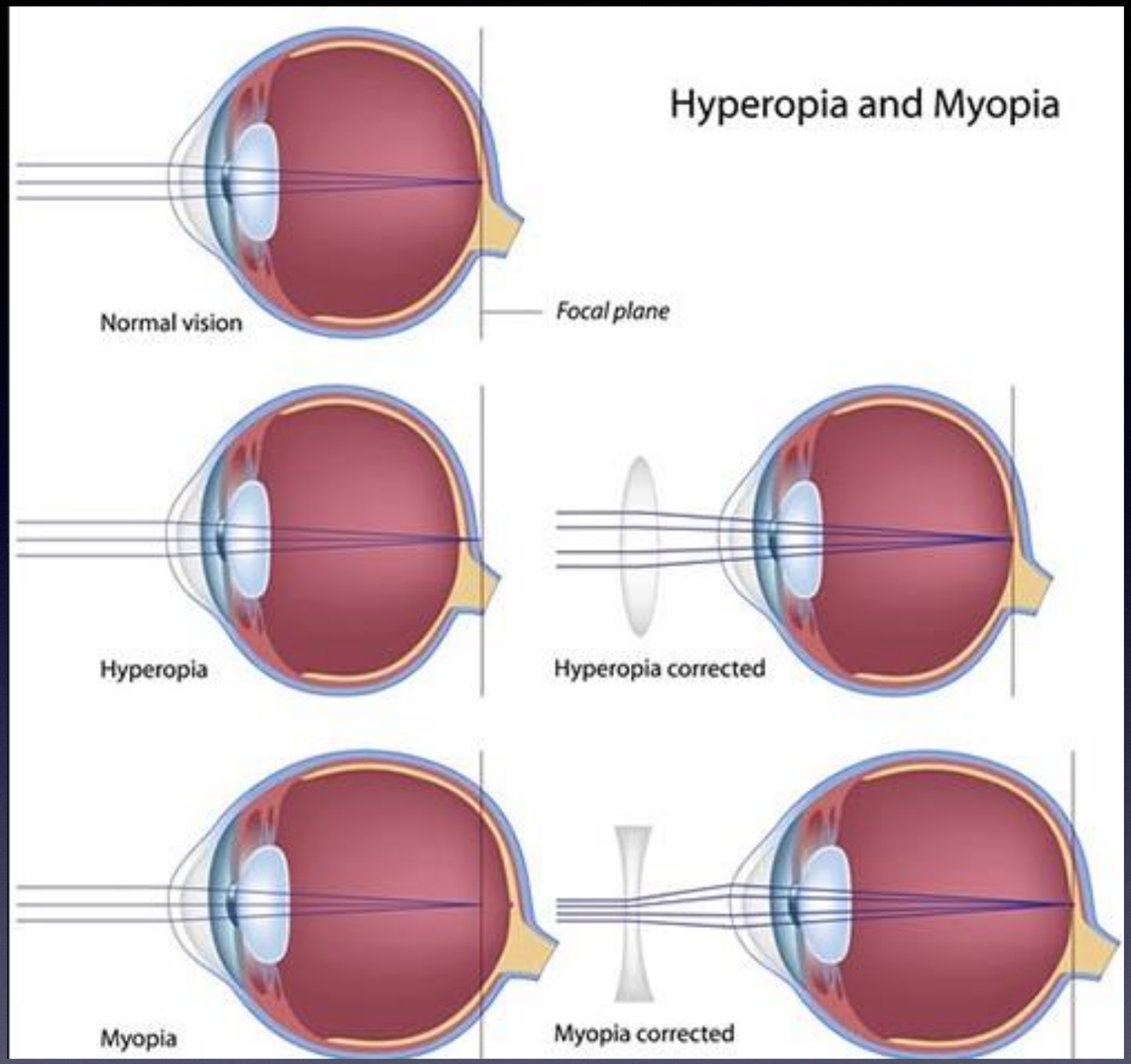
- Fine vision subserved by foveal anatomy
- Normal visual acuity 6/6 (20/20) = Emmetropia with Snellen Fraction “EVOTZ” ie the bottom line …cf 6/60 being the large “E” at the top of the chart
- Pinhole vison corrects ametropia!
- Refractive errors…myopia,hyperopia,astigmatism corrected by glasses/contact lenses/surgery
- Near acuity N5…(Newsprint N10), and expected deterioration with age ..presbyopia…around age 45 yrs need +1.00 reading glasses and at 65 yrs need + 3.00

Ocular Coherence Tomography OCT








Hyperopia and Myopia
Normal vision
Focal plane
Hyperopia
Hyperopia corrected
Myopia
Myopia corrected


Astigmatism
Light refracted to multiple areas of the retina
Cornea
Light
Lens
Retina
© 2003 WebMD, Inc.

Glasses and Occupation

- Appropriate correction of refractive error
- Reading glasses
- Computer screen working distance
- Safety glasses with Poly-carbonate in workplace
- Special indications eg Welding visors and specific safety standards
- NB: sports injuries eg badminton shuttle cocks cf squash ball protection by wrap around safety glasses

Standard Sussex Near Chart

SUSSEX VISION

TEST TYPES

N.5.

Now we have reached the trees—the beautiful trees! never so beautiful as to-day. Imagine the effect of a straight and regular double avenue of oaks, nearly a mile long, arching over-head, and closing into perspective like the roof and columns of a cathedral, every tree and branch encrusted with the bright and delicate congelation of hoar-frost, white and pure as snow, delicate and defined as carved ivory. How beautiful it is, how uniform, how various, how filling

— numerous renew assurance our sense ewe camera acorn assess cocoa source essence err —

N.6.

how satisfying to the eye and to the mind—above all, how melancholy! There is a thrilling awfulness, an intense feeling of simple power in that naked and colourless beauty which falls on the earth, like the thoughts of life—life pure and glorious and smiling—but still life. Sculpture has always the same effect on my imagination, and painting never. Colour is life.—We are now at the end of this magnificent avenue, and at the top of a steep eminence commanding

— ear race access cannon emu error mace summon season nevermore overawe crane —

N.8.

a wide view over four counties—a landscape of snow. A deep lane leads abruptly down the hill; a mere narrow cart-track, sinking between high banks clothed with fern and furze and low broom, crowned with luxuriant hedge-rows and famous for their summer smell of thyme.

— cam macaroon overseas race ocean excess nurse answer raven —

N.10.

How lovely these banks are now—the tall weeds and gorse fixed and stiffened in the hoar-frost, which fringes round the bright, prickly holly, the pendent foliage of the bramble, and the deep orange leaves of the pollard oaks ! Oh !

— accurse can name one recess oversee own newcomer —

N.12.

this is rime in its loveliest form ! And there is still a berry here and there on the holly, "blushing in its natural coral," through the delicate tracery, still a stray hip or haw for the birds, who

— same accrue car oxen recover ensnare nerve —

N.14.

abound here always. The poor birds, how tame they are, how sadly tame! There is the beautiful and rare crested

— ease on manner even crown cover arose —

N.18.

wren, "that shadow of a bird," as White, of Selbourne, calls it, perched in the middle

— severe room caravan era —

N.24.

of the hedge, nestling, as it were,

— surname seven arrow —

CE

Corneal Refractive Surgery

- Radial Keratotomy…..regression
- Photorefractive Keratectomy (PRK)
- Automated lamellar keratoplasty (ALK)
- Laser-assisted in situ Keratomileusis (LASIK)
- Small Incision Lenticule Extraction (SMILE) It is blade free and uses a femtosecond laser to create a lens-shaped disc of tissue within the cornea which is removed via a 4.5 mm incision with forceps perhaps creating the most robust mechanical outcome

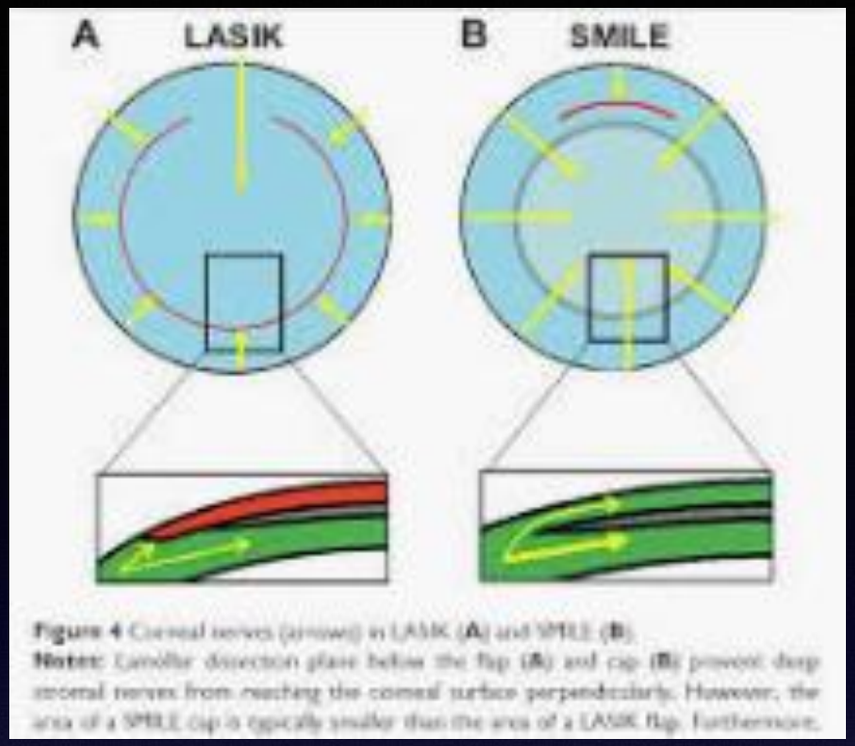
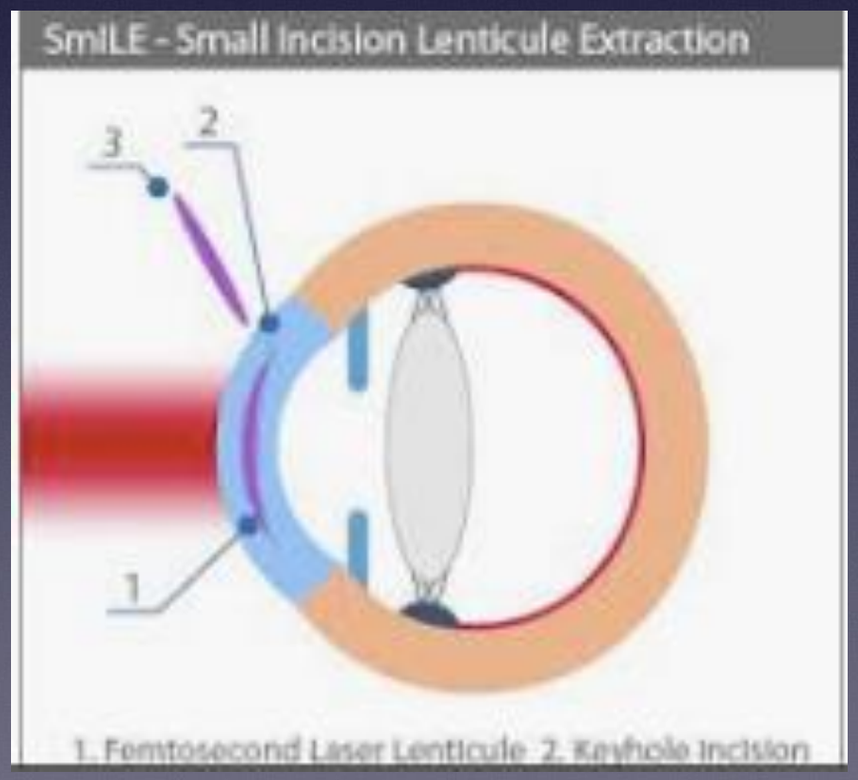
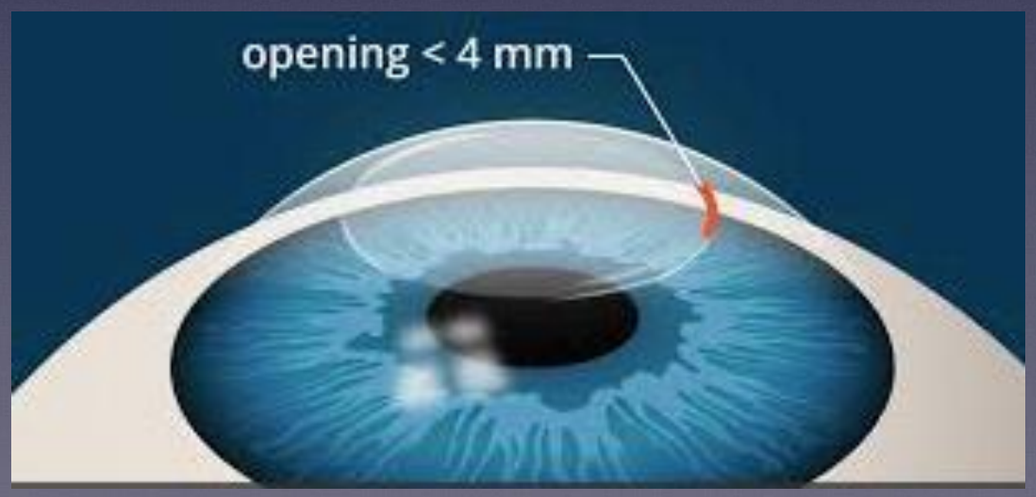


