Understanding Strabismus:
The Pursuit of Stereopsis
NAMS-AIIMS- PGIMER 2025

CENTRE FOR SIGHT
Every eye deserves the best
A Mahindra Collaboration

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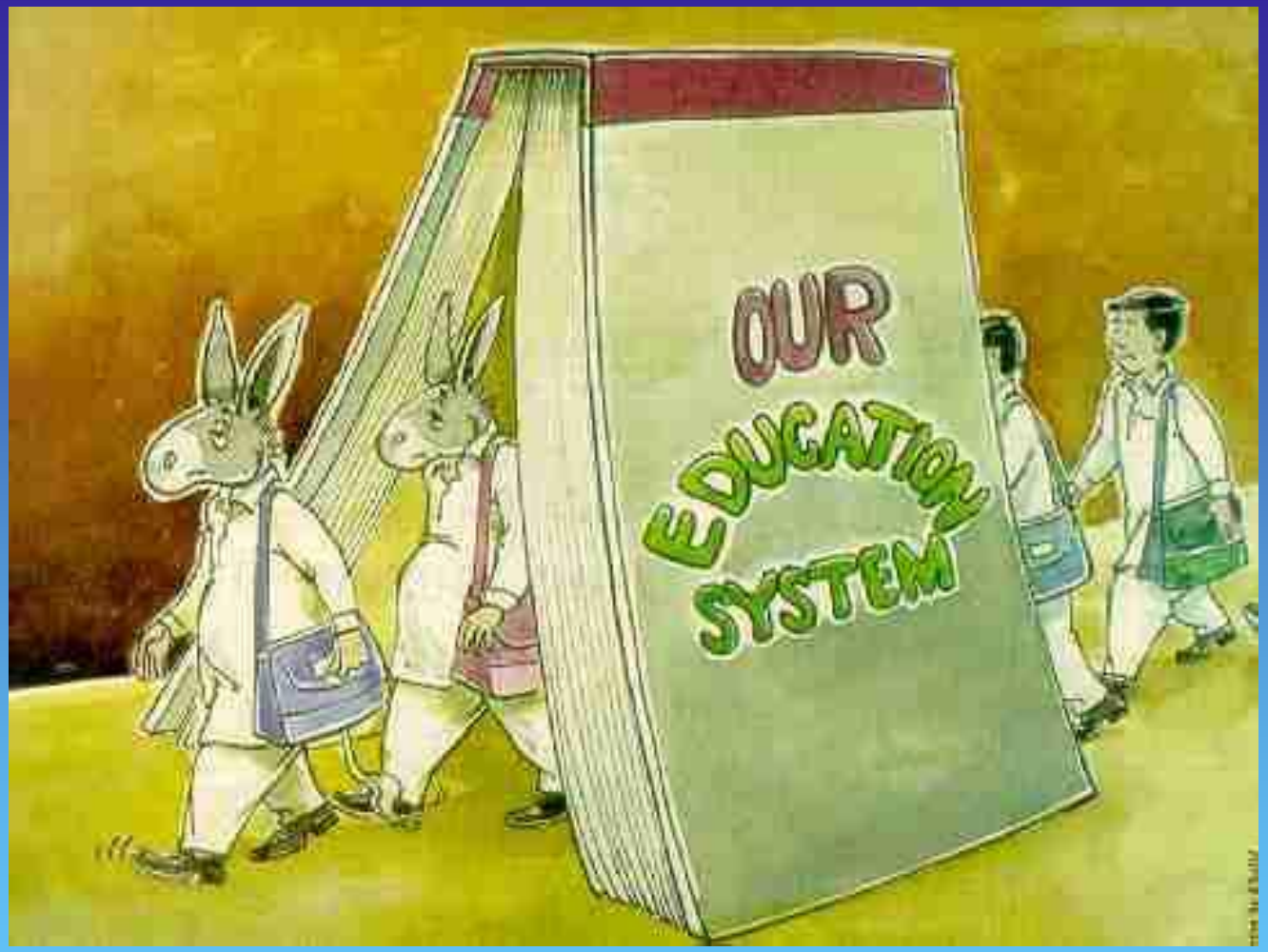
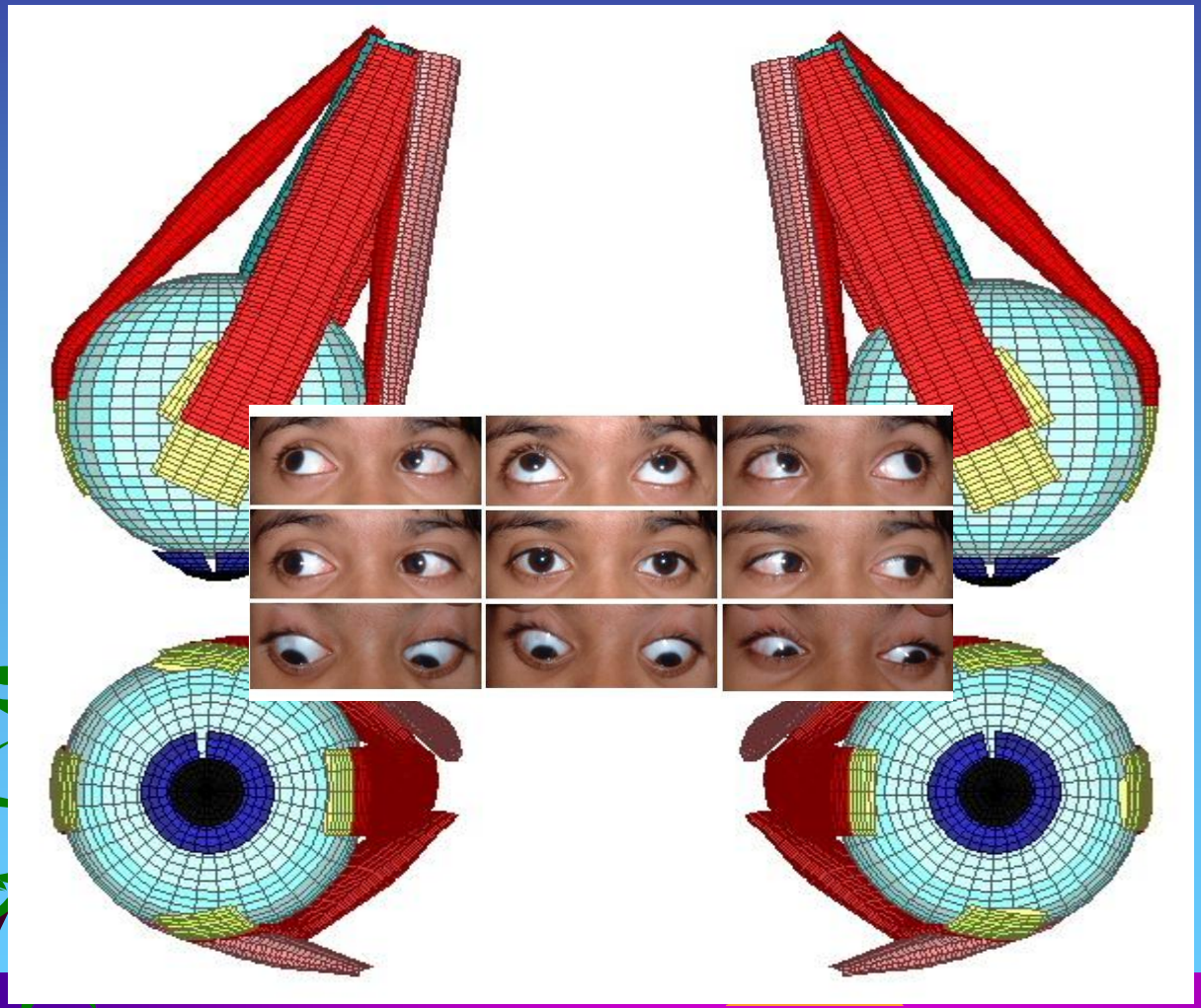
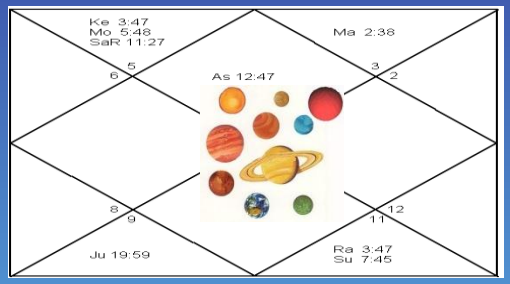


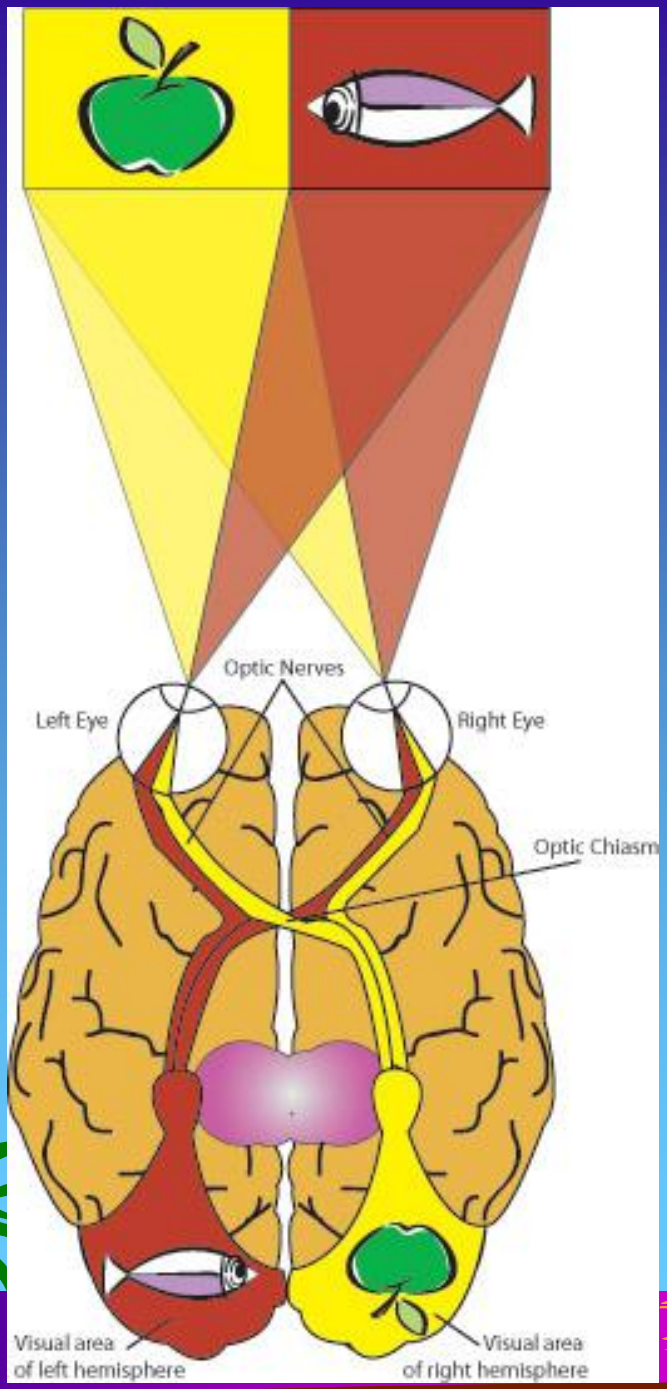
I have no relevant financial disclosures

Ocular motility: A play of twelve extraocular muscles in nine gazes

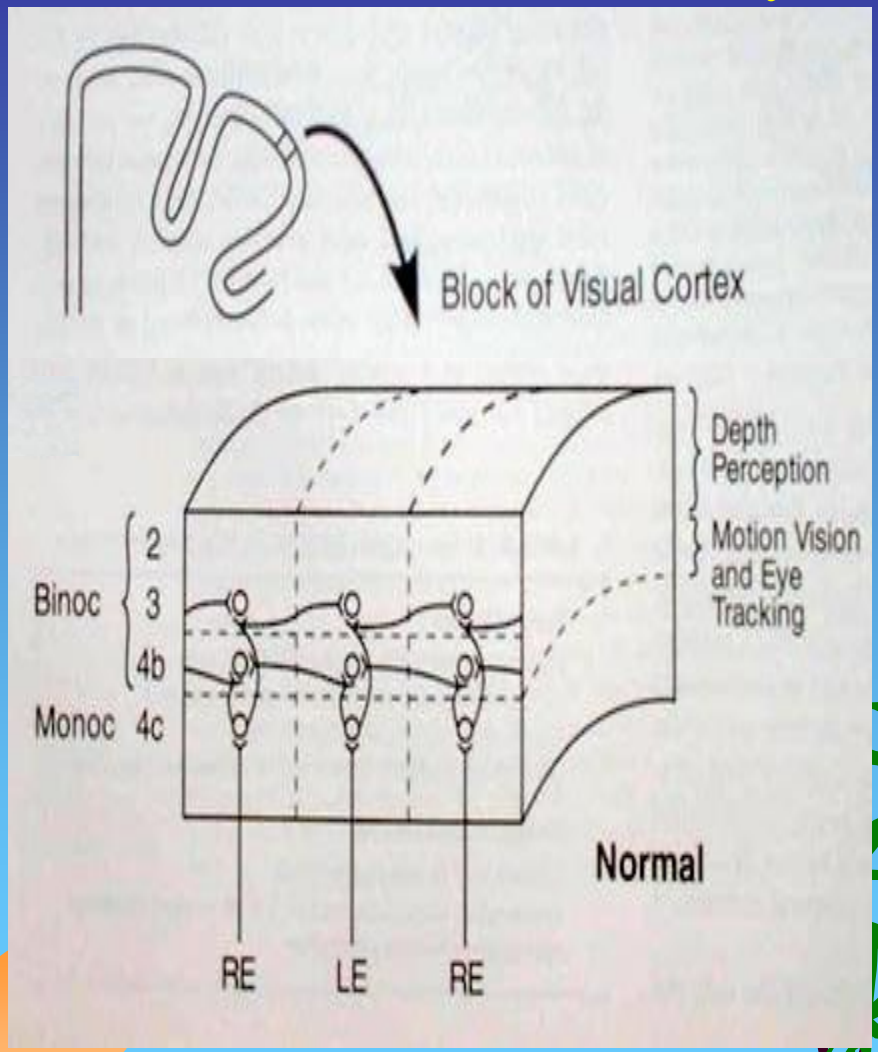




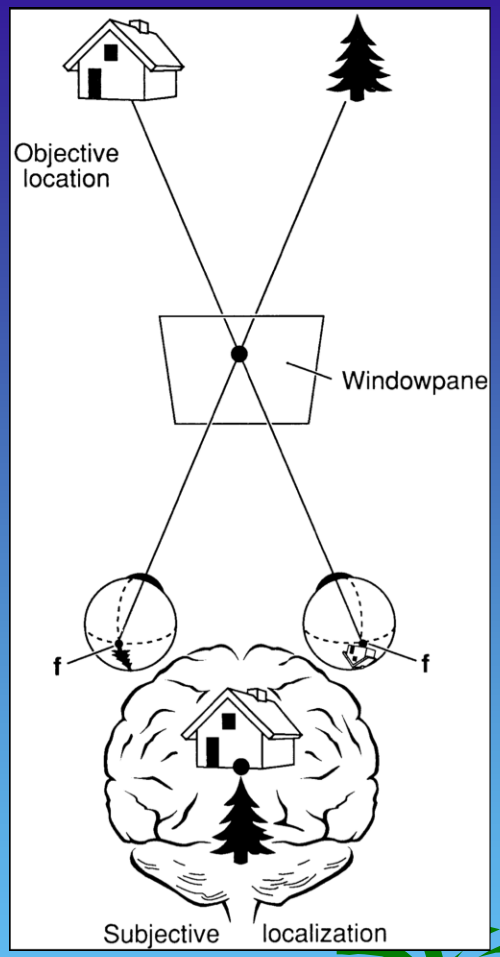
Twelve houses
nine planets

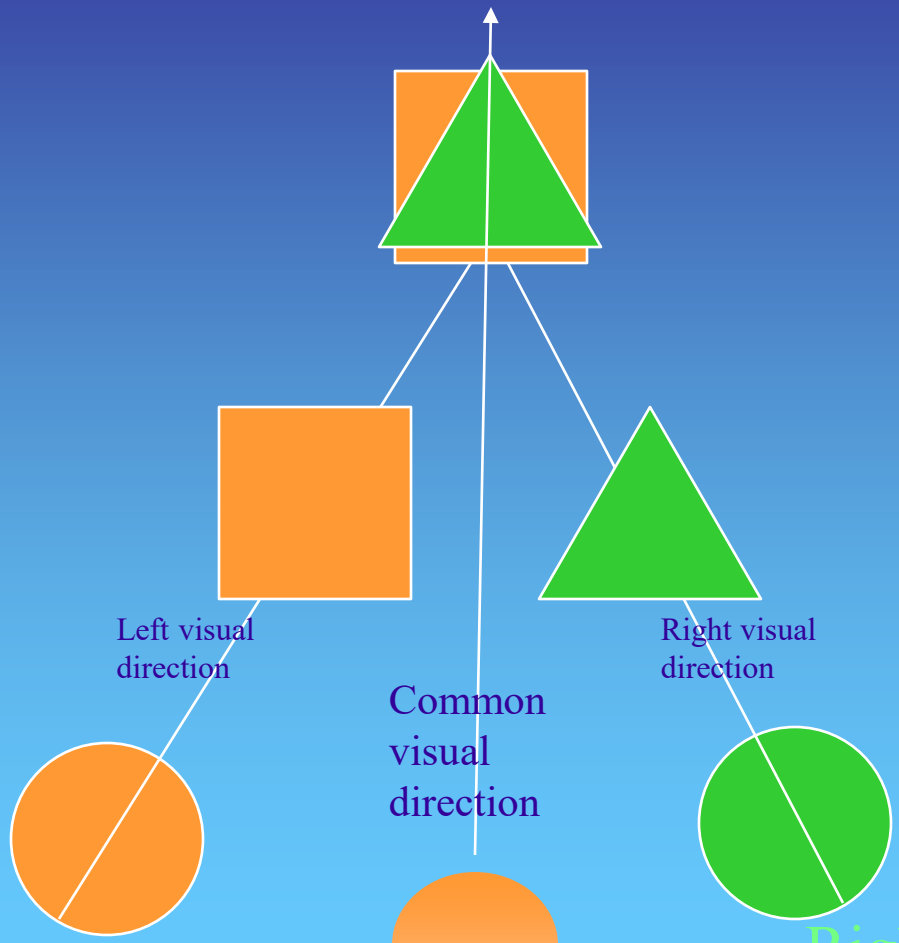


How we see binocularly?



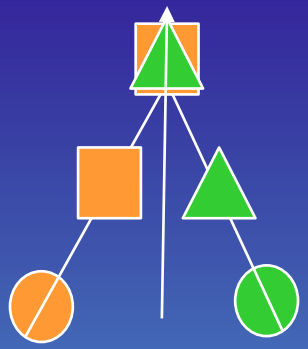
Binocular perception



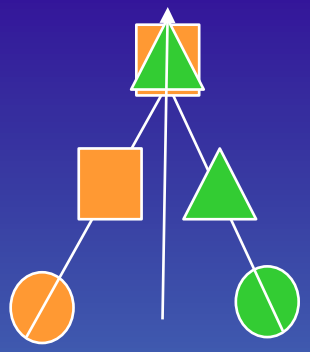


Physiological diplopia is evidence of this

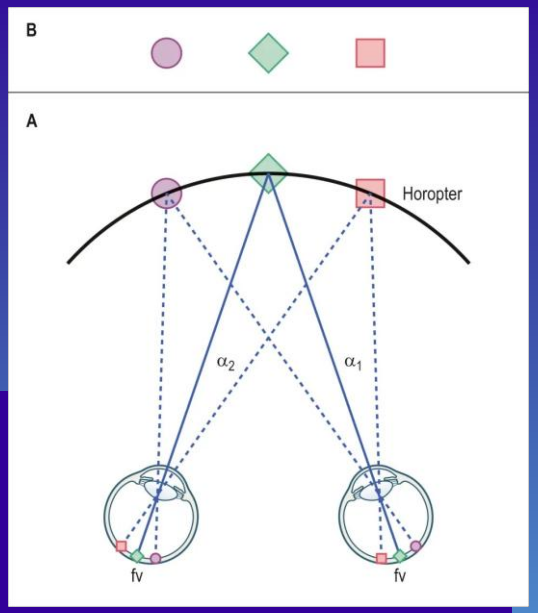
Alignment of eyes



- The two visual axes meet at the point of fixation or regard.
- The two foveas share a common visual direction.
- When they are not aligned: squint or strabismus results.

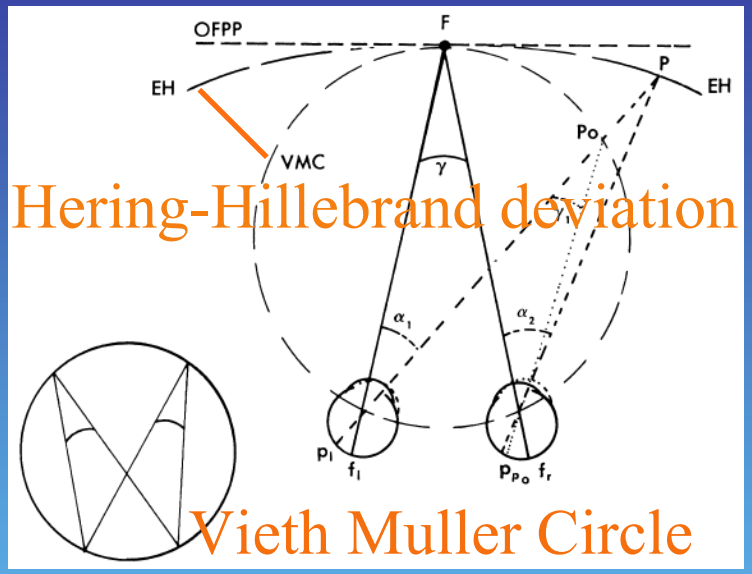


Binocular vision



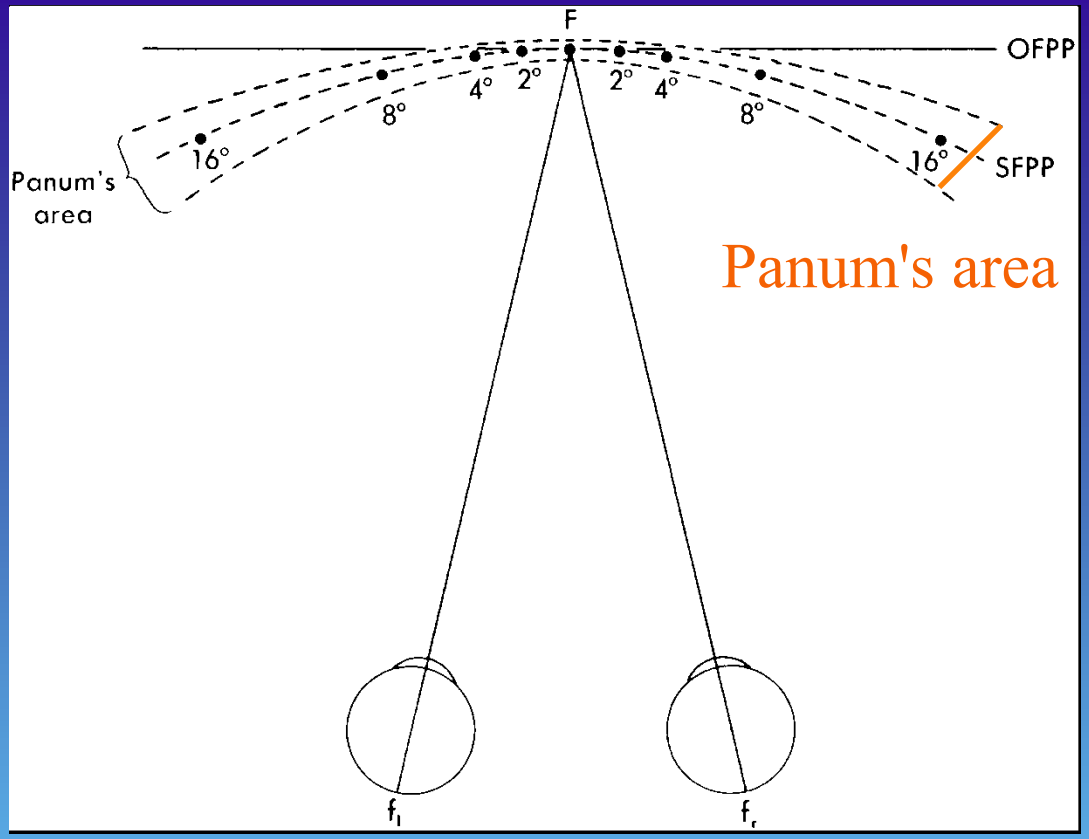
- Principal visual direction:
  - fovea to fixing object
- Fovea of the two eyes correspond:
  - foveo-foveal (normal) retinal correspondence,NRC
- Retinal points have pt to pt correspondence
- Corresponding points: BSV:no diplopia
- Disparate points:diplopia

Horopter

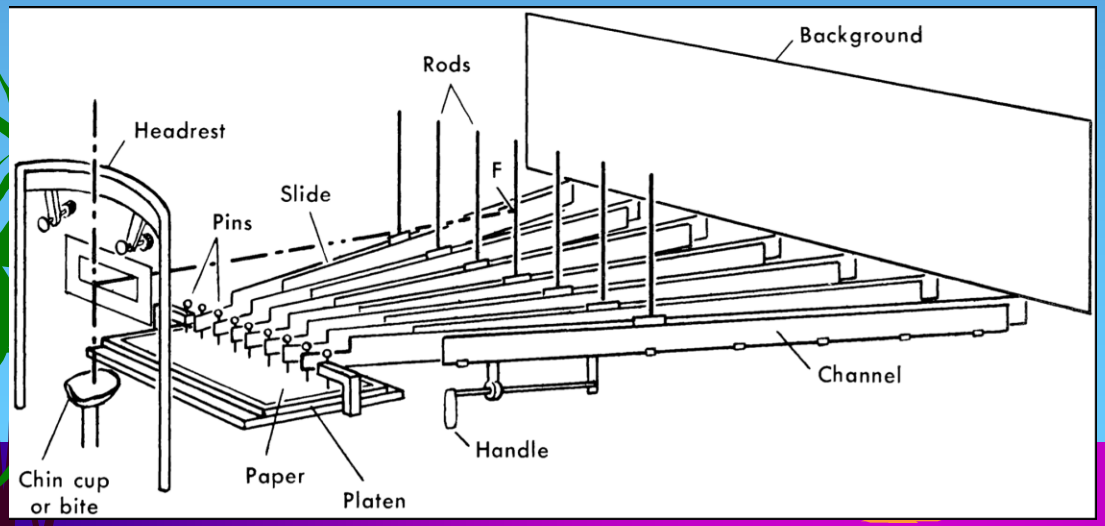


Hering-Hillebrand deviation

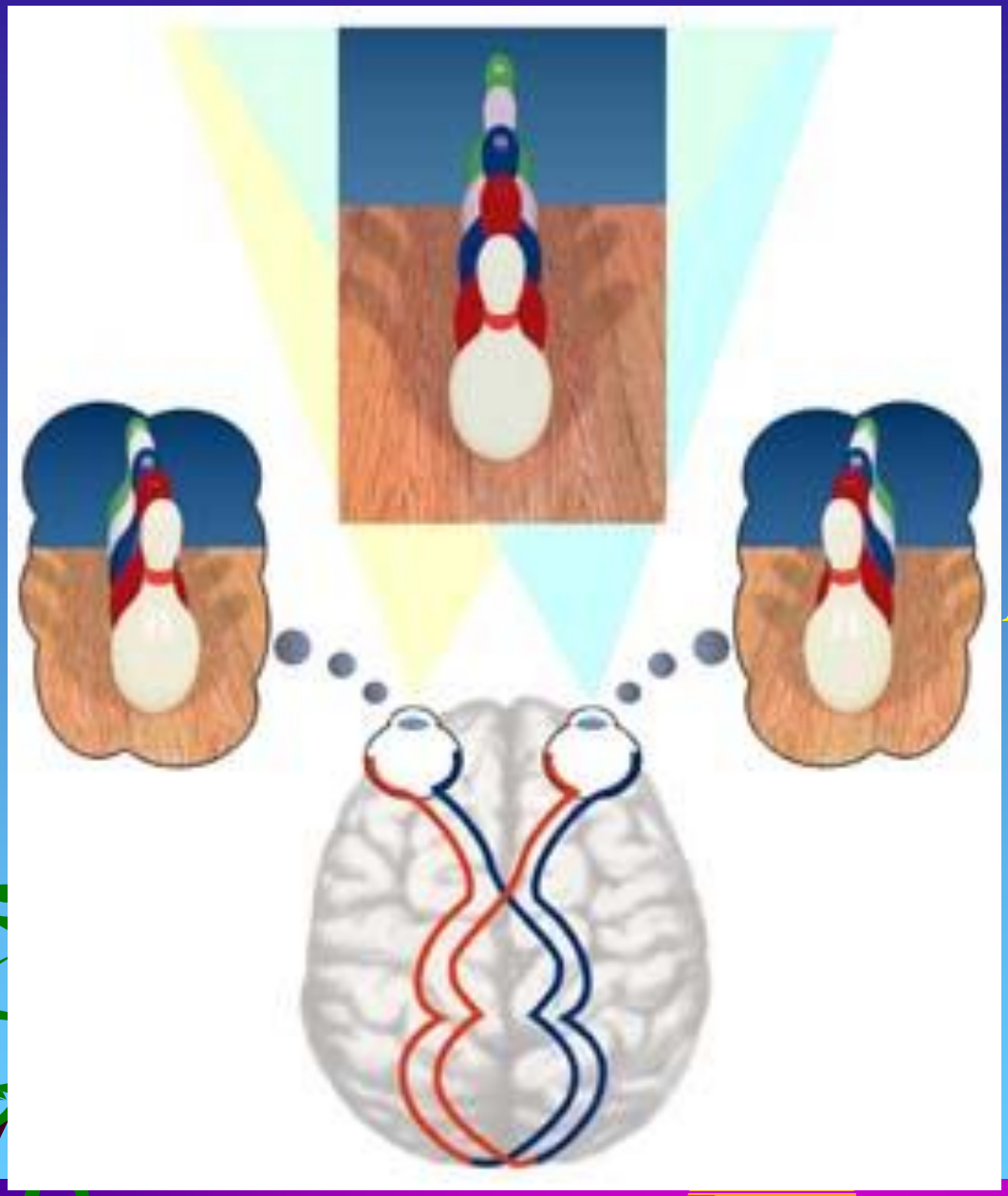
Vieth Muller Circle



Panum's area



Disparity within Panum's area: BSV
Outside it: Diplopia



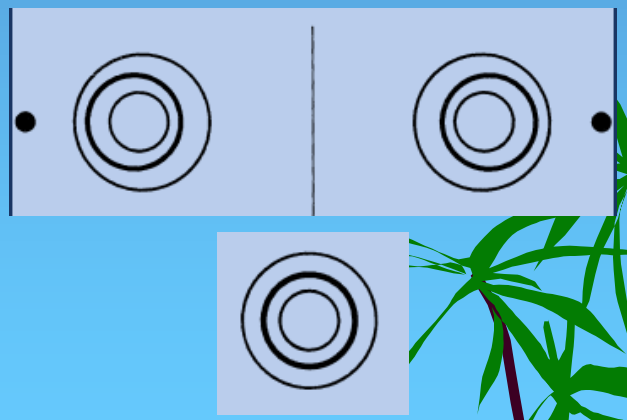
Stereopsis:

Each eye sees things little differently

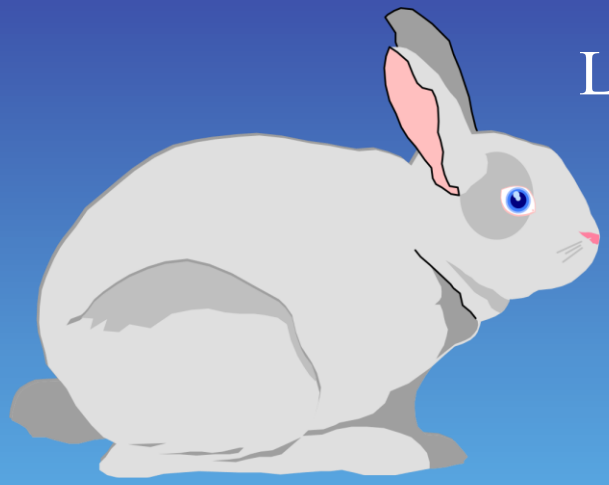
The disparities are within Panum's fusional limits