Figure 4 Corneal nerves (arrows) in LASIK (**A**) and SMILE (**B**).
Notes: Lamellar dissection plane below the flap (**A**) and cap (**B**) prevent deep stromal nerves from reaching the corneal surface perpendicularly. However, the area of a SMILE cap is typically smaller than the area of a LASIK flap. Furthermore,

Refractive Laser Surgery





Pupillary Function

- An objective measure of visual function comparing one eye to the other
- PERLA
- Relative Afferent Pupillary
- Defect (RAPD)

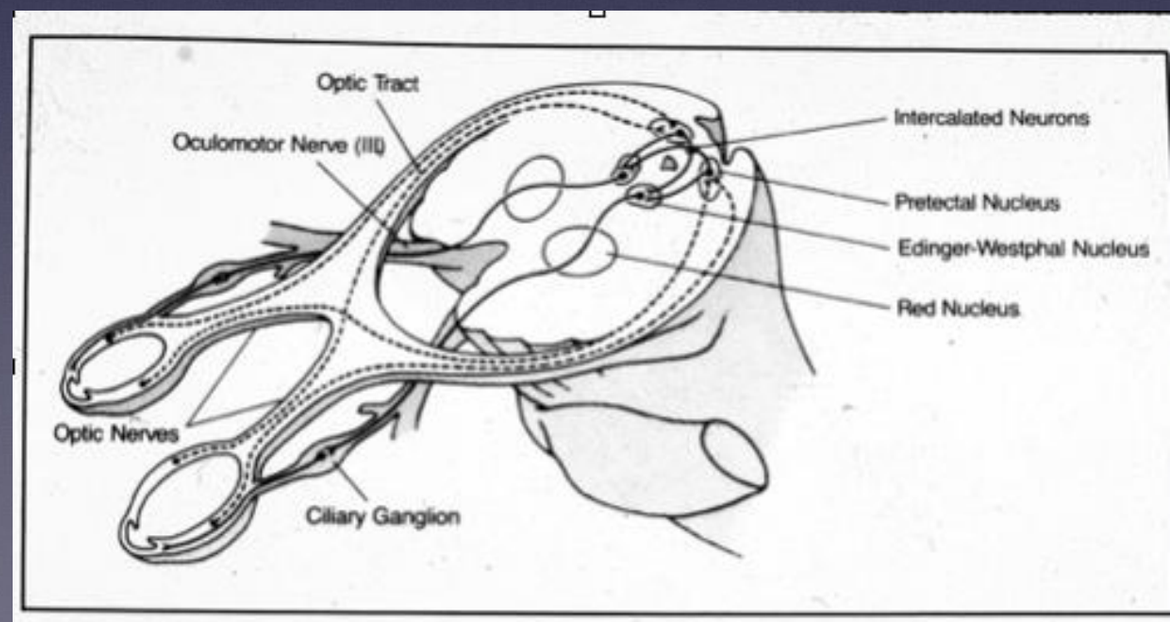
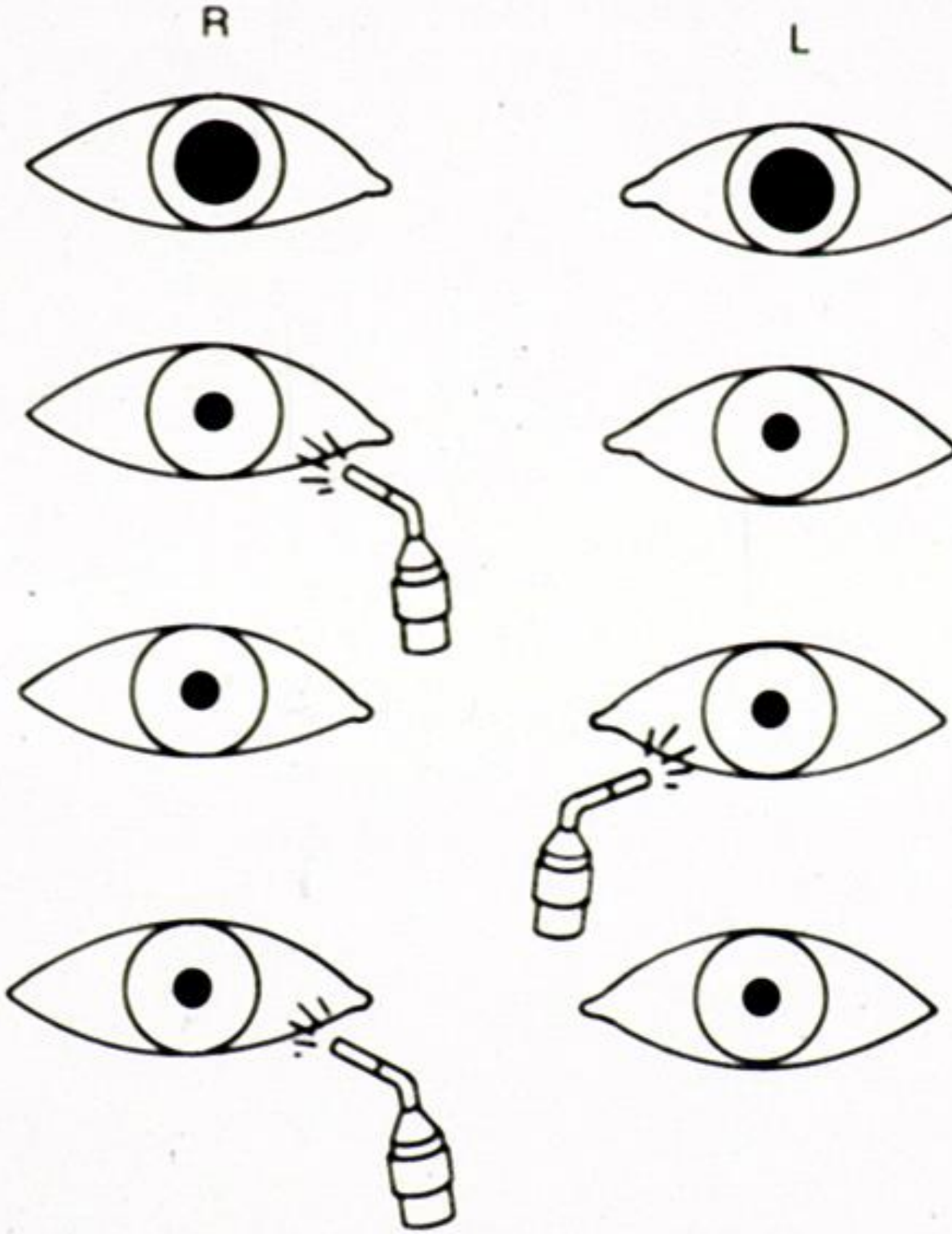
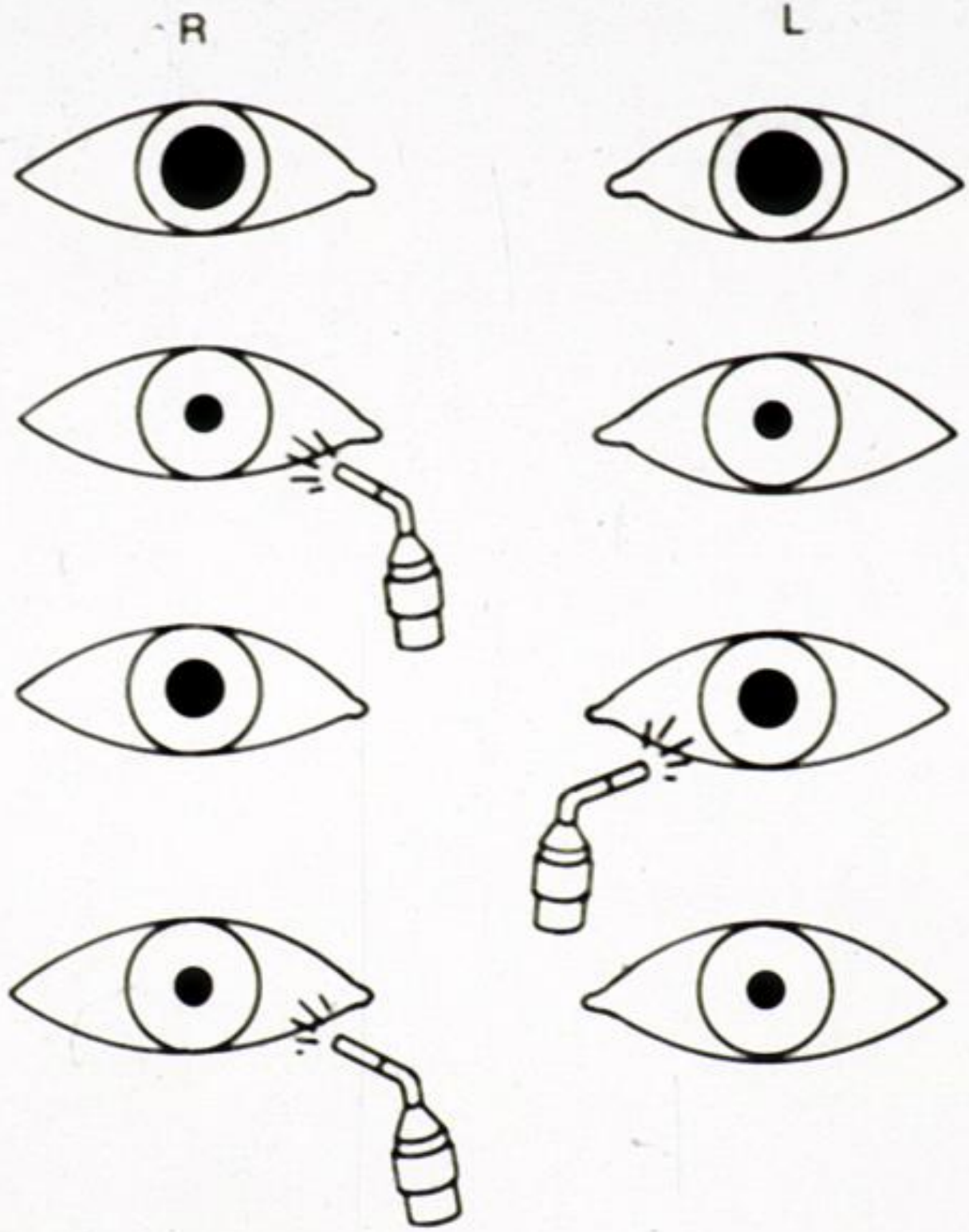


Fig. 8-1. Pathway of the pupillary light reflex (Redrawn from Miller NR: Walsh and Hoyt's Clinical Neuro-ophthalmology. Baltimore, Williams & Wilkins, 1985, p. 421).