Are fused to give the

3D effect



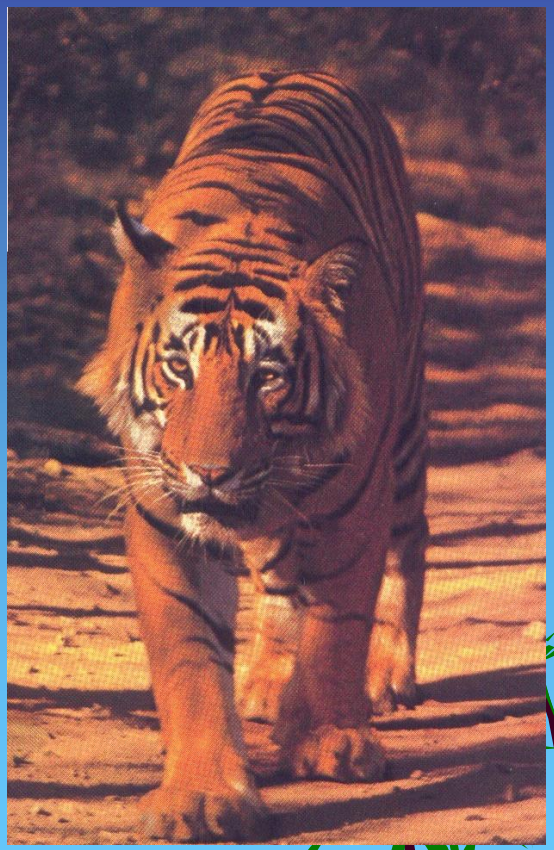
Two eyes : an asset

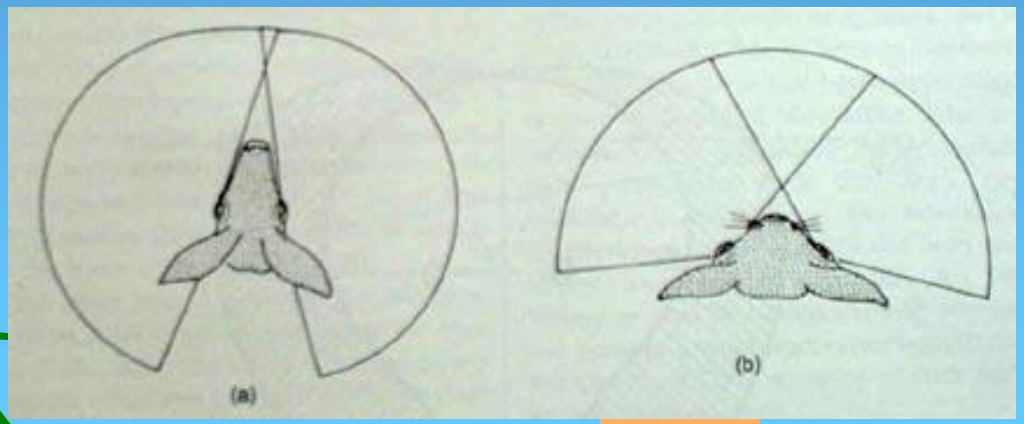


Large field

vs

Stereopsis





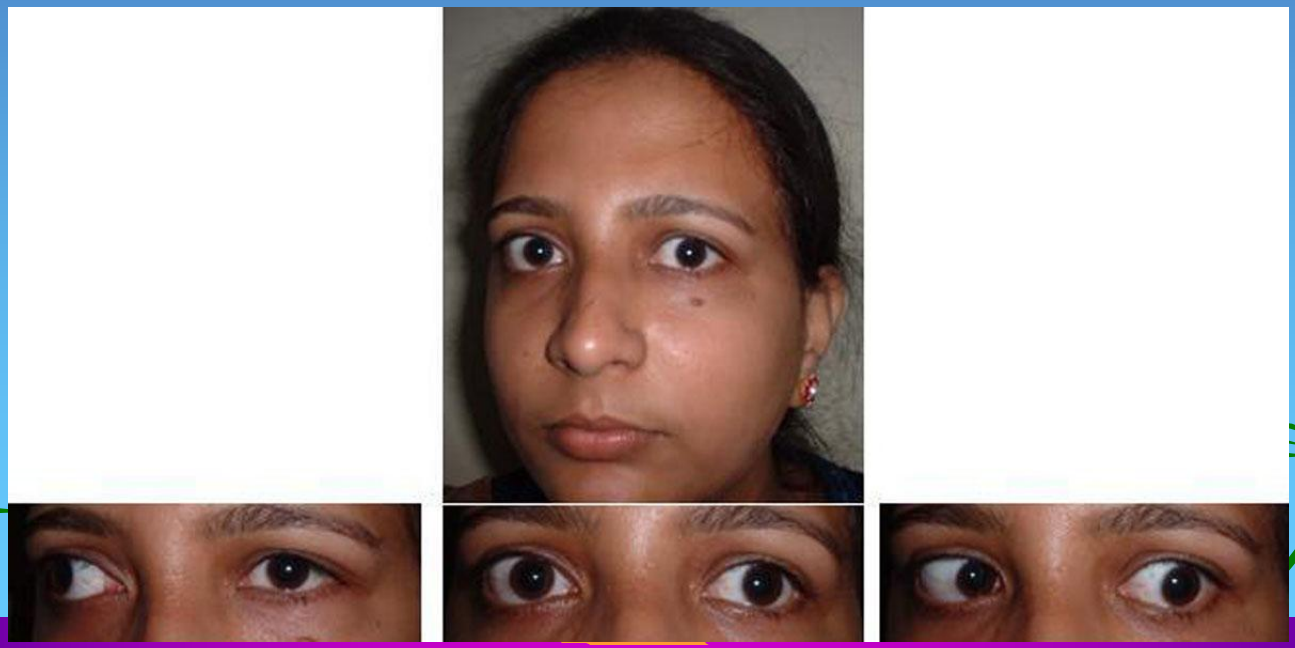
Bugbears of misalignment

when Asset becomes a Liability!

- Asthenopia and headache
- Diplopia
- Confusion
- Past-pointing
- Vertigo
- Psychosocial problems

Coping the bugbears:
Motor Adaptations

- Head posture
  - Face turn to right or left
  - Chin up or down
  - Head tilt to left or right
- Blind spot mechanism: Esotropia of 12-15 degree : 25-30pd



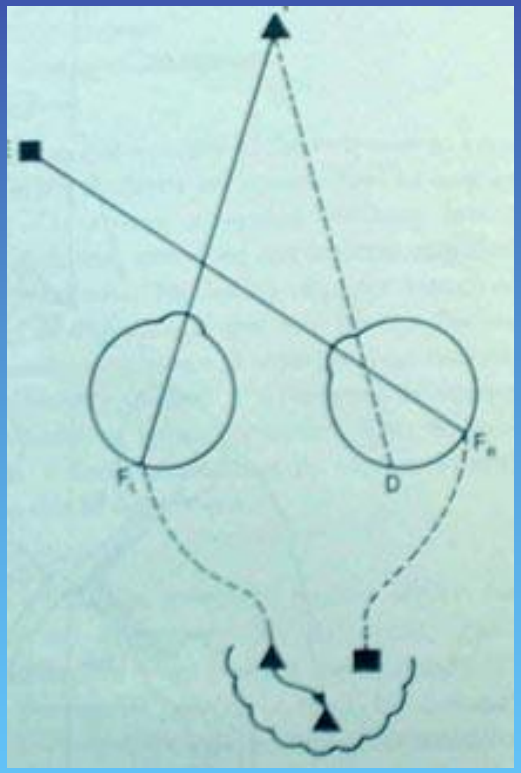
Head postures: different types

Face turn

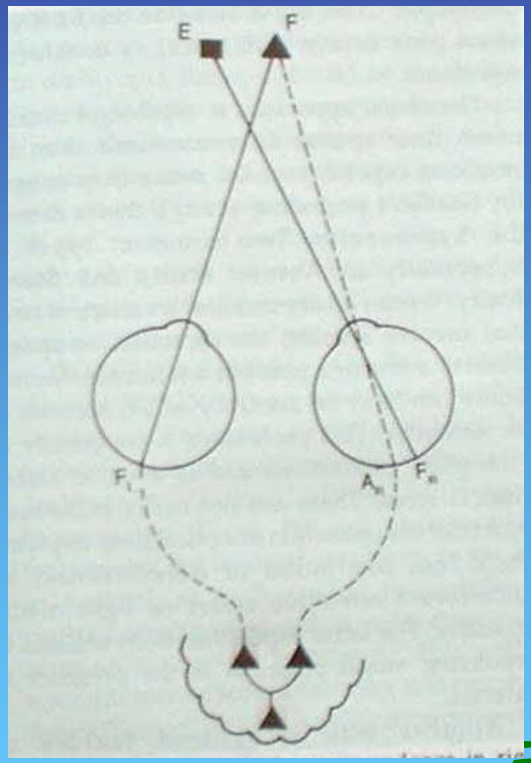
Chin down

Head tilt

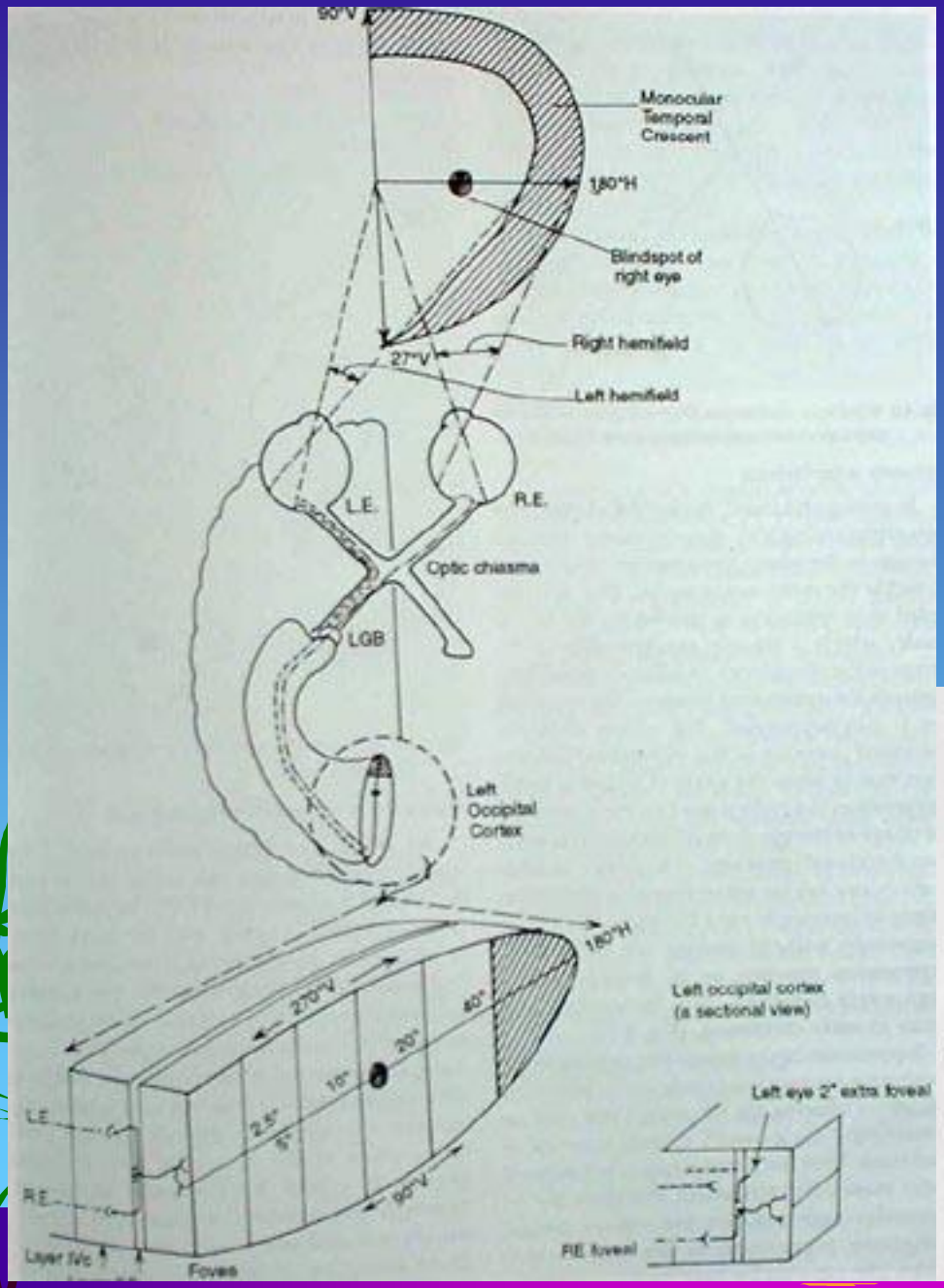
Coping the bugbears: Sensory Adaptations



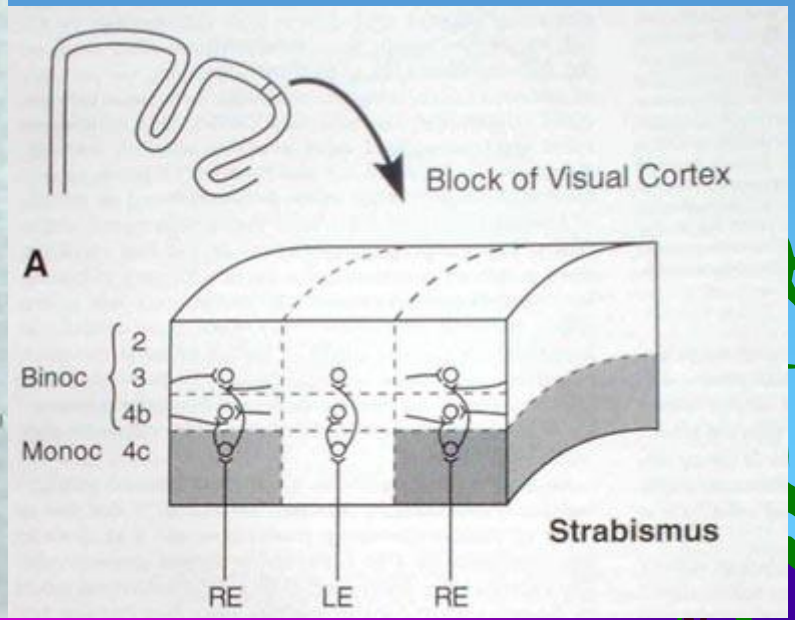
suppression



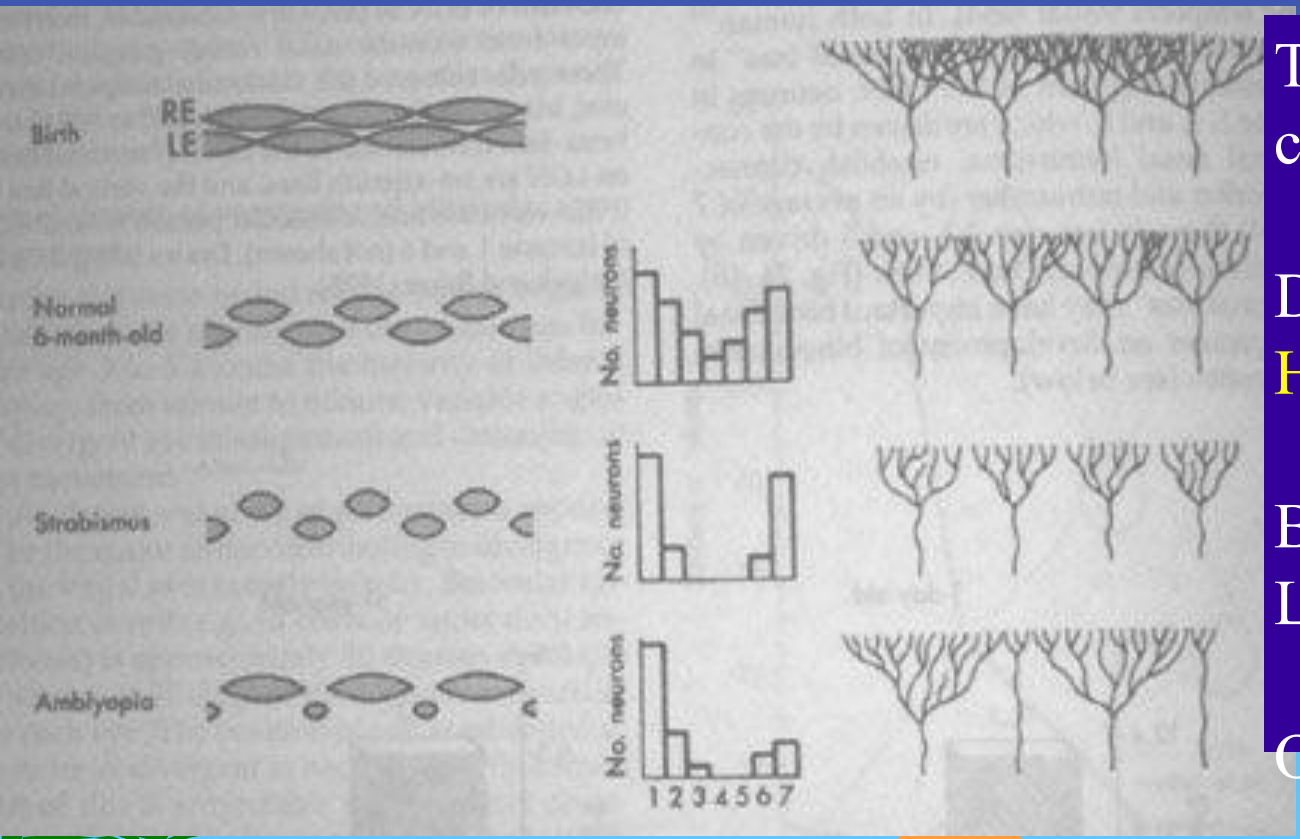
Anomalous retinal correspondence



In small angle deviations upto 8pd foveo-extrafoveal areas re-synapse to give Harmonious ARC