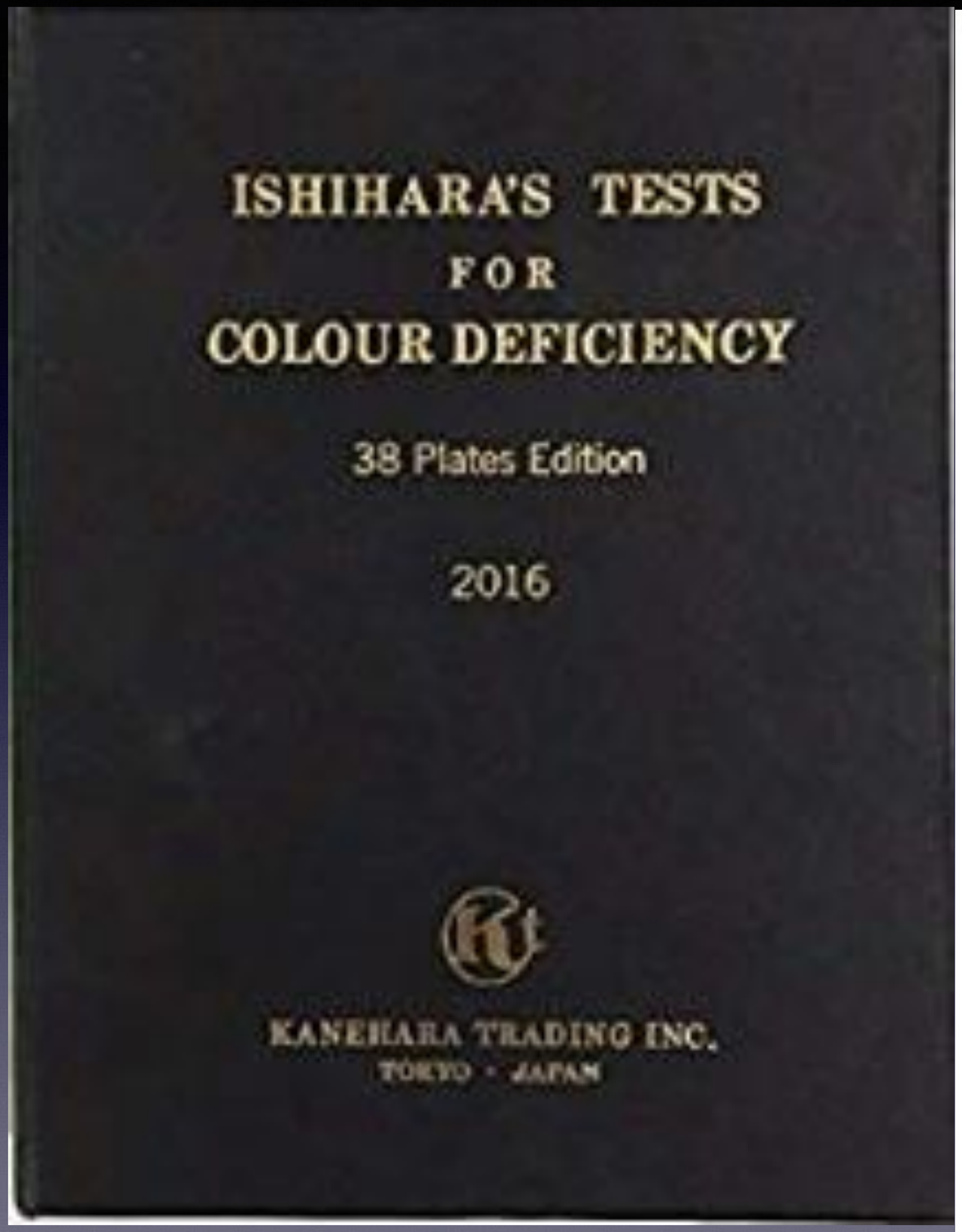
ig. 8-4. Normal response to swinging flashlight test with no change in size of pupils.



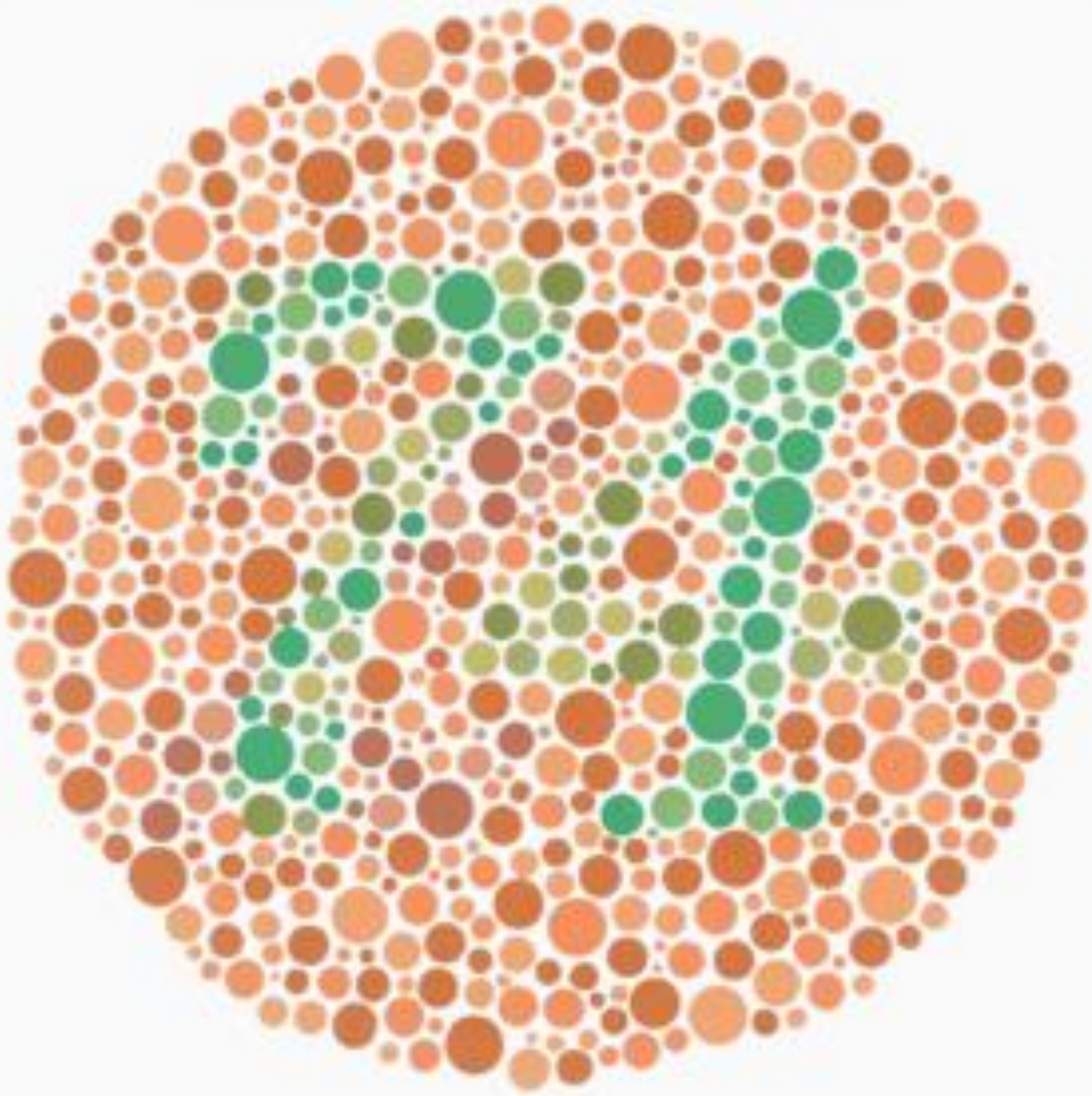
ig. 8-5. Afferent pupillary defect in left eye using swinging flashlight test. The pupils constrict when the light is shined e right eye; however, when the flashlight is swung back to the left eye, both pupils dilate.

Colour Vision

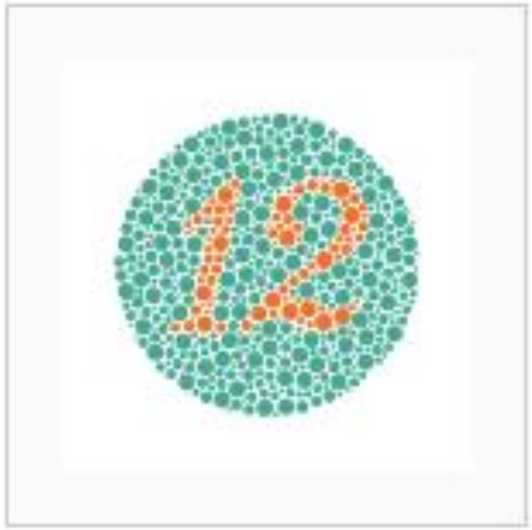
- Colour vision mediated via three cone receptor system
- Variability in perception (~8% males with red/green deficiency)
- Testing may be important in certain occupations
- Red/Green Lantern test for railway workers 1800’s
- Ishihara Pseudo-Isochromatic Plates
- Farnsworth Munsell 100 Hue Testing - advanced colour matching used in paint and textile industries



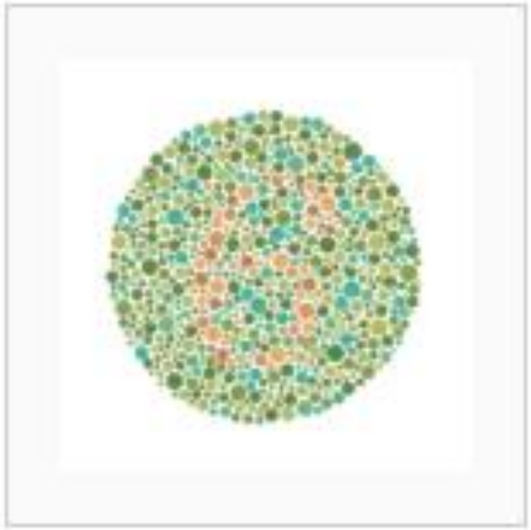
Color perception test



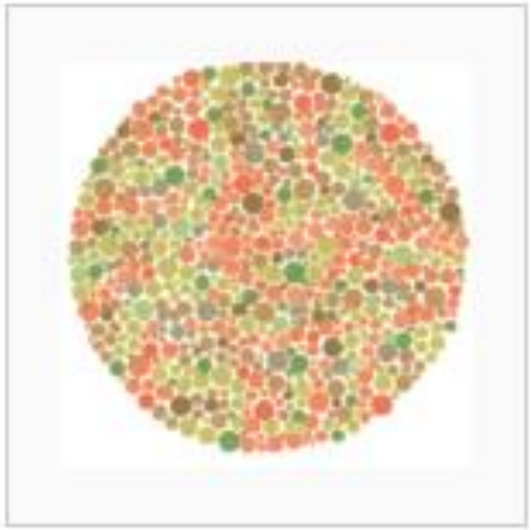
Example of an Ishihara color test plate. The number "74" should be clearly visible to viewers with normal color vision. Viewers with dichromacy or anomalous trichromacy may read it as "21", and viewers with monochromacy may see nothing.



Ishihara Plate No. 1 (12)



Ishihara Plate No. 13 (6)



Ishihara Plate No. 19 (Nothing (hidden figure plate); Red-Green deficiency can trace a line)

Ishihara Plate No. 23 (42)

Occupational screening [edit]

The United States Navy uses the Ishihara plates (and alternatives) for color vision screening. The current passing score is 12 correct of 14 red/green test plates (not including the demonstration plate). Research has shown that scores below twelve indicate color vision deficiency, and twelve or more correct indicate normal color vision, with 97% sensitivity and 100% specificity. The sensitivity of the Ishihara test varies by the number of plates allowed to pass, which can vary by institutional policy. Sensitivity also may be influenced by test administration (strength of lighting, time allowed to answer) and testing errors (coaching by administrators, smudges or marks made upon the plates).

Electricians

- Mostly male dominated occupation
- ~8% males “colour blind”
- Colour perception obviously a safety issue given the risk of colour perception variables!

NZ Standard Wiring

Wiring Colors (Flexible Cordage & Fixed Cabling)

Standard[a] wire insulation colours

Flexible cable (e.g., extension, power, and lamp cords)			
Region or country	**Phases**	**Neutral**	**Protective earth/ground**
Argentina, European Union, South Africa (IEC 60446)			
Australia, New Zealand (AS/NZS 3000:2007 3.8.1, 3.8.3)	 ,  (previously), "any colour other than green, yellow, green/yellow, black or light blue"	 ,  (previously)	 ,  (previously)

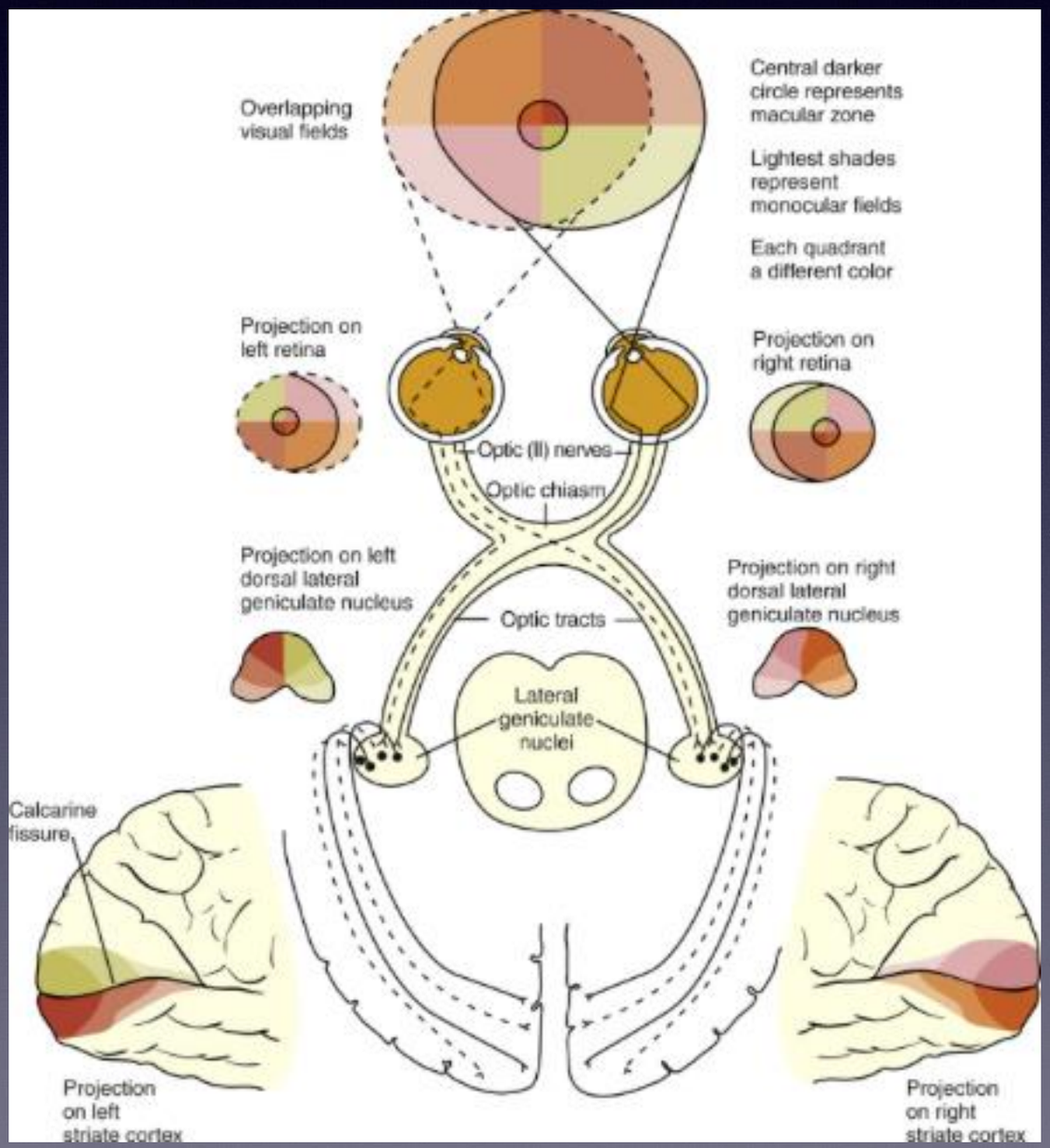
Stereopsis

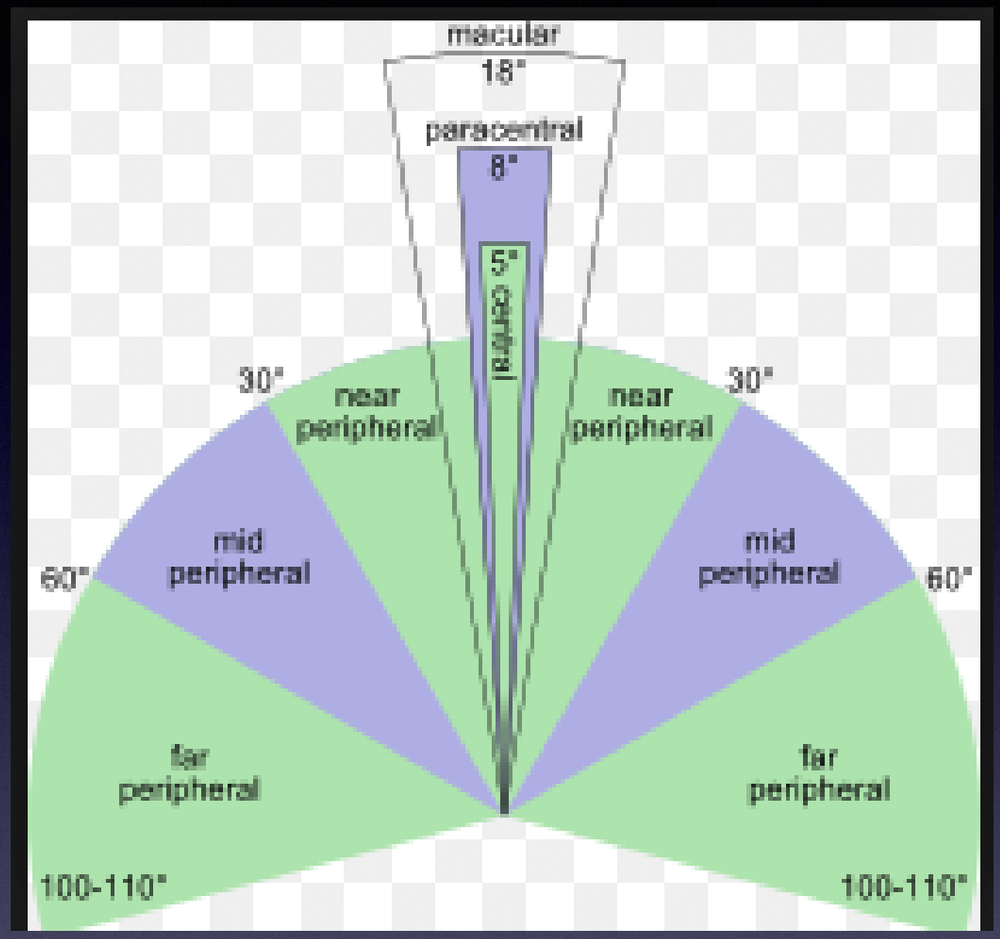
- There are two distinct aspects to stereopsis: coarse stereopsis and fine stereopsis, and provide depth information of different degree of spatial and temporal precision.
- The ability of stereopsis can be tested by, for example, the Lang stereo-test, which consists of a random-dot stereogram
- Specific employment situations that require testing eg surgeons!
- Note patients with long standing amblyopia often adapt surprising well using other clues to depth perception

Peripheral Vision

- Each eye has a horizontal field @ 160 degrees and a vertical field @ 100 degrees
- Binocular visual field
- Testing visual fields in clinical situation best with confrontation to a red target/counting fingers in quadrants
- Formal visual field testing with Automated Perimetry (Zeiss Humphrey/ Medmont…testing central 30 degrees
- Binocular visual field testing = Esterman Perimetry with both eyes open ie usual functional situation

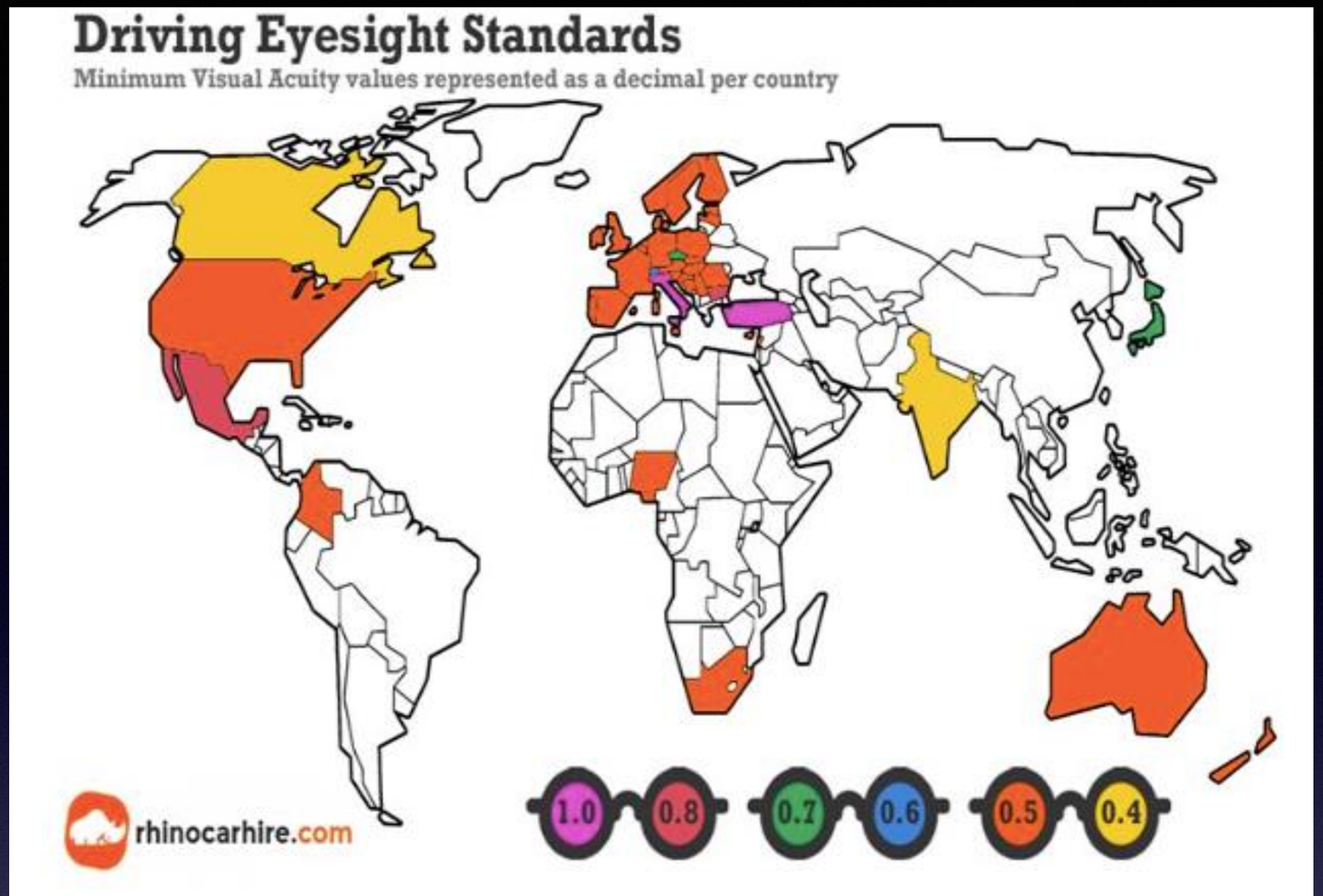
Visual Fields





Vision and Driving

- The standard of visual acuity required is 6/12 using both eyes together, with or without correcting lenses for a standard Class 1 License
- A person with two functional eyes must have a field vision of 140 degrees.
- There should be no significant pathological field defect in the binocular field that encroaches within 20 degrees of fixation either above or below the horizontal meridian. This includes homonymous hemianopic, homonymous quadrantanopic and bitemporal hemianopic defects within 20 degrees of fixation.