Amblyopia: the cortical substrate: social analogy



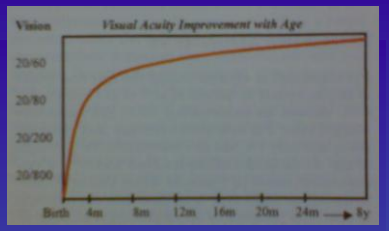
Two strangers come together

Develop normal
Harmonious marriage

Both dominant & fight:
Live separately, divorce

One dominates

Tychsen L. Binocular vision in Adler's Physiology 6th edition



Amblyopia

A developmental anomaly of vision

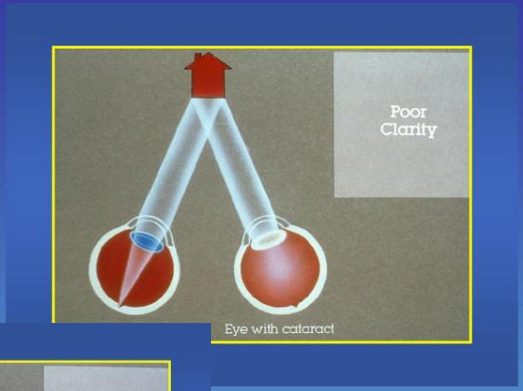
We are not born with 6/6 vision but acquire it,

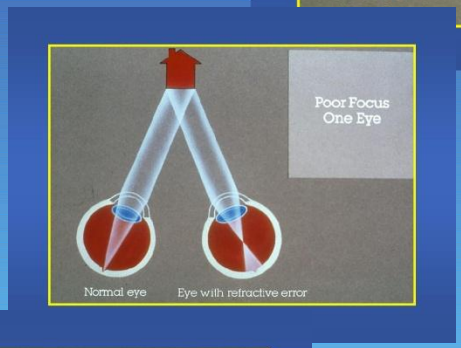
Cortex learns a new language that is vision

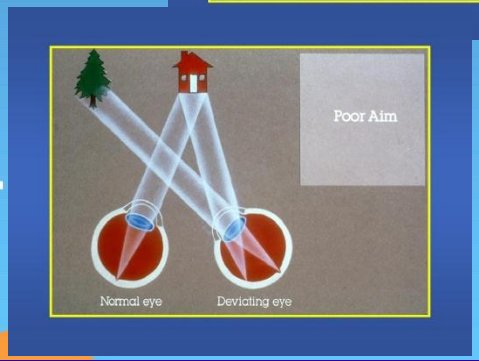
- Diminution of vision in one or both eyes
- despite best refractive correction
- with no obvious pathology of ocular media or visual pathways
- due to visual deprivation or abnormal binocular interaction
- Is fully correctable if timely done

Causes of Amblyopia

- Stimulus deprivation amblyopia
  - Ametropic: high uncorrected ref error
  - Cataract or media opacities
- Anisometropic amblyopia
  - Unequal uncorrected ref error
  - aniseikonia
- Strabismic amblyopia
- Nystagmus, Organic etc.

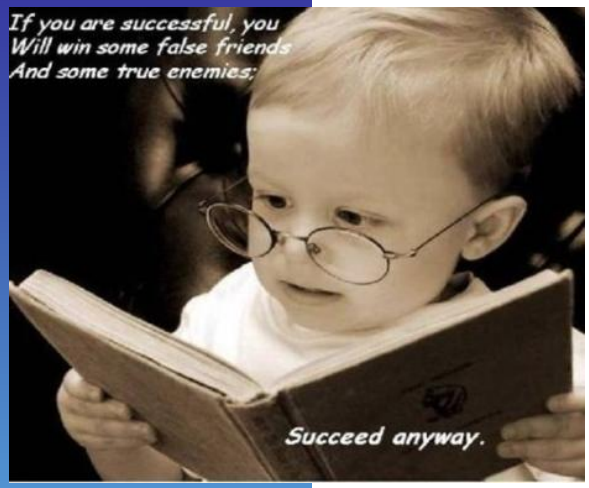




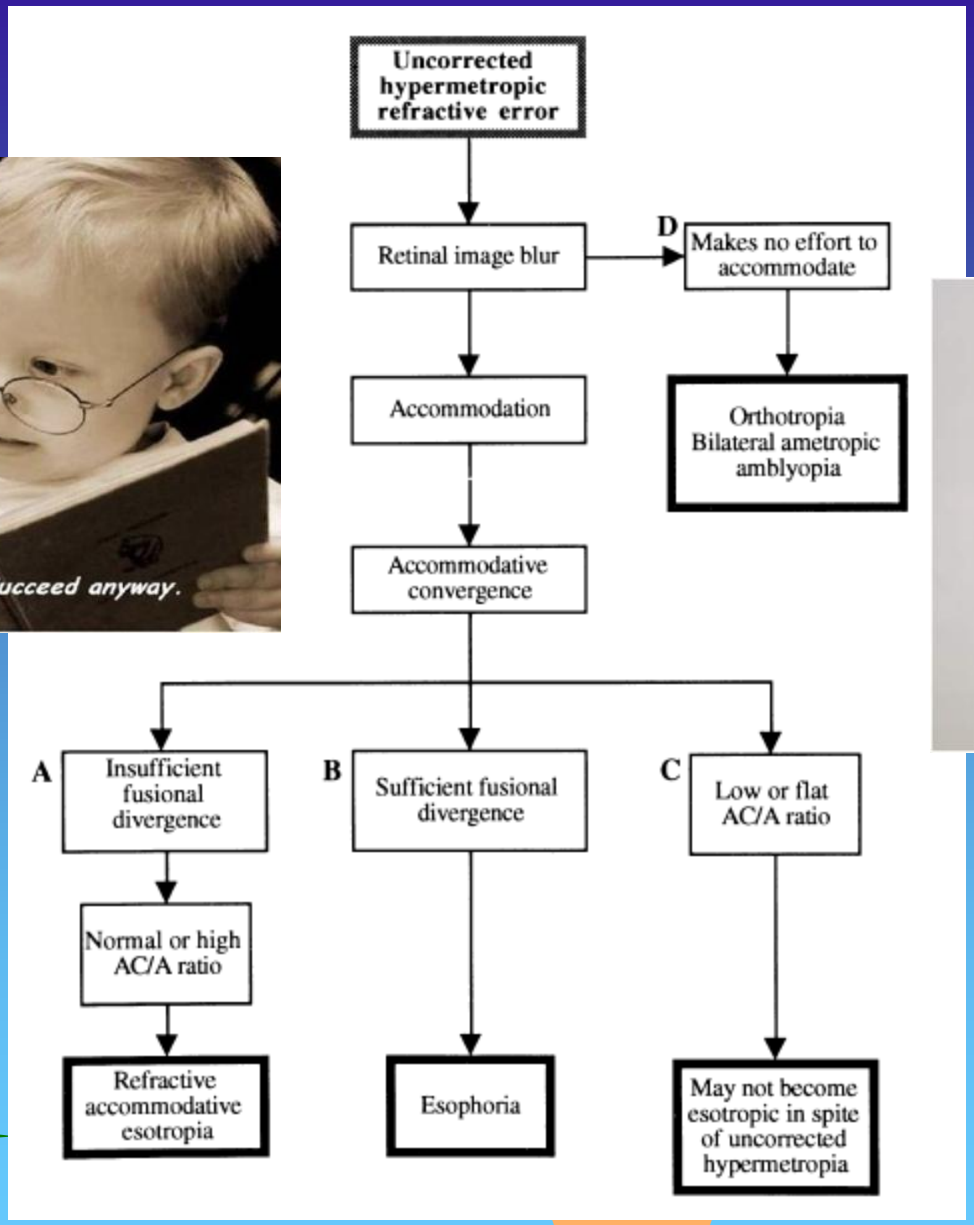


Mixed etiology is possible, even with organic conditions!

A story of two kids



Type A



Lazy

Strabismus: A Decision Making Approach. St Louis, Mosby–Year Book, 1994, p 95.)

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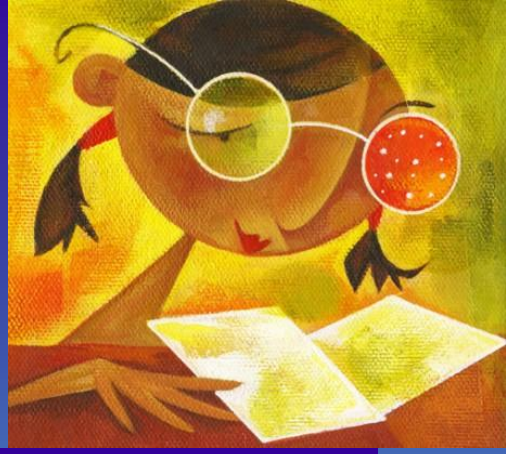
Correcting Amblyopia
Occlusion : Full time vs Part Time

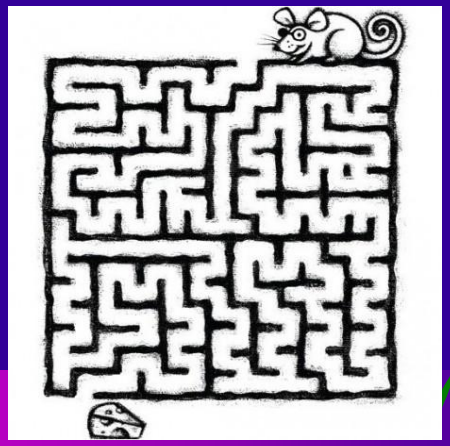
- **Full time Age dependent alternation**
  - **Dominant eye vs amblyopic eye**
  - **Upto 2 years= 2:1**
  - **3,4,5,6,6+ = 3:1.4:1,5:1,6:1,same**
  - **Part Time Occlusion: 6hours/2 hours**

Concept of occlusion hours: 120 occl hours
=1logMAR imp.
Stewart et.al MOTAS: 2004

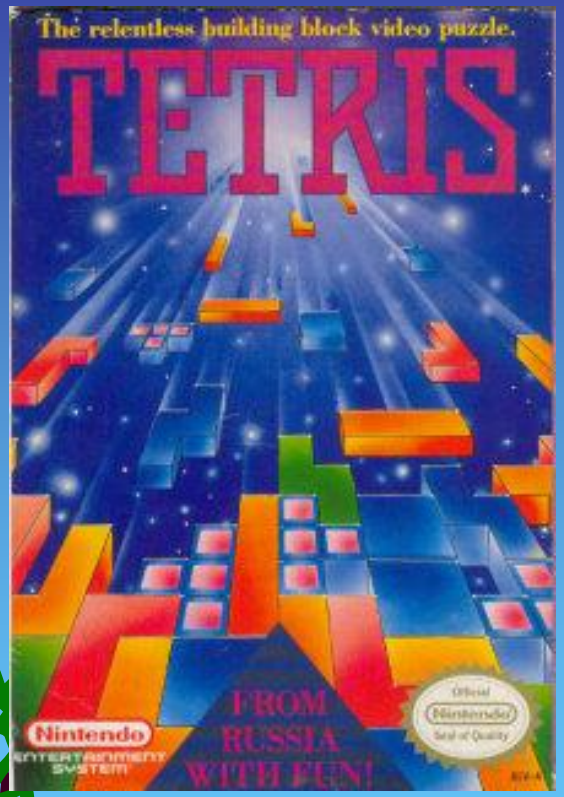
Active Vision Exercises



- Three different kinds of intervention:
- Monocular Perceptual Learning (PL),
- Monocular Videogame Play (VGP)
- Dichoptic PL or VGP



Binocular Vision Stimulation: a new paradigm to treat amblyopia



Binocular videogames exercises whereby the amblyopic eye and the normal eye are used to play binocularly:
Study done at RPC
Presented AAPOS, 2019, San Diego

Improvement in BCVA In Anisometropic Amblyopia: Occlusion vs Binocular Videogames:
Thesis of Dr Shayeri Roy, AAPOS San Diego 2019

Eye pads to I-pads

Sensory Assessment

Fixation preference

Inference : Left eye has poor vision

Fixation preference test

CSM: Central /Steady/Maintained Fixation

Follow eye movements: Horizontal/Vertical

Pearl: If eye prefers to be fixed in adduction: Adduction Null
Will require Posterior fixation on MR with recession

Fixation devices: for near and distance

CSM: Central /Steady/Maintained Fixation

Follow eye movements: Horizontal/Vertical

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Fixation devices：for distance

Assessment of poor vision

- Fixation preference
- Maintenance of fixation
- 10 pd prism test
- Tests for amblyopiogenic factors:
  - Bruckner's fundus reflex:photoscreening
- Special visual acuity tests.