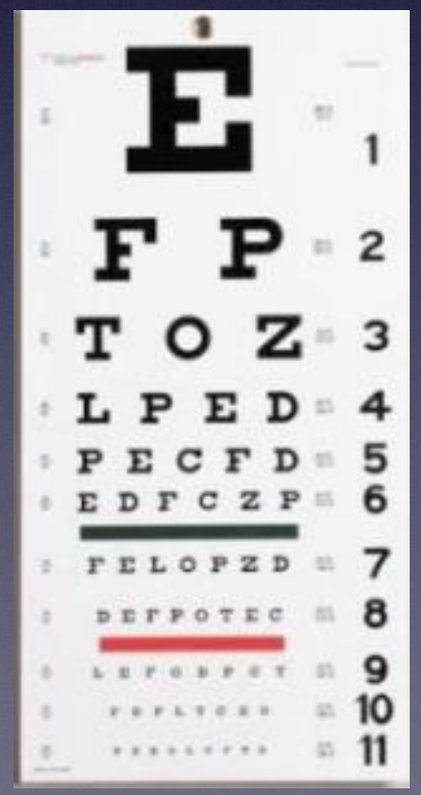


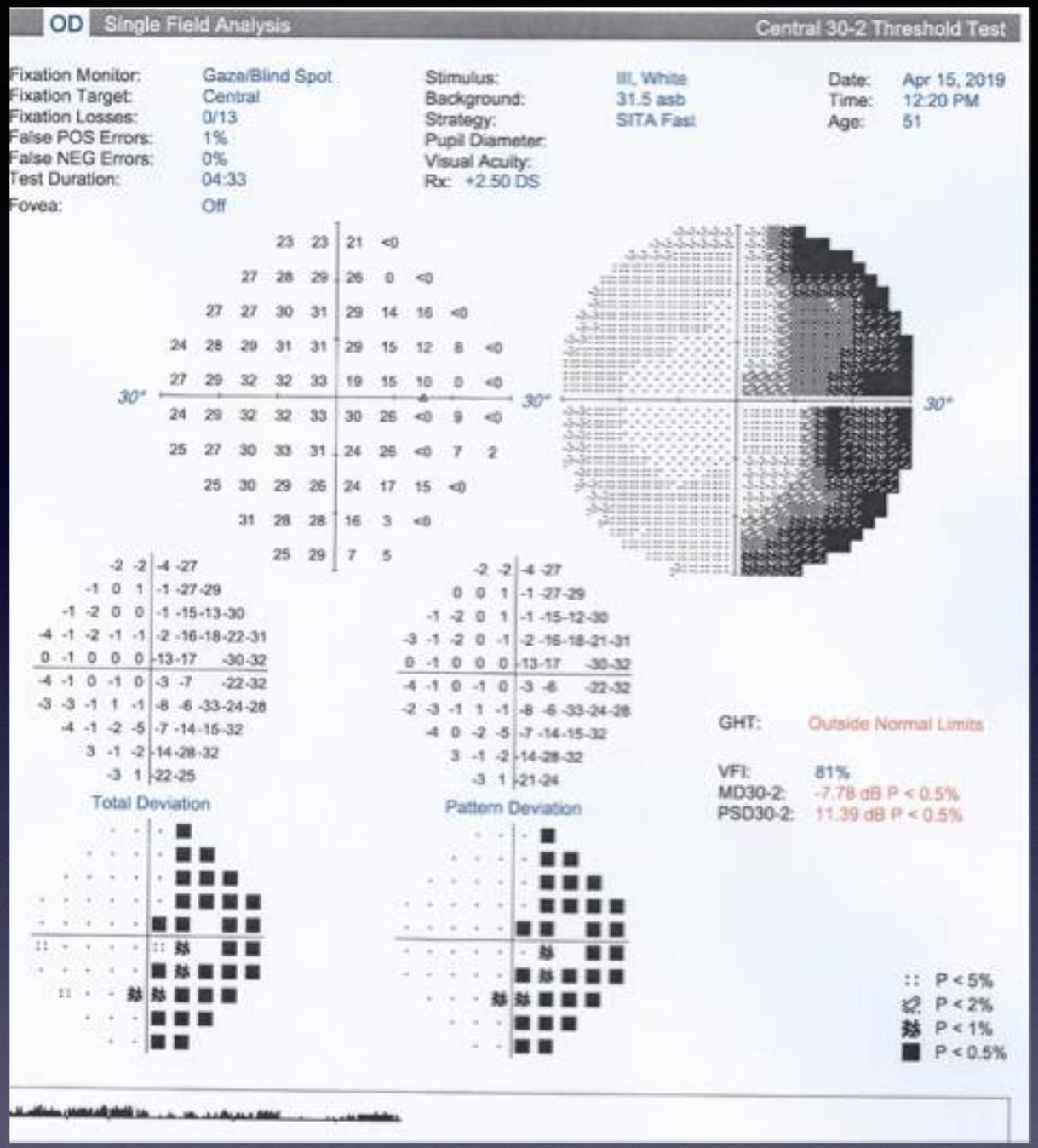
Country	Visual Acuity*	Snellen	Distance (M)**	Distance (ft)**	Buses***
Australia	0.5	6/12	20	65	1
Austria	0.5	6/12	20	65	2
Belgium	0.5	6/12	20	65	2
Bulgaria	0.8	6/7.5	32	104	3
Canada	0.4	20/50	16	52	2
Mexico	0.8	20/25	32	104	3
New Zealand	0.5	6/12	20	65	2
Nigeria	0.5	6/12	20	65	2
Norway	0.5	6/12	20	65	2
Switzerland	0.63	6/9.5	25	81.25	2+
The Netherlands	0.5	6/12	20	65	2
Turkey	1	6/	40	130	4
UK	0.5	6/12	20	65	2
USA	0.5	20/40	20	65	2

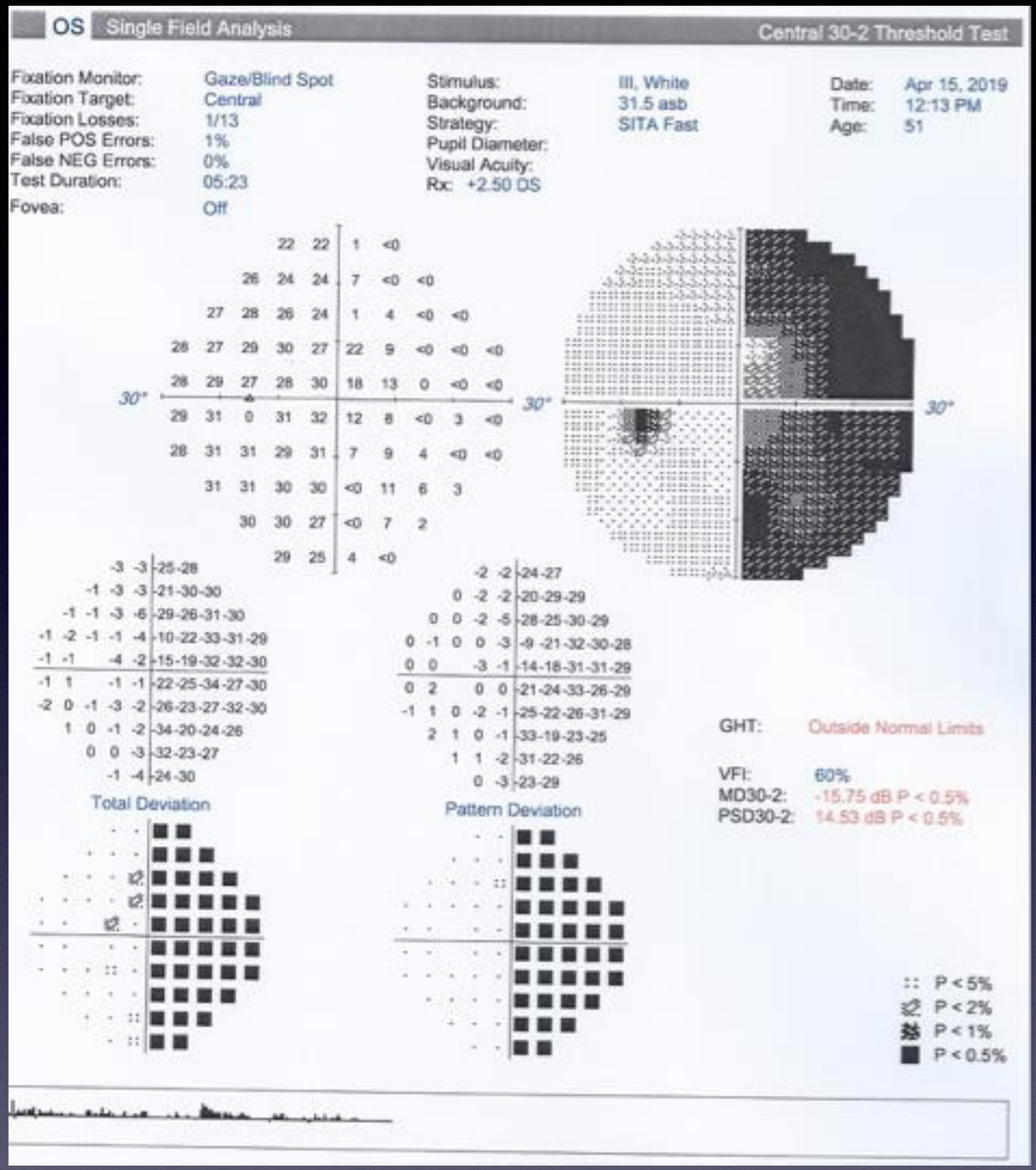
6/12

0.5

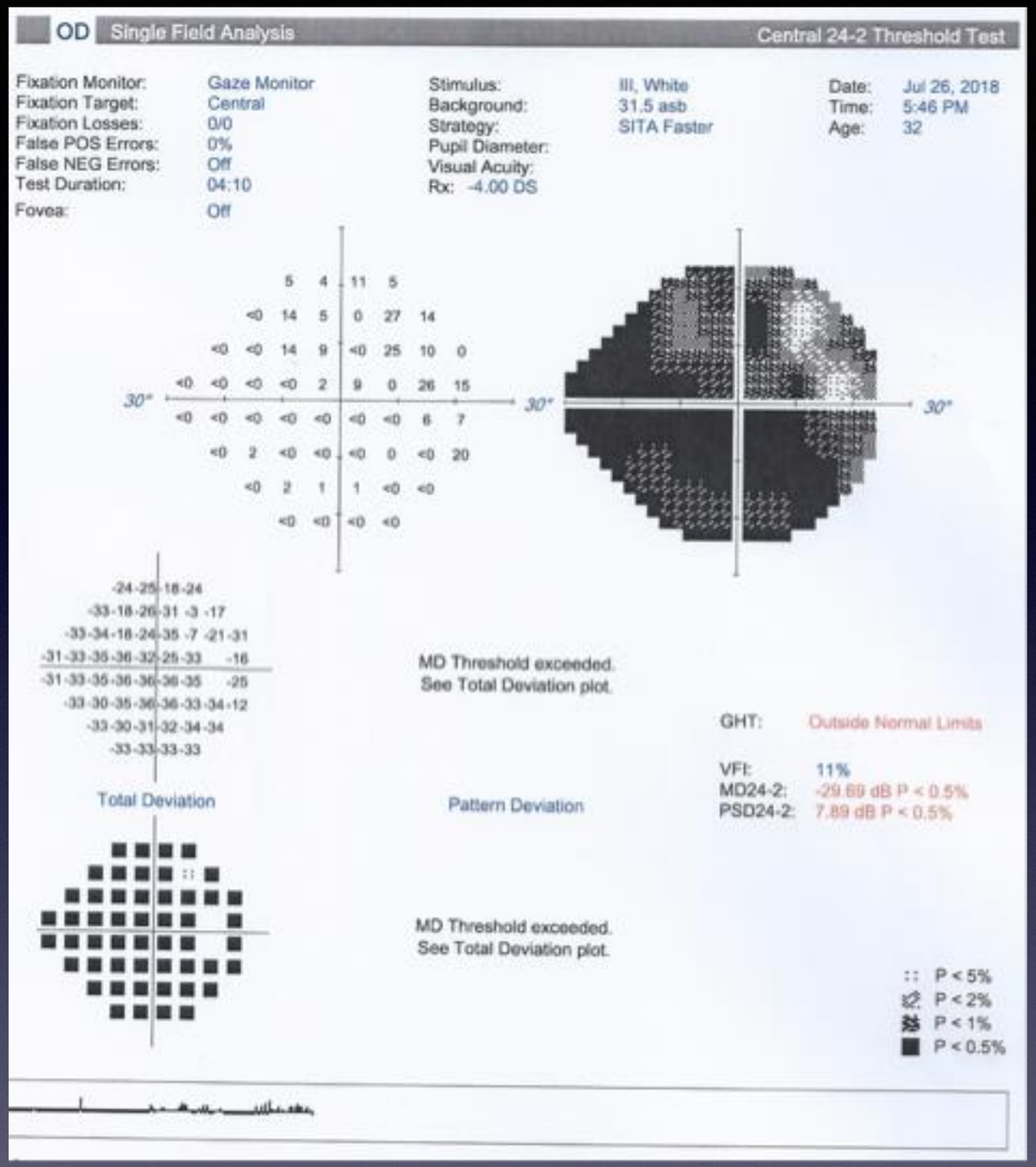
20/40

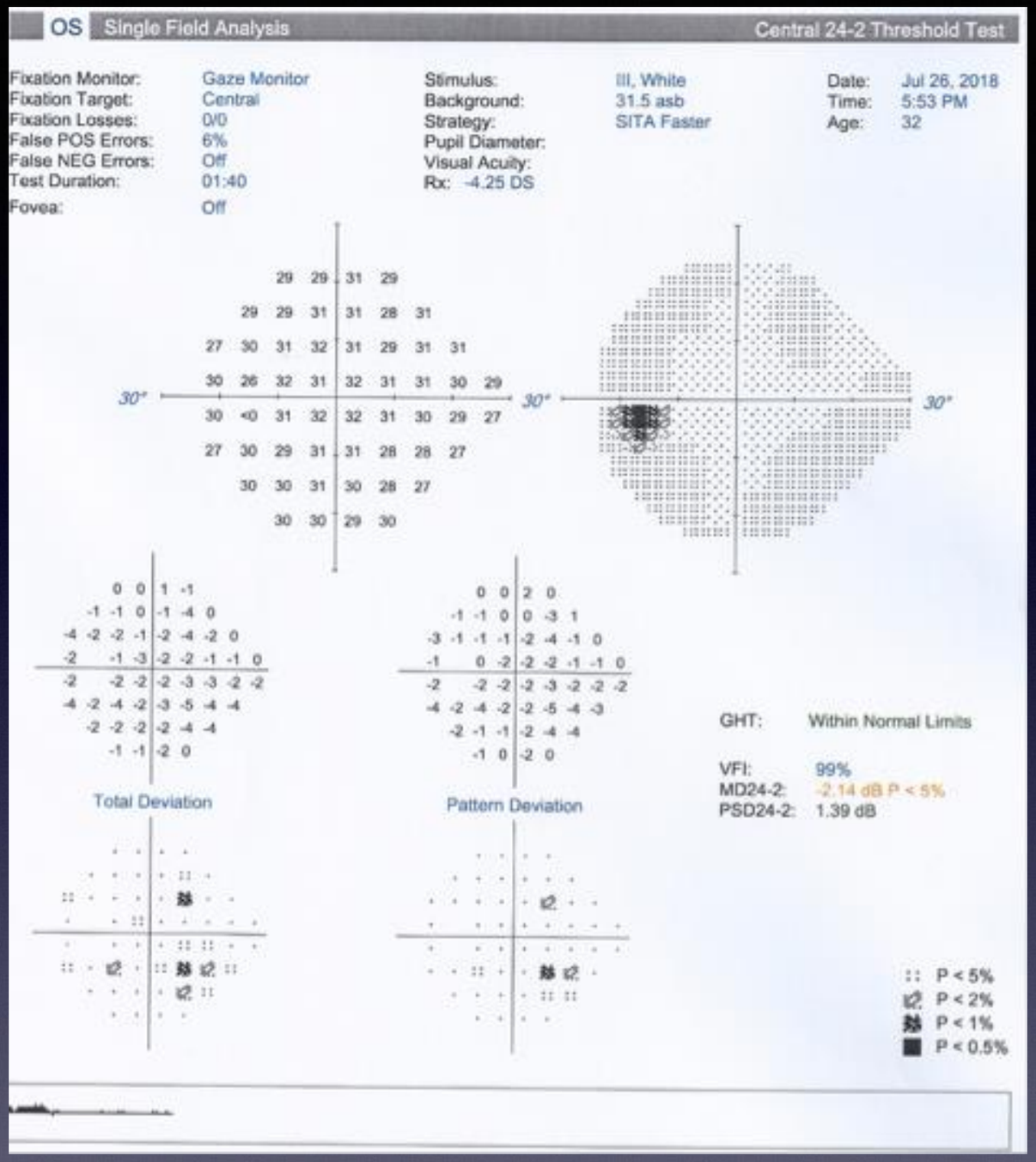






Right Homonymous Hemianopia
(Left sided brain injury)