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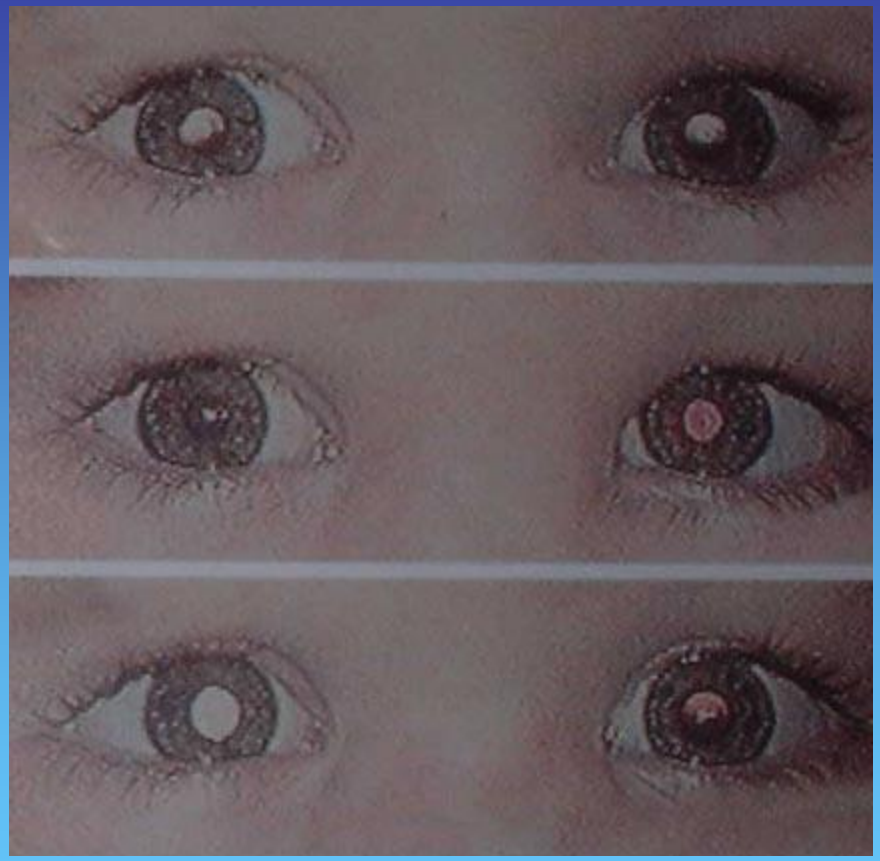
Photoscreeners



Hyperopic crescent

Esotrope fixing with RE

Esotrope fixing with LE

Bruckner's test

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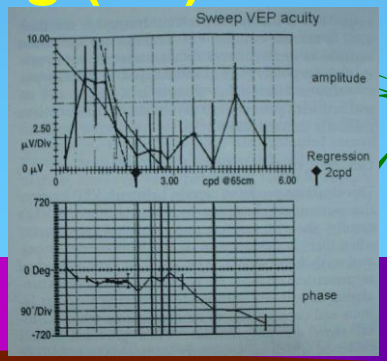
Methods of visual acuity

1.Detection acuity tests

- Catford drum
- Boeck candy beads
- STYCAR graded balls test

2.Resolution acuity tests

- OKN drum
- Preferential looking (PL) tests
- Pattern VEP



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Methods of visual acuity

3.Recognition acuity tests

- **Picture identification on behavioural pattern**
  - **Cardiff acuity cards**
  - **OKNOVIS**
- **Picture identification**
  - **Allen's cards**
  - **Sheridan's miniature toys**
- **Direction identification**
  - **Landolt's C**
  - **Snellen's E**
  - **Sjogren's hand test**
  - **Arrows**
- **Letter identification**
  - **Snellen's**
  - **Sheridan's letter test**
  - **Lippman's HOTV test**

Best for Amblyopia detection

Vision screening for infants and children

Age	Screening tests	Findings for referral
Birth -6mo	• Red reflex test • Corneal light reflex test • External examination	• CO,Cataract,RD • Strabismus • Structural defects
7-12mon	• Red reflex test • Corneal light reflex test • Occlusion of each eye • Fixation and following	As above Amblyopia
1-5yrs	• Red reflex test • Corneal light reflex test • VA test • Stereo acuity	As above Refractive error Amblyopia

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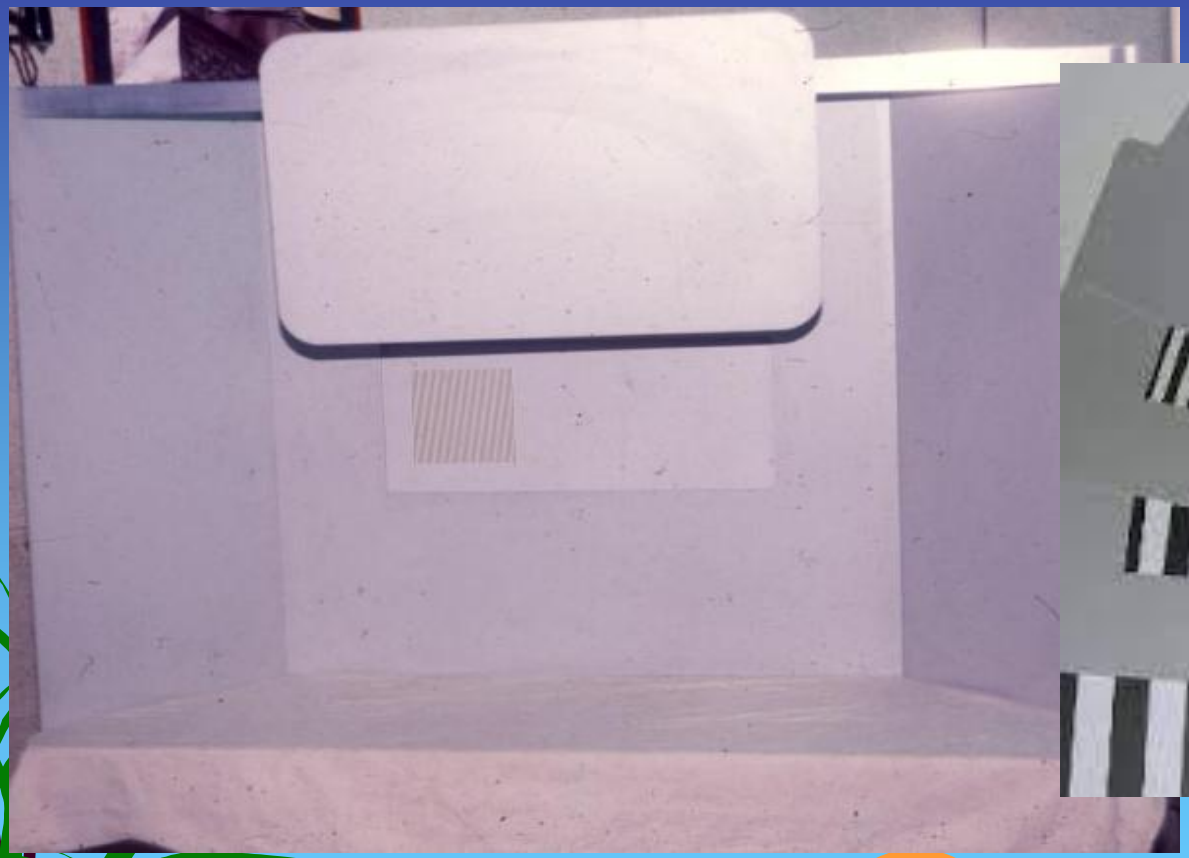
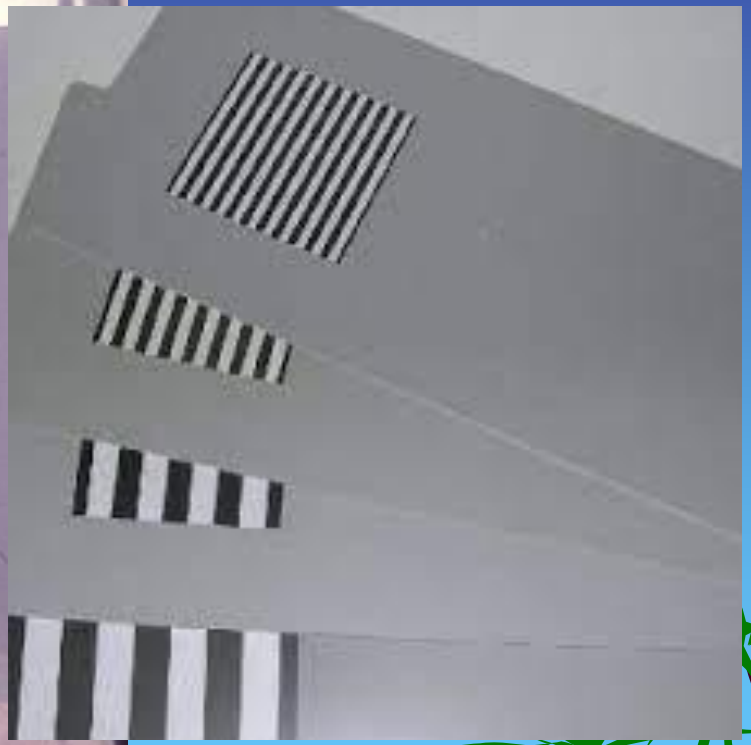
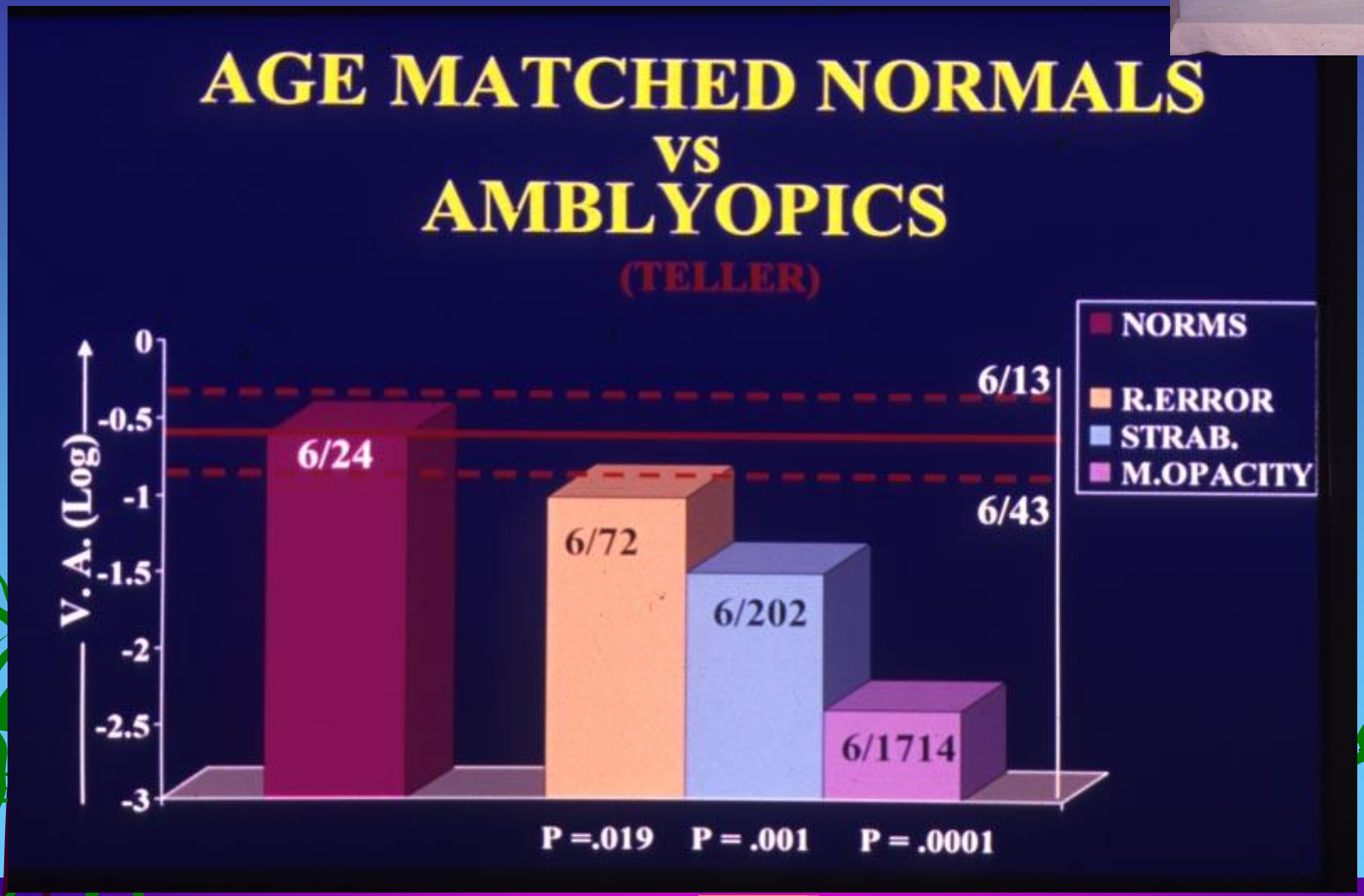
Teller acuity cards





Teller Acuity



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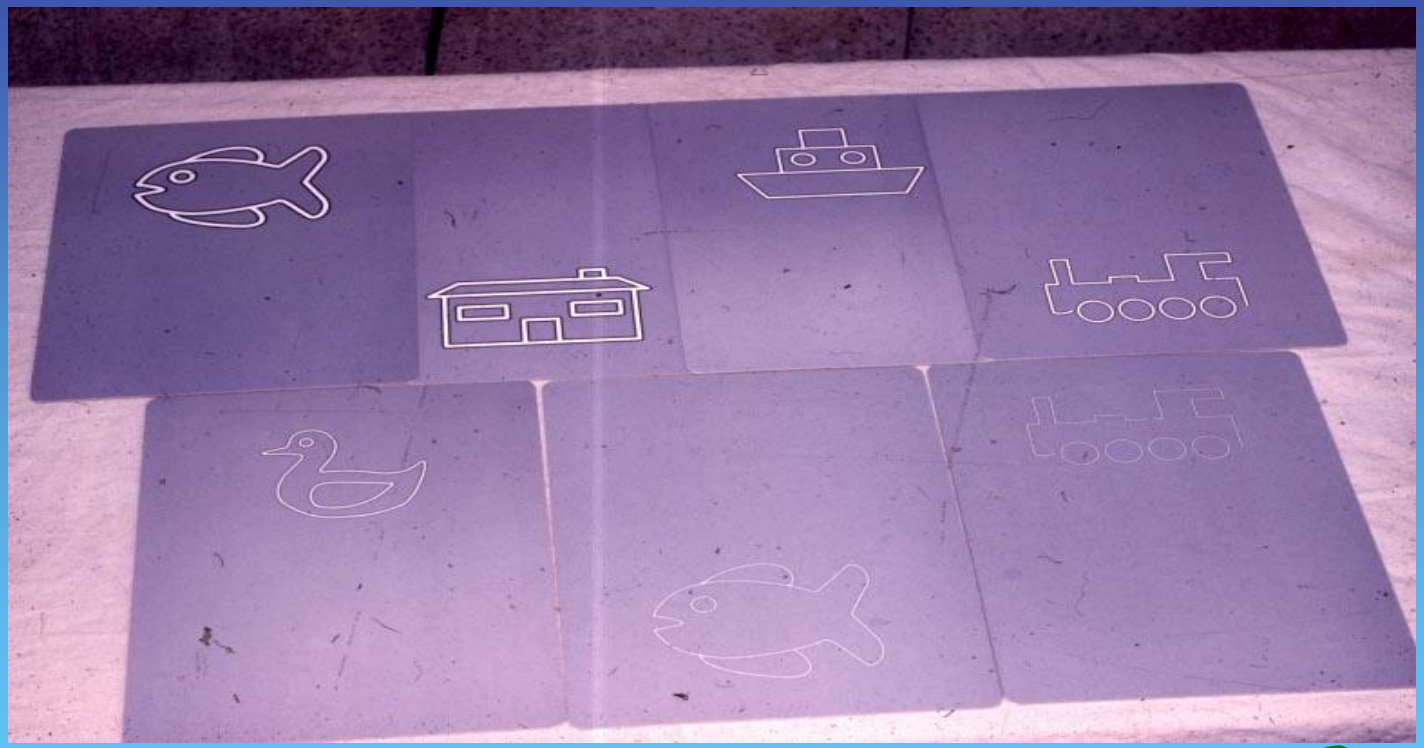
Cardiff Acuity Cards: vanishing optotypes



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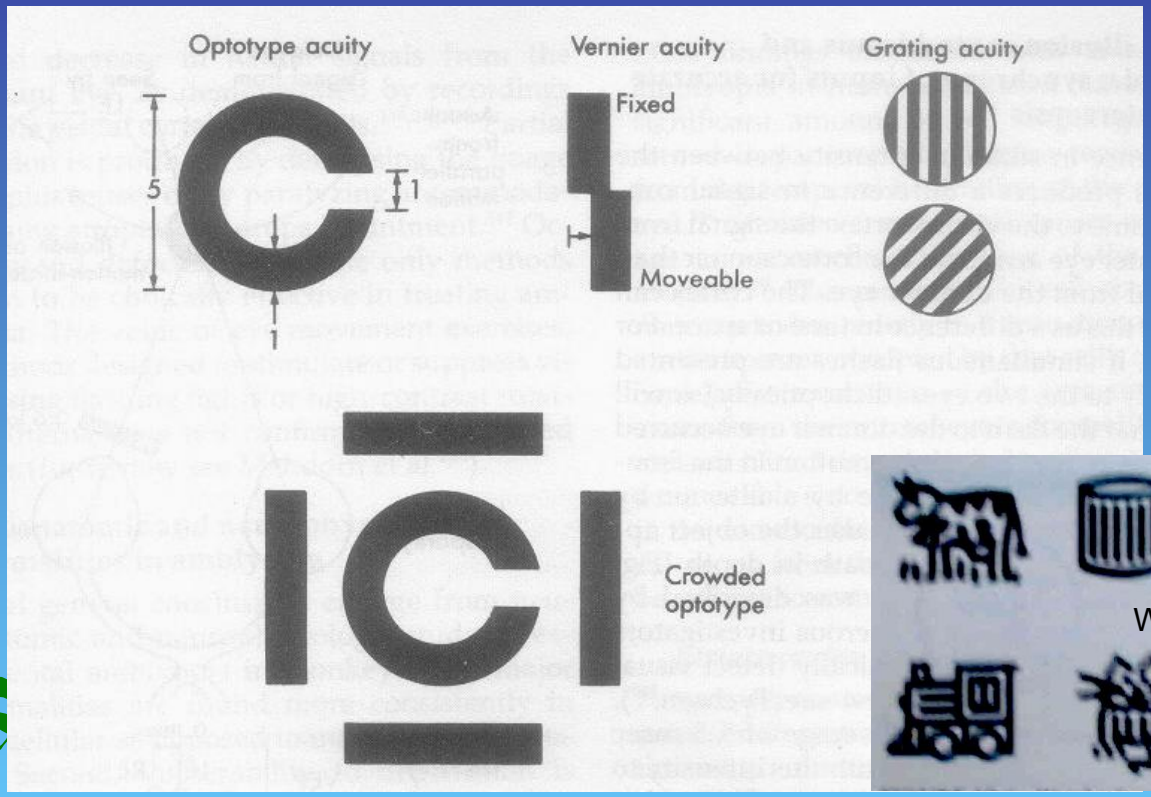
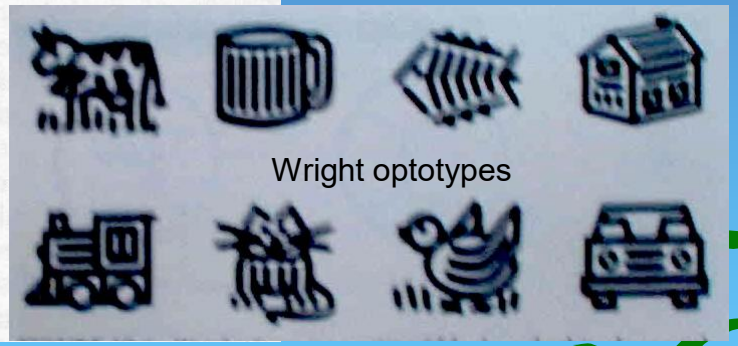
Assessment of Visual acuity