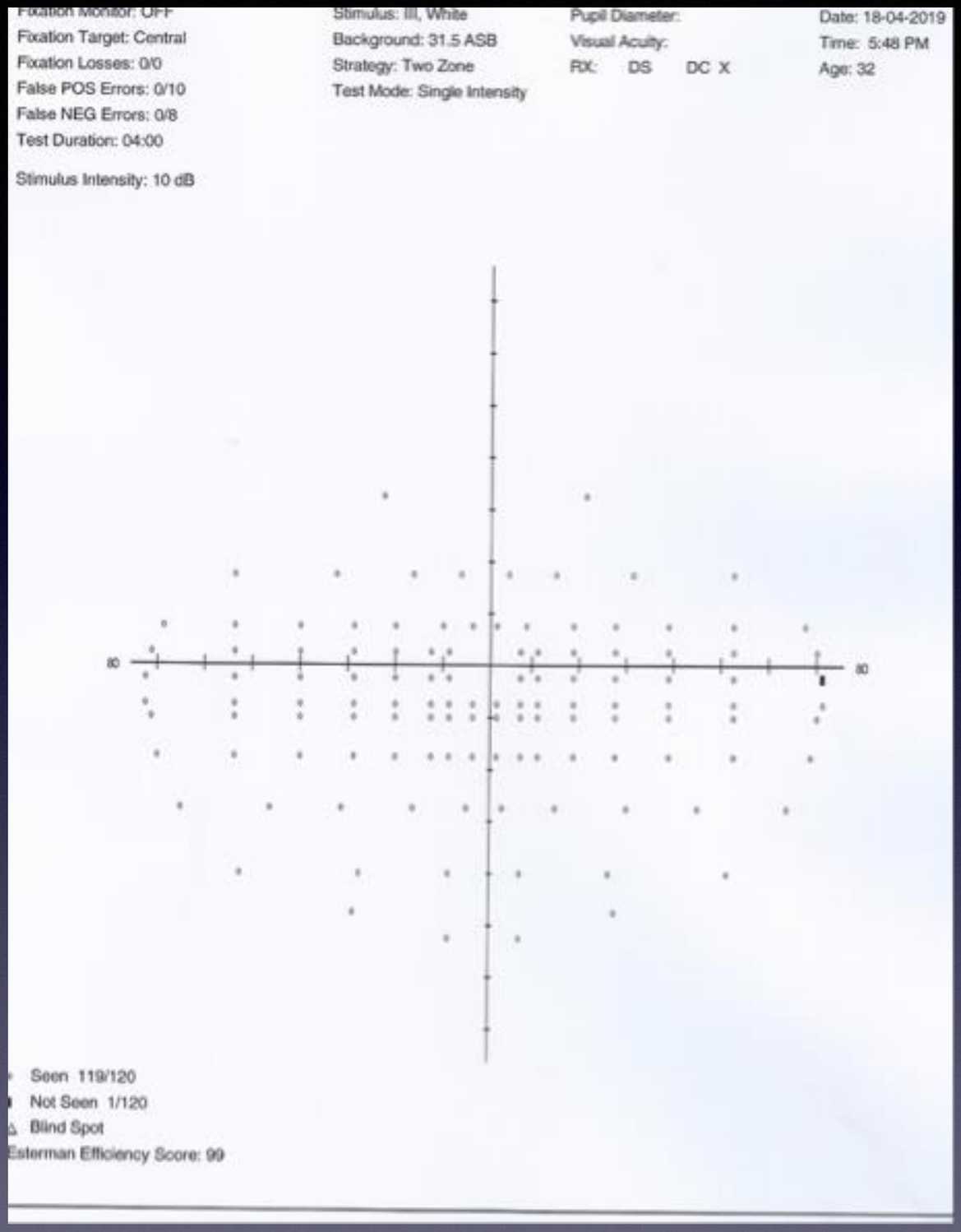


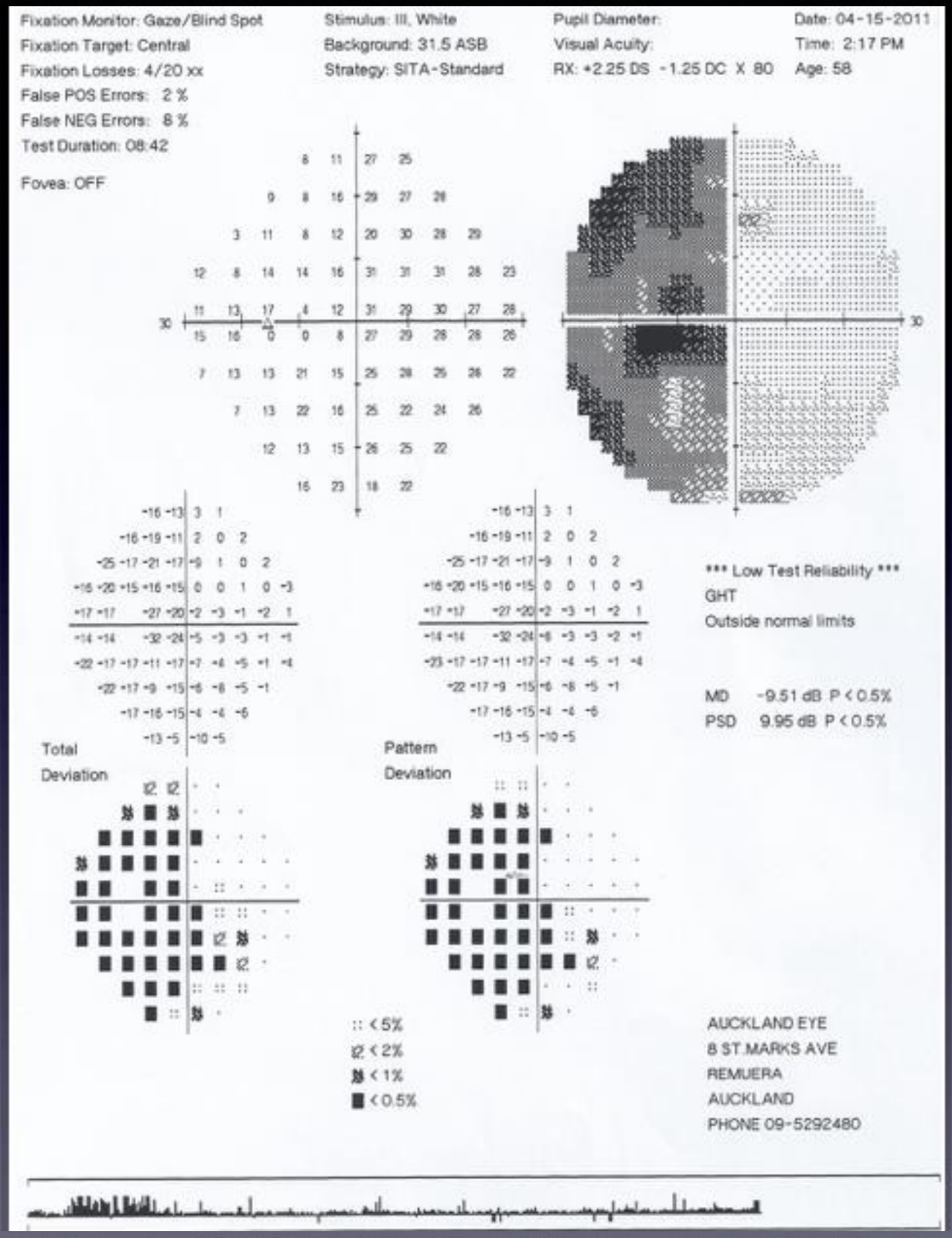
Right Optic Atrophy

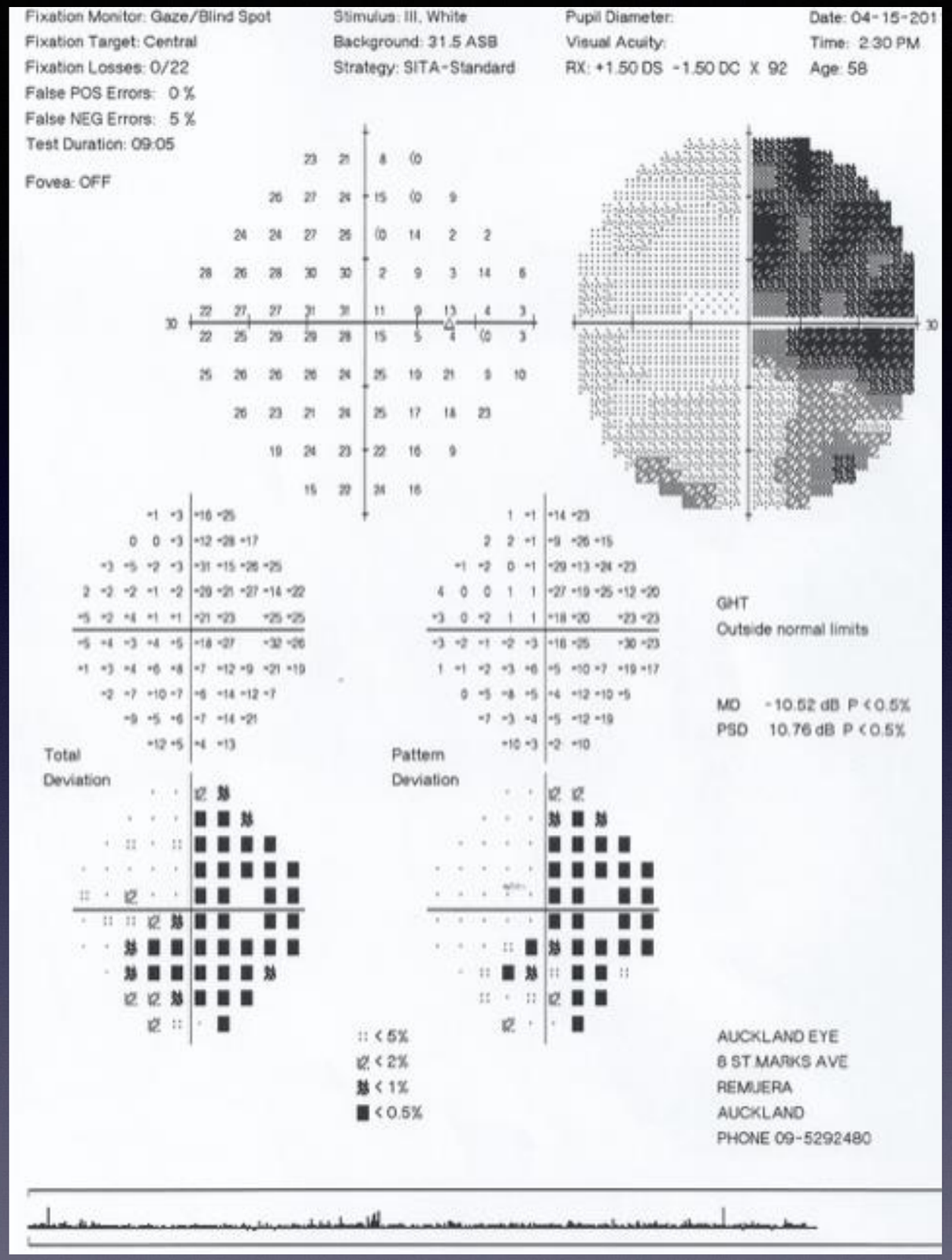
Esterman Binocular Visual Field

Both eyes open
Represents reality of vision

Same patient as previous slides with marked vision loss OD (CF), OS (6/6)







Bi-Temporal Hemianopia = Chiasmal Lesion

Special Licenses

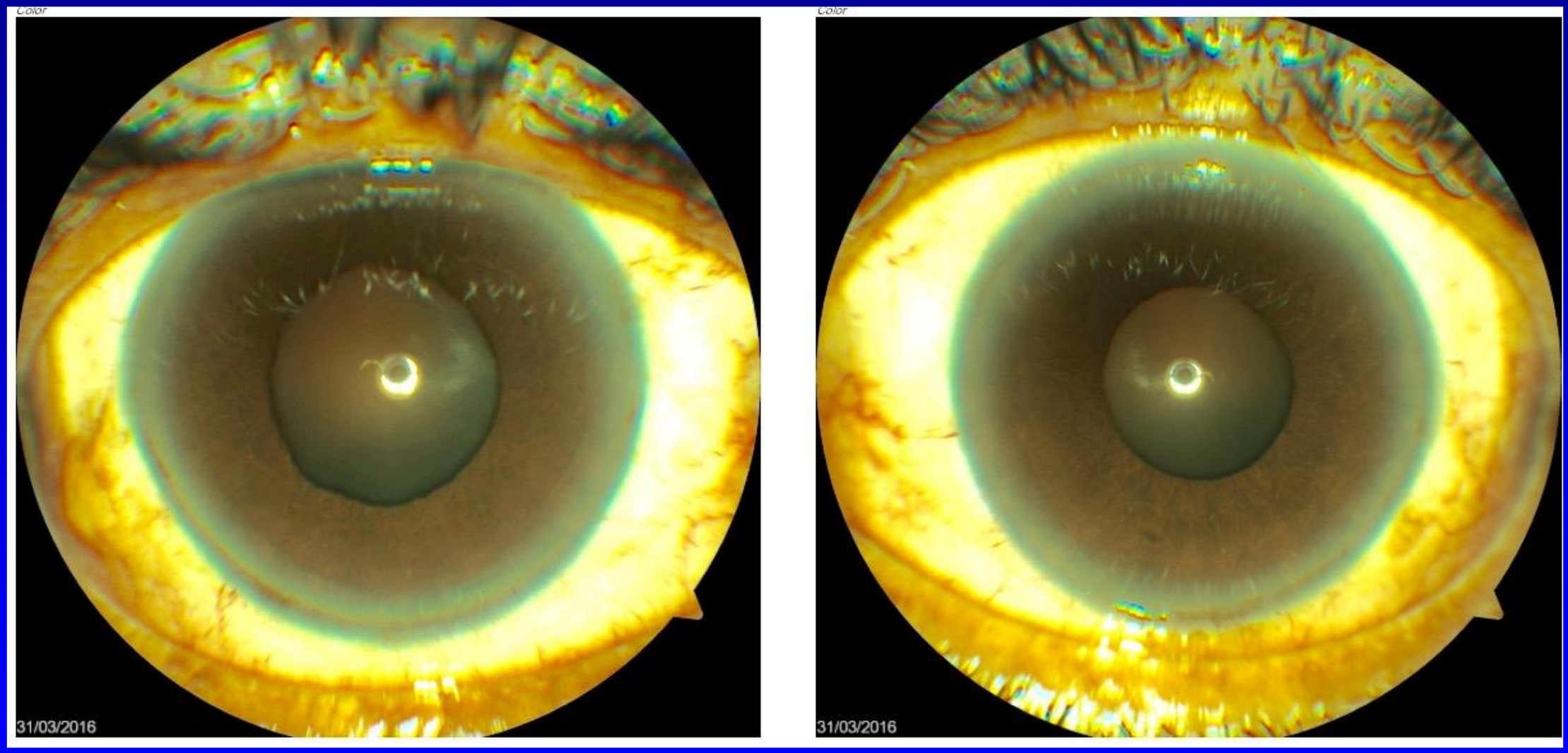
- Heavy Traffic : 6/9 OU
- Commercial Drivers : 6/9 OU
- Train Drivers : 6/9 better eye and 6/12 fellow eye
- Airline Pilots : Distant visual acuity, with or without correction, shall be 6/9 or better monocularly, and 6/6 or better binocularly.
- Police / Fire services with specific requirements related to occupational hazards!
- Maritime NZ : Visual acuity and colour vision!

Eye Injuries

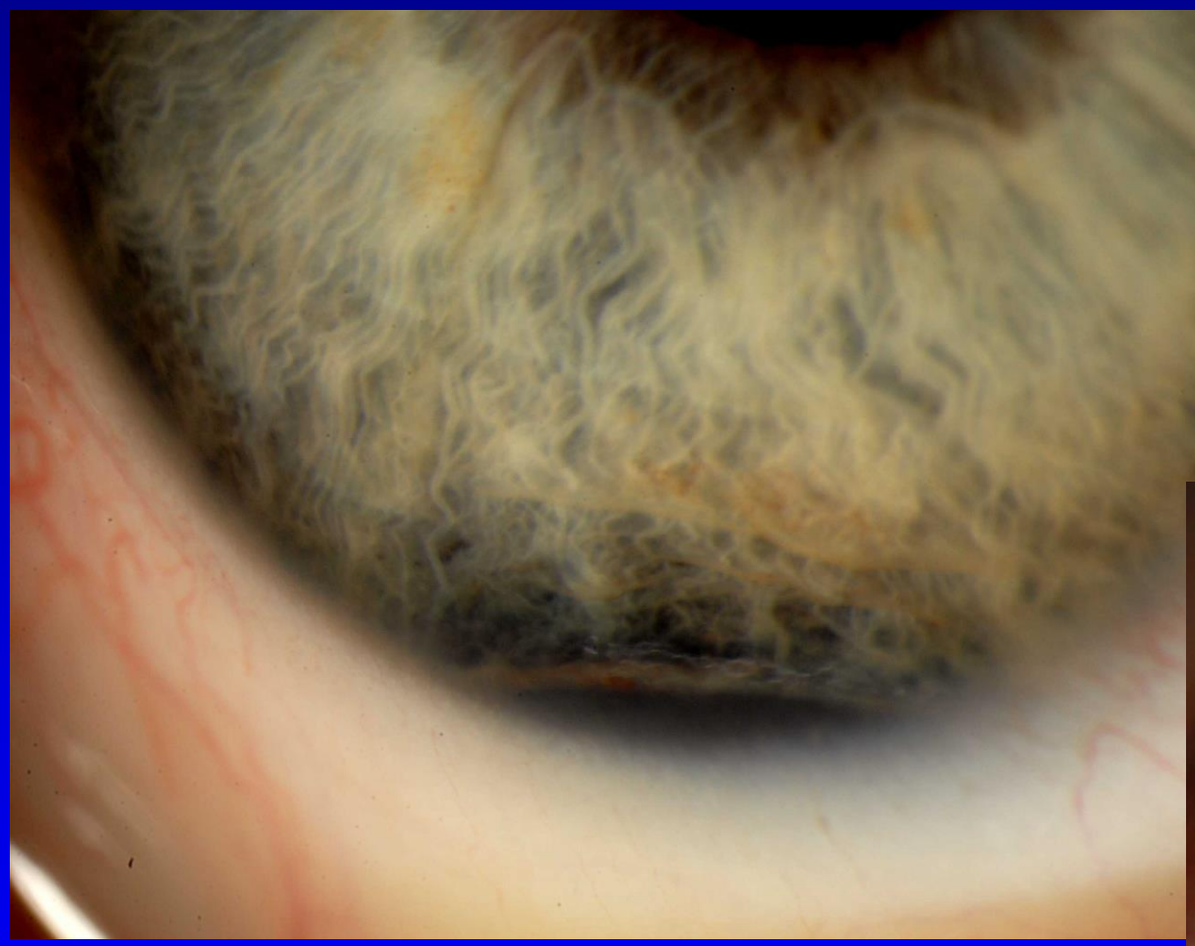
- Blunt trauma to the eye causing traumatic mydriasis - irido-dialysis - angle recession resulting in secondary glaucoma - cyclo-dialysis cleft resulting in hypotony
- Hyphaema - blood in anterior chamber and if prolonged risk of corneal blood staining. (Risk of recurrent haemorrhage)
- Traumatic cataract with anterior petalloid pattern
- Globe rupture without open wound - Note of risk from previous eye surgery
- Lacerations to cornea and sclera with hallmark irregular pupil

Left optic disc examination

Blunt Trauma OD!