Different optotypes



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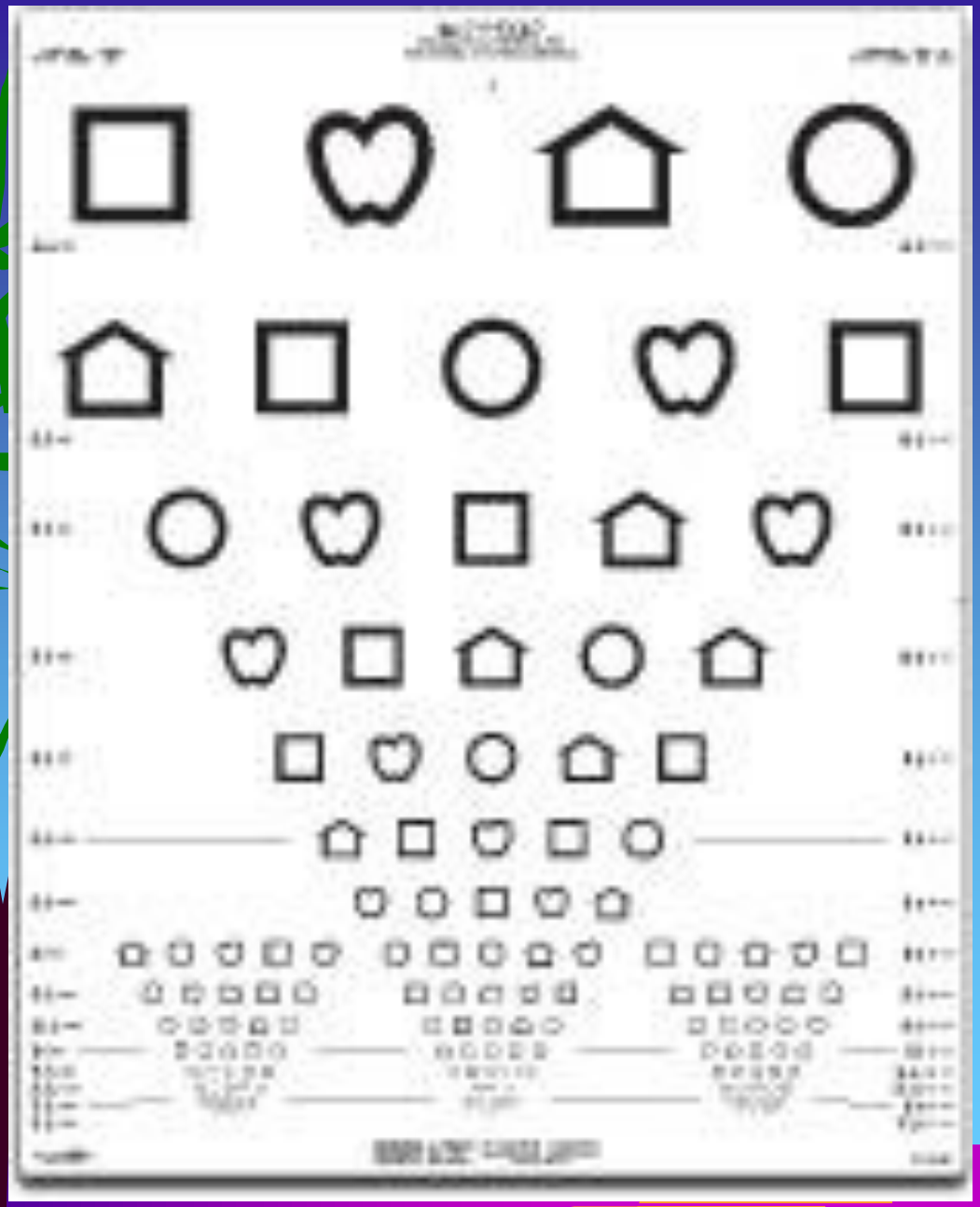
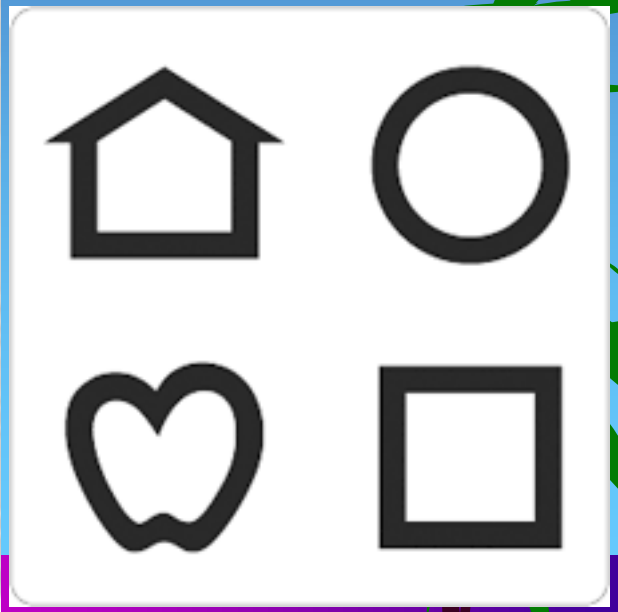
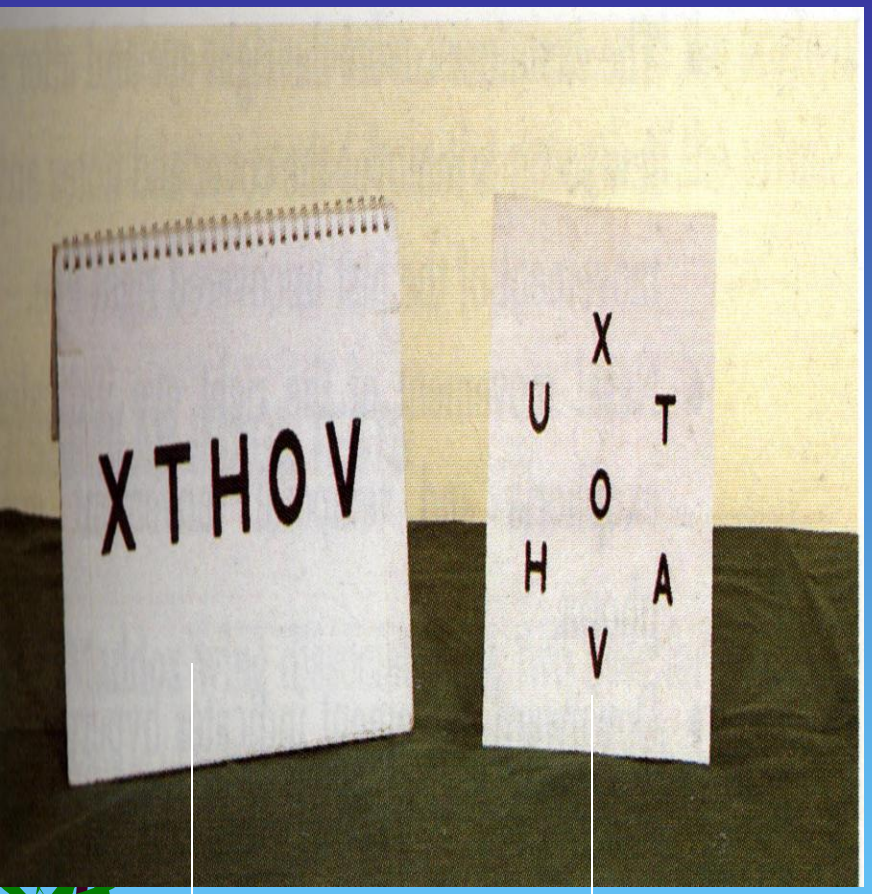
Lea Symbols Chart





Sheridan – Gardner test



five letter test 7 letter test

To be identified at 3m and either named or shown in another card with the child

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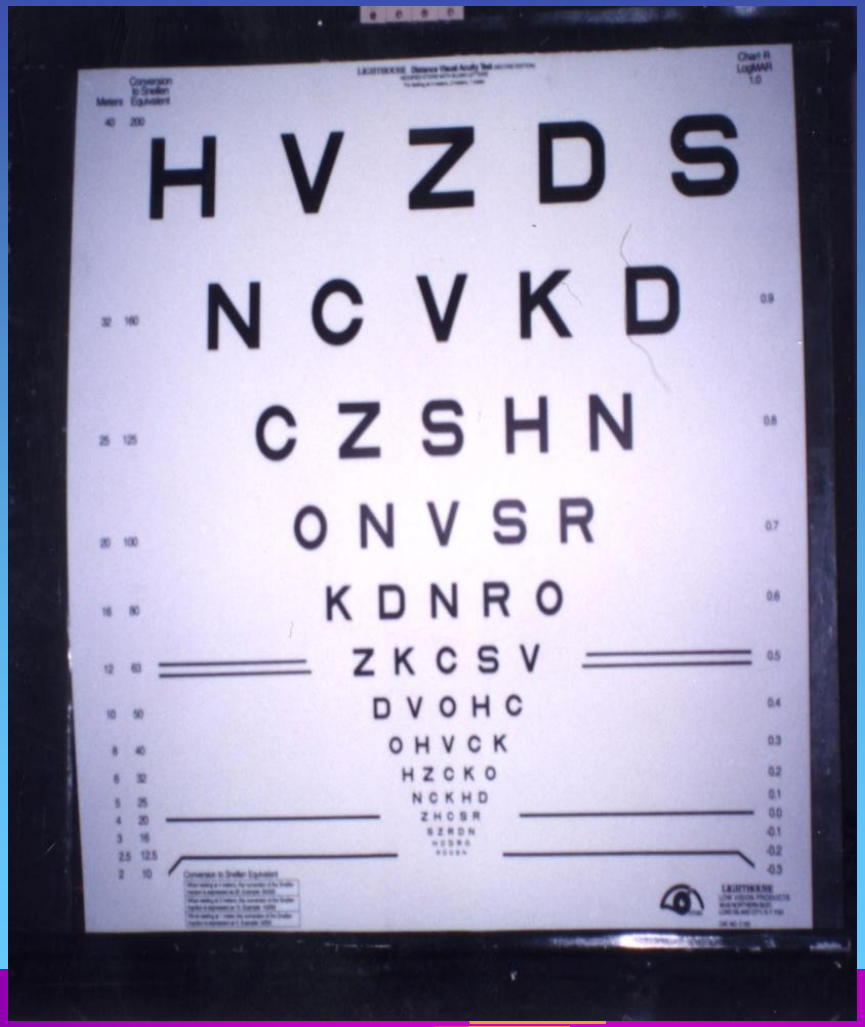
ETDRS Charts
LogMAR



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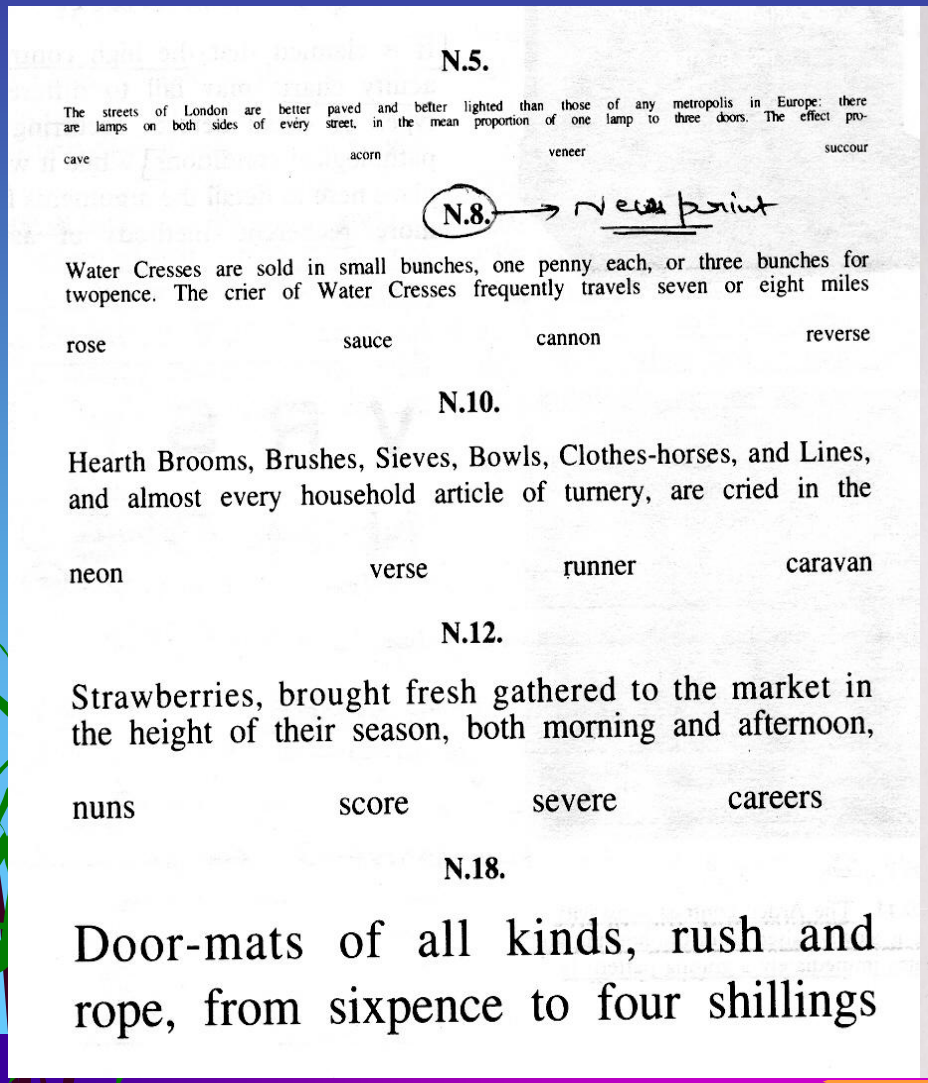
Near Vision Charts



N.5.

The streets of London are better paved and better lighted than those of any metropolis in Europe: there are lamps on both sides of every street, in the mean proportion of one lamp to three doors. The effect pro-

cave acorn veneer succour

N.8.

Water Cresses are sold in small bunches, one penny each, or three bunches for twopence. The crier of Water Cresses frequently travels seven or eight miles

rose sauce cannon reverse

N.10.

Hearth Brooms, Brushes, Sieves, Bowls, Clothes-horses, and Lines, and almost every household article of turnery, are cried in the

neon verse runner caravan

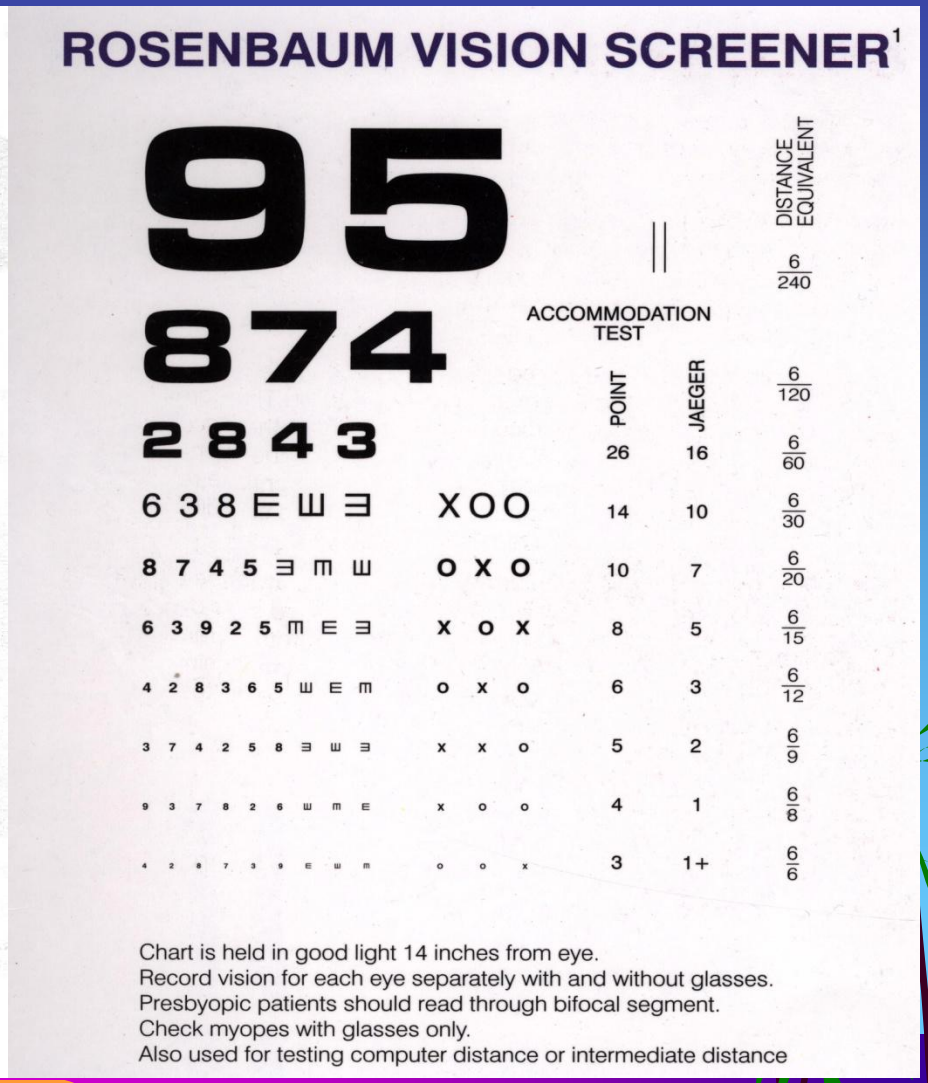
N.12.

Strawberries, brought fresh gathered to the market in the height of their season, both morning and afternoon,

nuns score severe careers

N.18.

Door-mats of all kinds, rush and rope, from sixpence to four shillings



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Age appropriate Vision test

Tests of visual acuity	Age most suitable
Preferential-looking (PL) Gratings-based (Teller, Keeler)	3-18 months
Vanishing Optotypes (Cardiff)	12-30 months
Picture Matching (Kay, Elliott)	2-4 years
Single letter (Sheridan-Gardiner, Sonksen-Silver)	3-5 years
Linear Snellen and log MAR (Bailey-Lovie, Glasgow)	4 years and on

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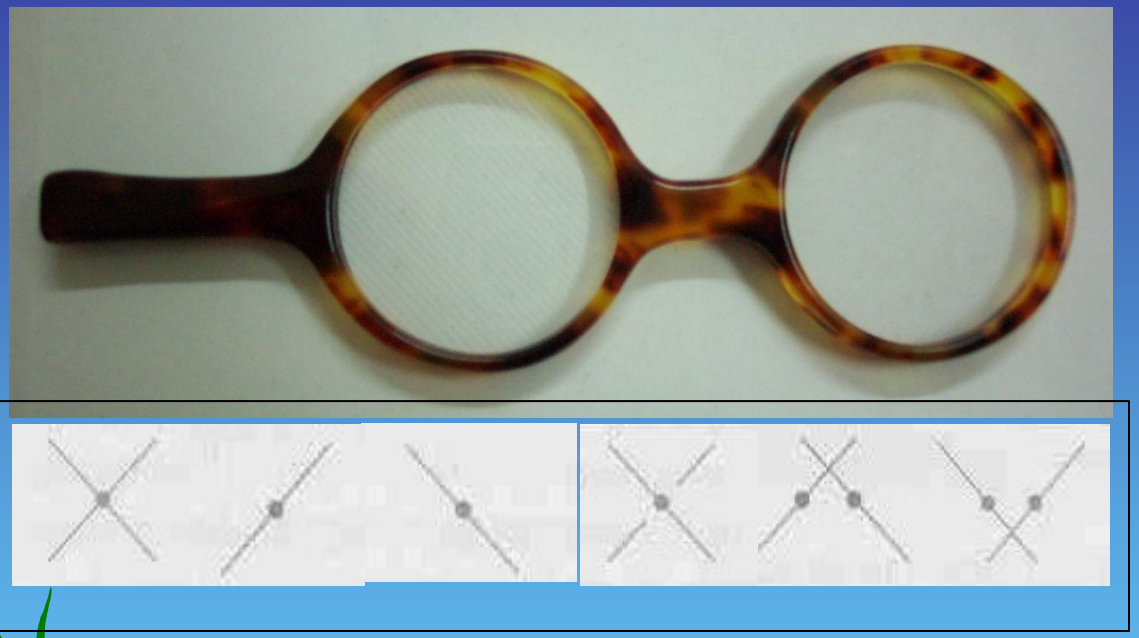
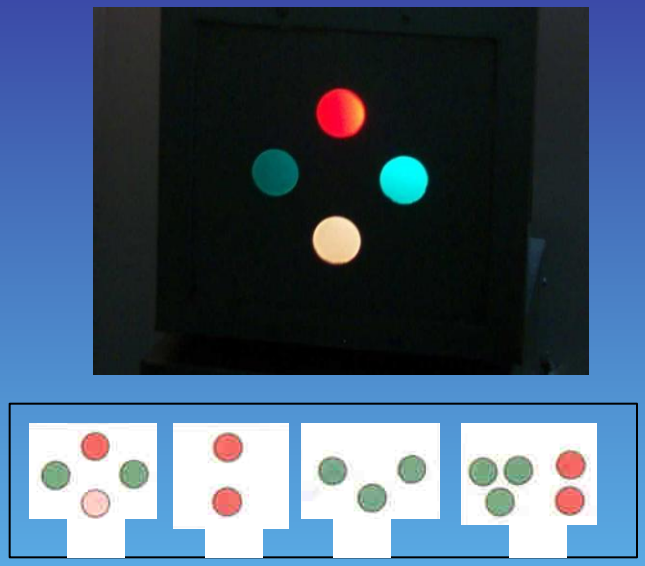
Binocular testing

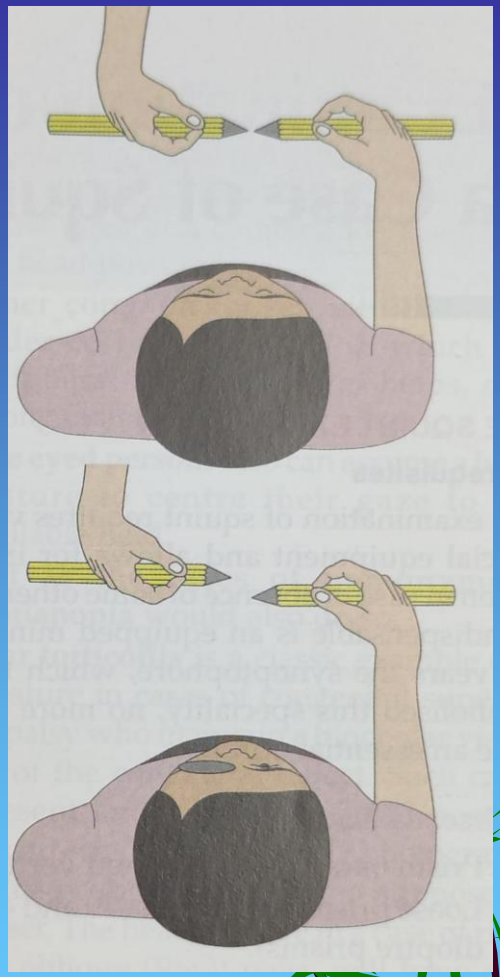


Bagolini striated glasses



Worth 4 dot test

Modified Lang's 2 pencil test



Simple bedside test works well to demonstrate gross stereopsis

Nongpiur M and **Sharma P**. Horizontal Lang two-pencil test as a screening test for stereopsis and binocularity **Indian J Ophthalmol**: 2010

Assessing stereo-acuity

RANDOT with polaroid glasses

TNO test with red-green glasses

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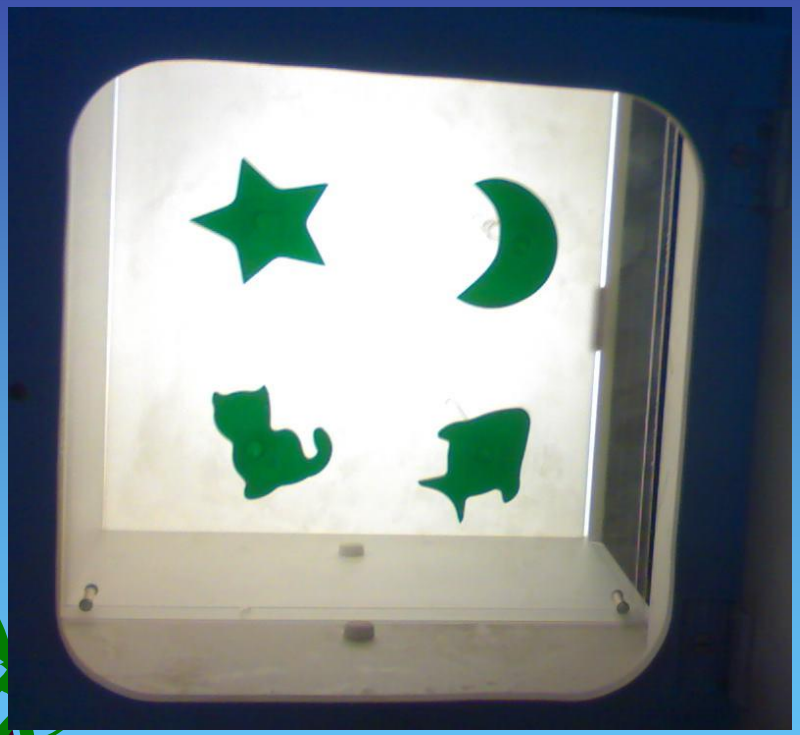
Distance stereoacuity

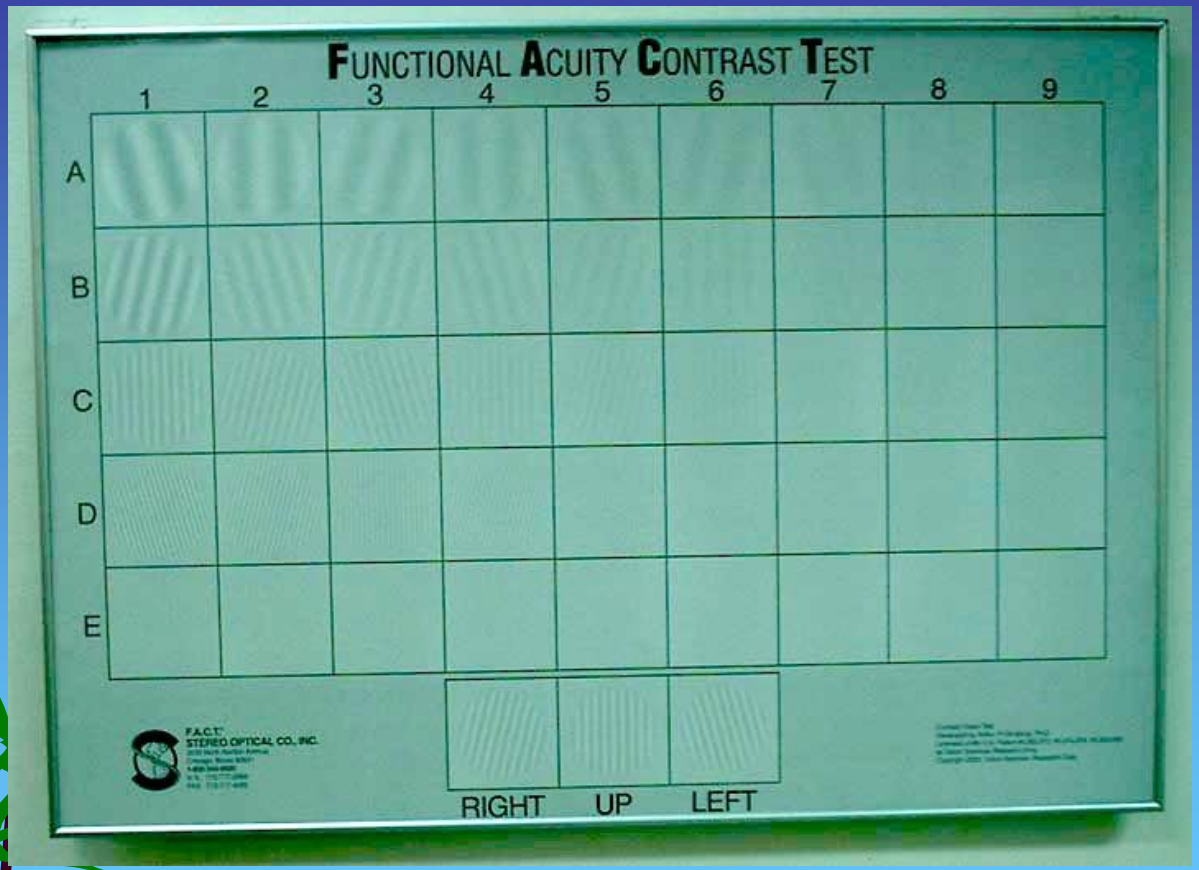
Frisby Davis Distance, FD2



Distance Randot

Done at 3 metres distance: 400, 200, 100 & 60 secs of arc

Assessing contrast sensitivity



Functional Acuity Contrast Test

Pelli Robson chart

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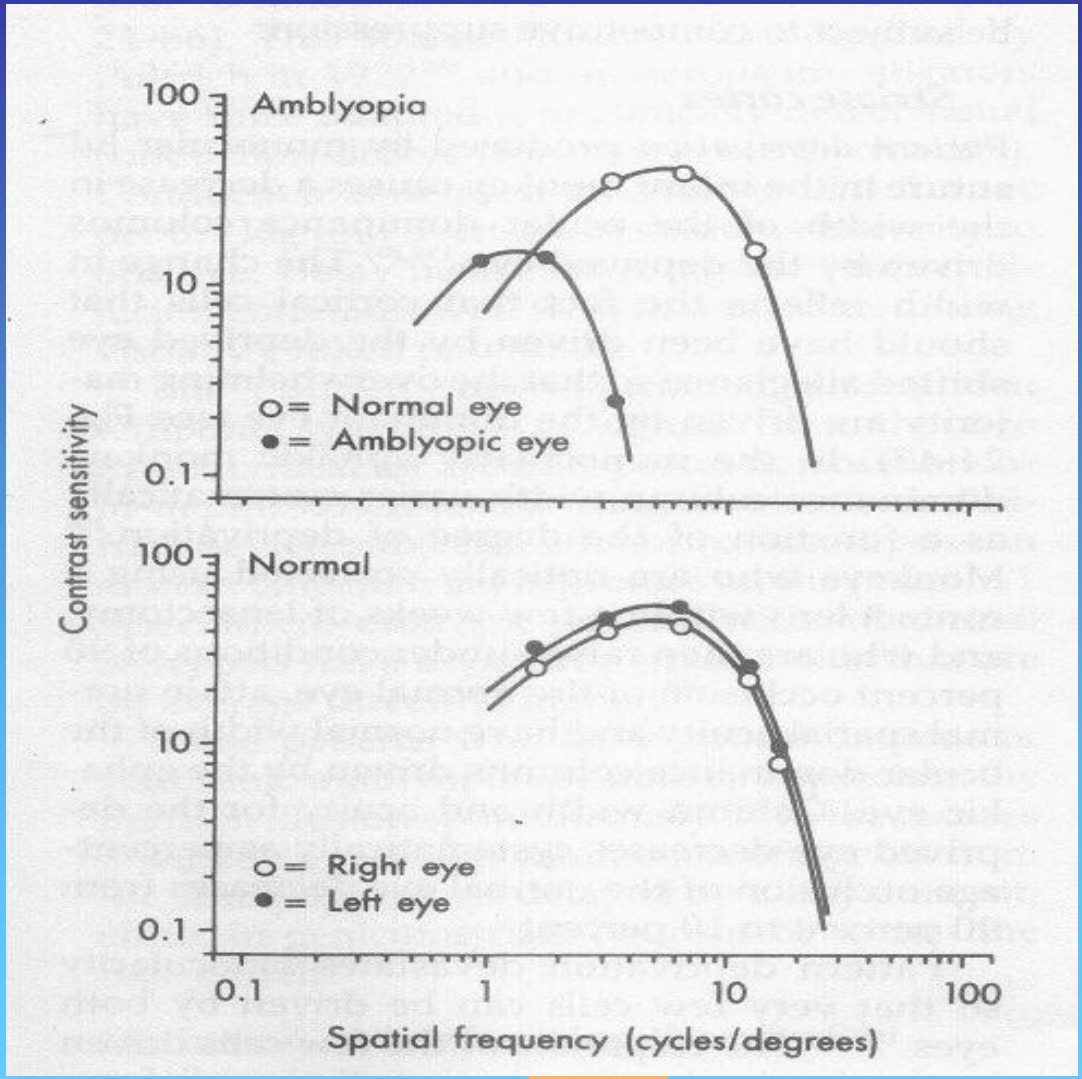
Assessing contrast sensitivity