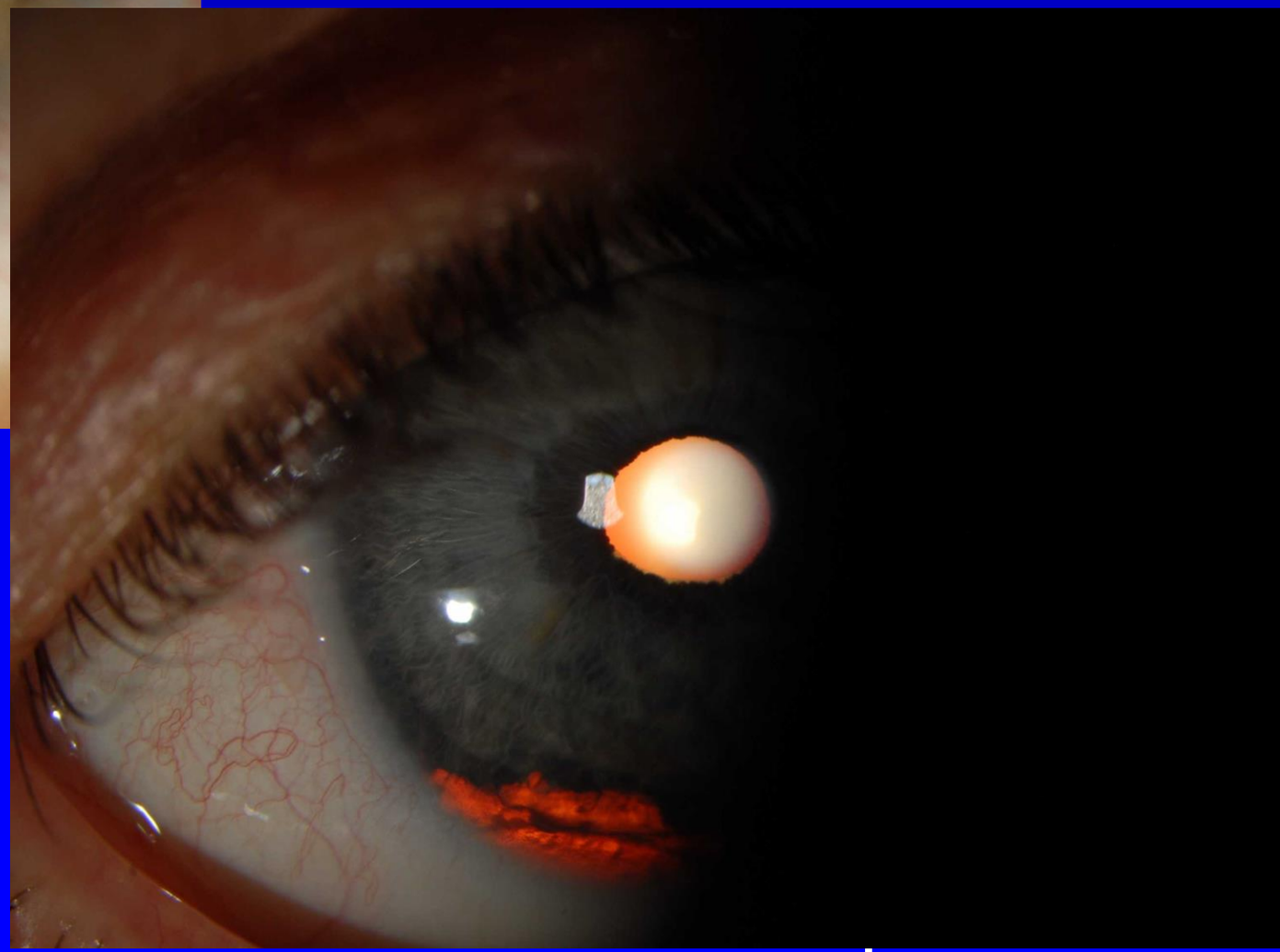


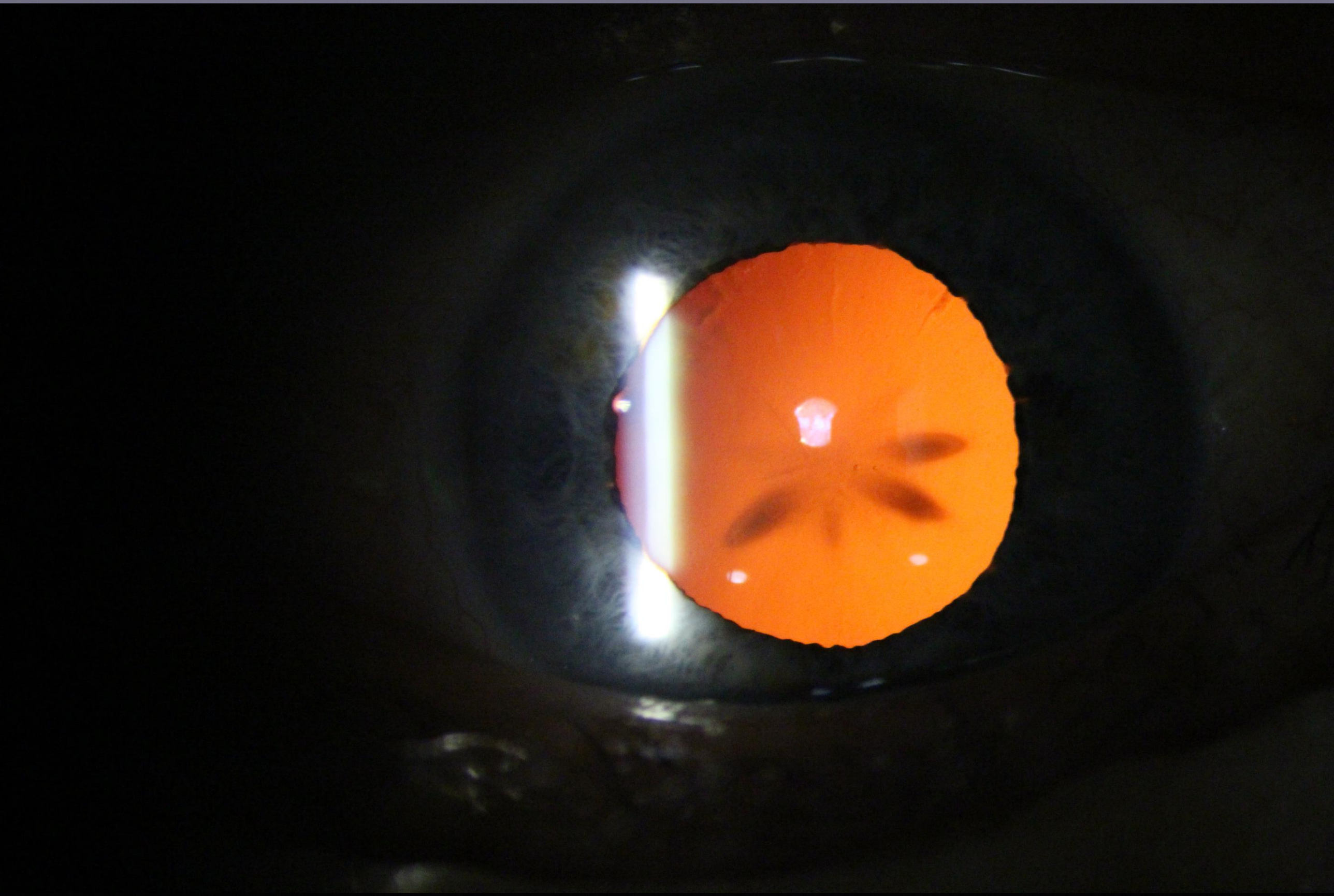
Blunt Trauma OD(Nail gun!)



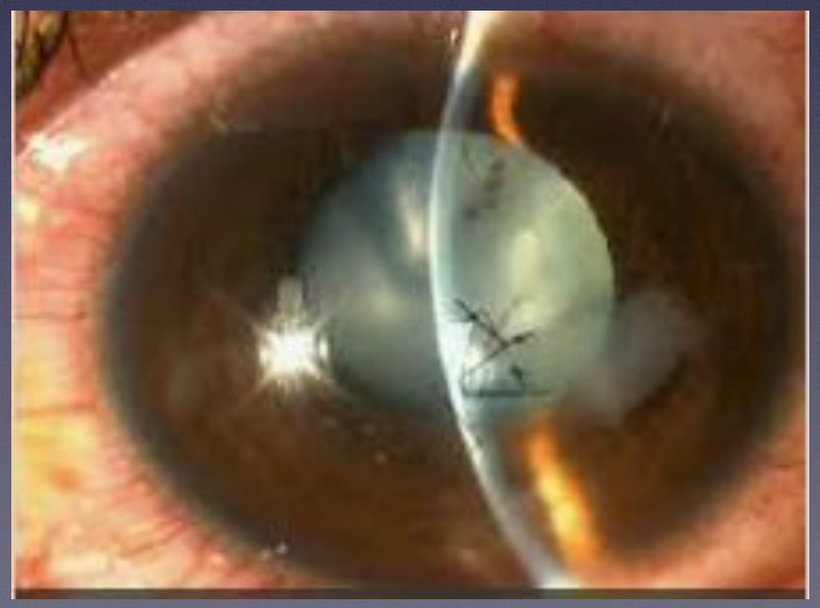
Iridodialysis

Polycoria





Corneal Injuries



Eye Injuries

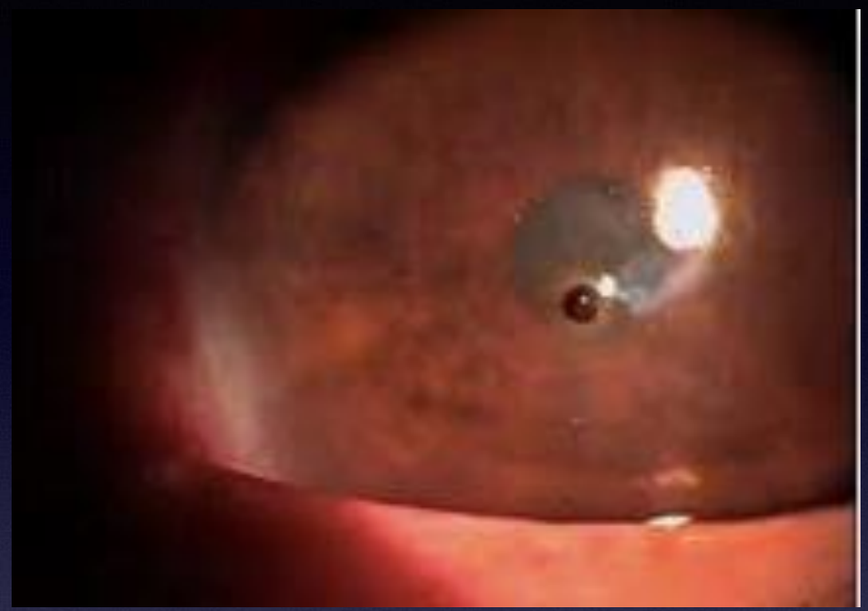
- Commotio retinae = “contra coup”equivalent with energy transferred to posterior segment and specific damage to the macula. Acutely haemorrhage may be present.

- Retinal detachment when trauma results in a retinal tear/hole with fluid under the retina…symptoms of flashes and floaters with a shadow across the vision…early detection and surgical treatment with vitrectomy results in better outcomes

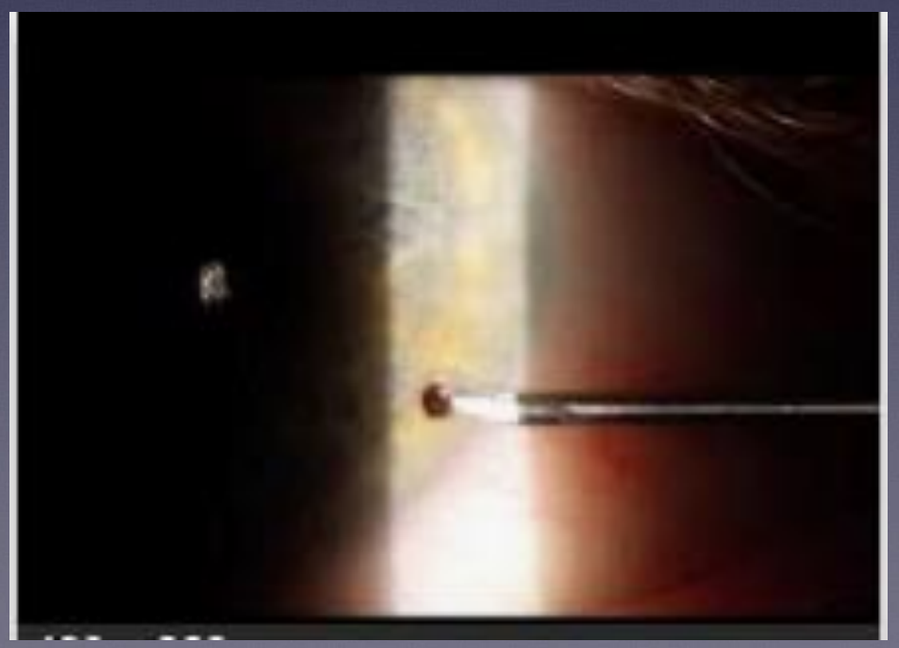
Eye Injuries

- Surface foreign bodies especially on the cornea symptomatic and easily seen but should be removed under slit lamp control
- Rust rings
- History of injury paramount to determine required evaluation…grinding injury more likely to be low velocity rather than hitting metal on metal with high velocity and risk of penetration
- Plain X Ray orbits no longer adequate and best imaging via CT Scan
- Removal depending on size and nature of FB…magnet for iron
- Missed diagnosis = risk of siderosis and loss of vision!

CT Scan showing three intra-ocular FB's



Corneal FB



Head Injuries

- Extremely variable deficits associated with severity of head injury
- Recovery prolonged and often more rapid in younger patients
- Visual field defects often homonymous
- Parietal lobe injuries resulting in hemi-field neglect
- Convergence/accommodative insufficiency commonly occurs but usually slowly resolves with time
- Beware of reading difficulties in presbyopic age group which appear to be potentiated by the injury (coincidental)

Thank you