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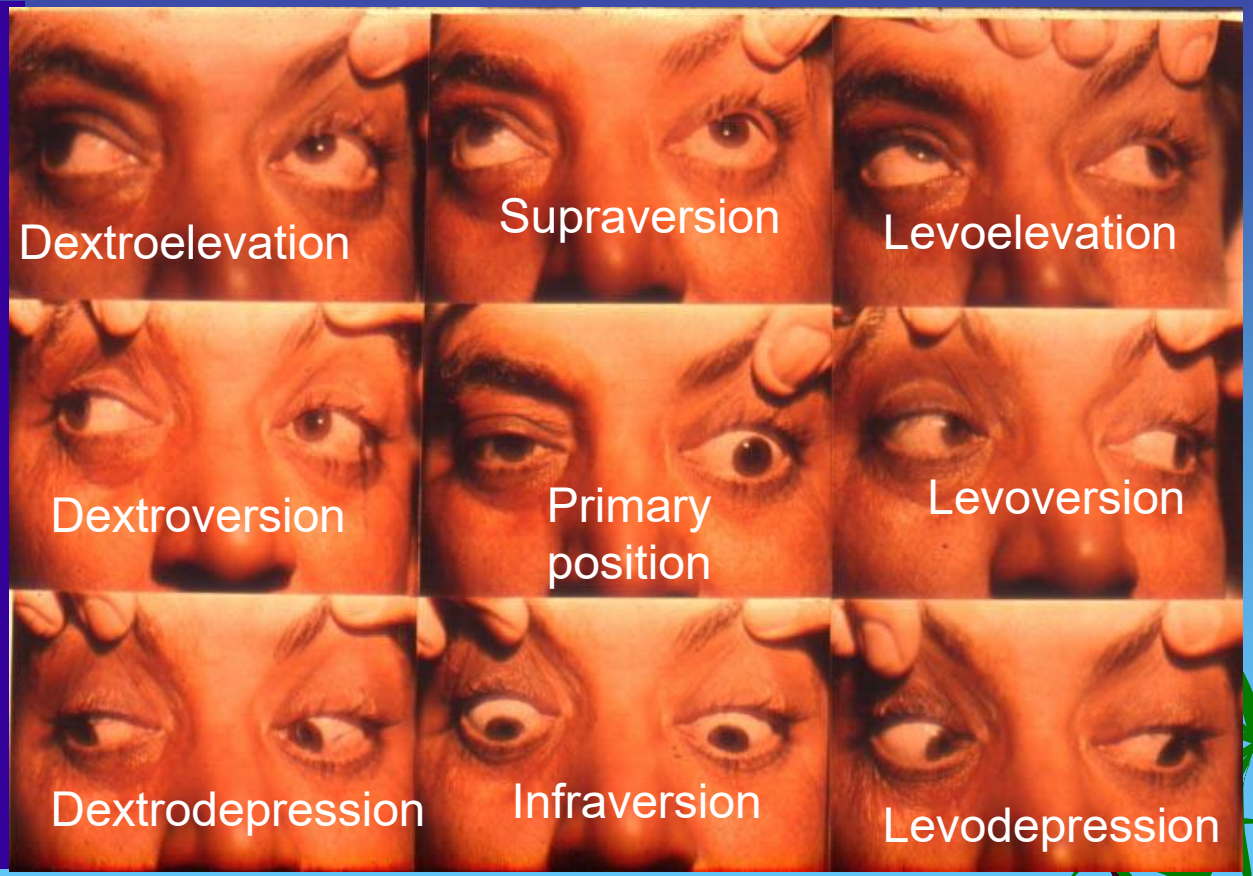
Different gaze positions

- Horizontal:
  - Esotropia
  - Exotropia
- Vertical:
  - Hypertropia
  - Hypotropia
- Torsional
  - Incyclotropia
  - Excyclotropia



Taming the Terrible

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Recipe in Strabismus: OCIPE

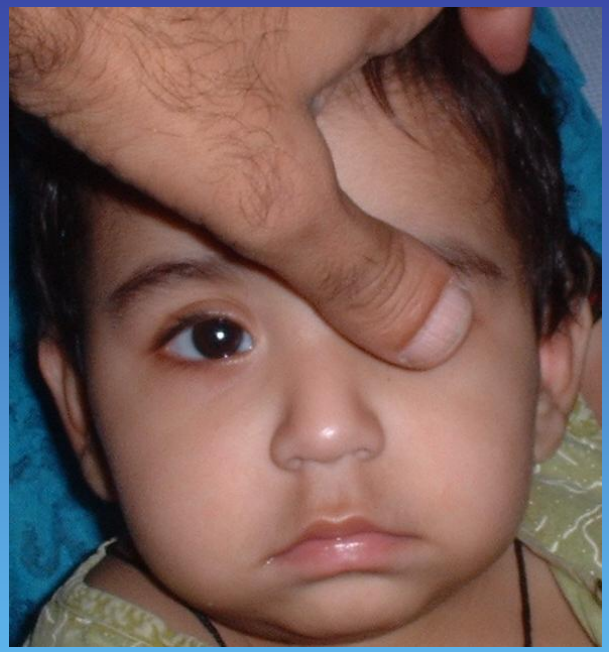
- Observe
- Confirm
- Infer
- Plan
- Execute

Pseudostrabismus

pseudoesotropia

pseudoexotropia

Cover test


Look at the movement of the other eye as one eye is covered

Cover- Uncover test



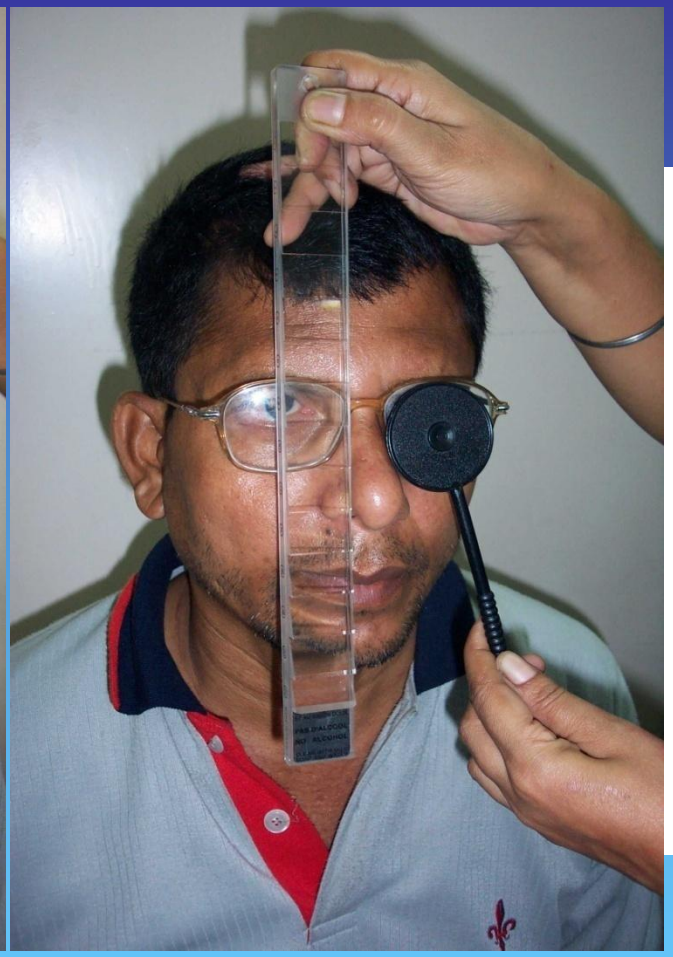
Look at the movement of the left eye as right eye is covered

Cover test

Look at the movement of the other eye as the straight eye is covered

Cover Uncover test

Prism Cover Test



Use prisms for deviation and not degrees from Hirschberg !

Simultaneous Prism Cover Test vs Alternate Prism Cover Test

- Simultaneous Prism Cover Test is to measure a tropia
  - The apparently straight eye is covered while we measure the deviation of the “deviating” eye.
- Alternate Prism Cover Test is to measure a phoria (including a tropia)
  - Prisms applied till the movement of redressal of the “uncovered” eye is no more

Simultaneous Prism Cover Test

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Alternate Prism Cover Test

Simultaneous PBCT is to measure a tropia

Alternate PBCT is to measure a phoria also

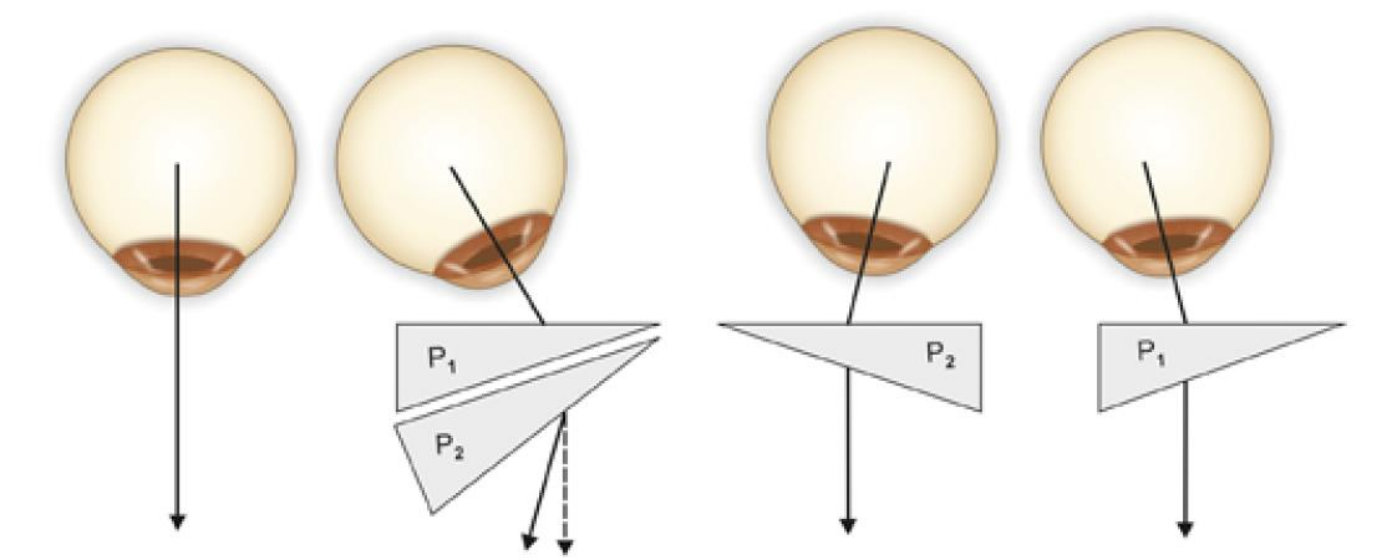
Stacking prisms

Fig. 2.2 On the bottom is a 40 Δ prism. On top of that is a sandwich of two 20 Δ prisms. The top prism sandwich has a much greater value than the 40 Δ prism, as evidenced by it displacing the image of the pencil much further

2+2 is not =4, but =5

Kushner, Strabismus, 2017

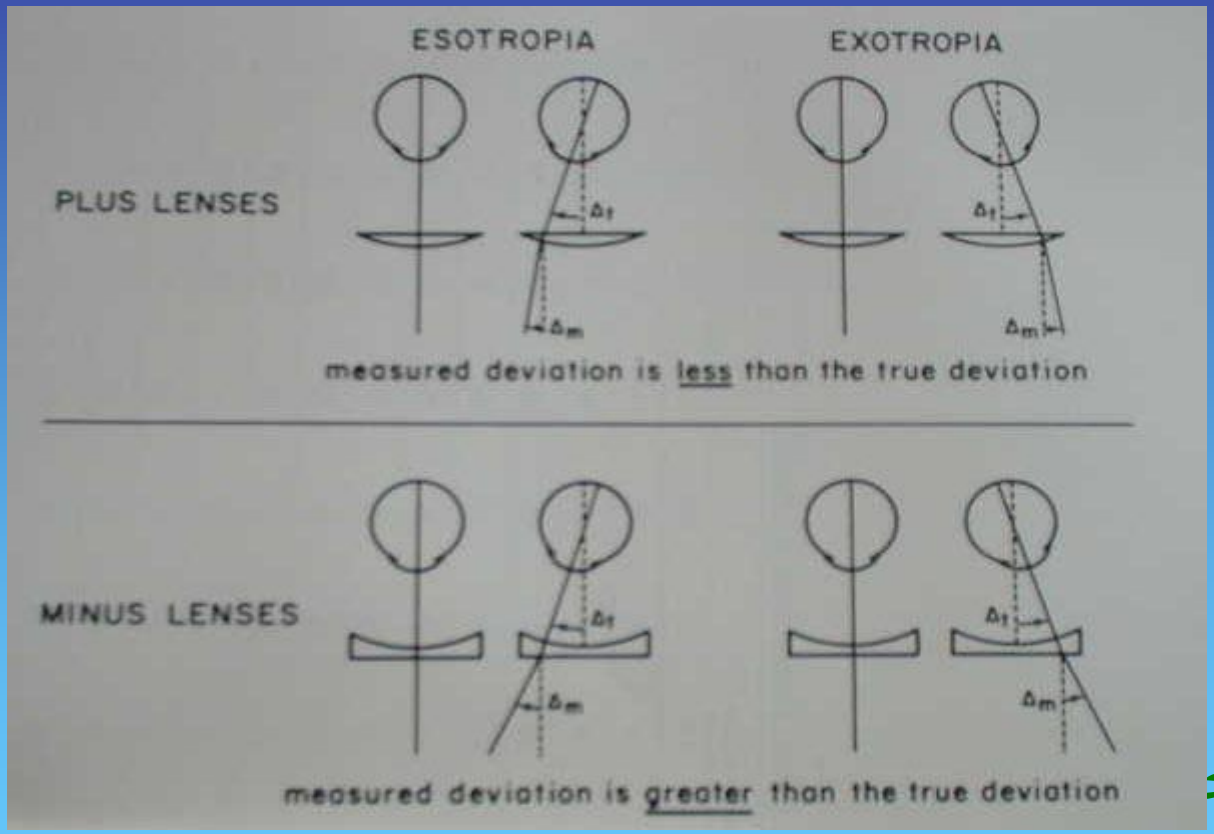
Pre-operative perils:
Faulty examination technique for Prisms



Do not stack prisms split them over the two eyes

Pre-operative perils:

Faulty examination technique



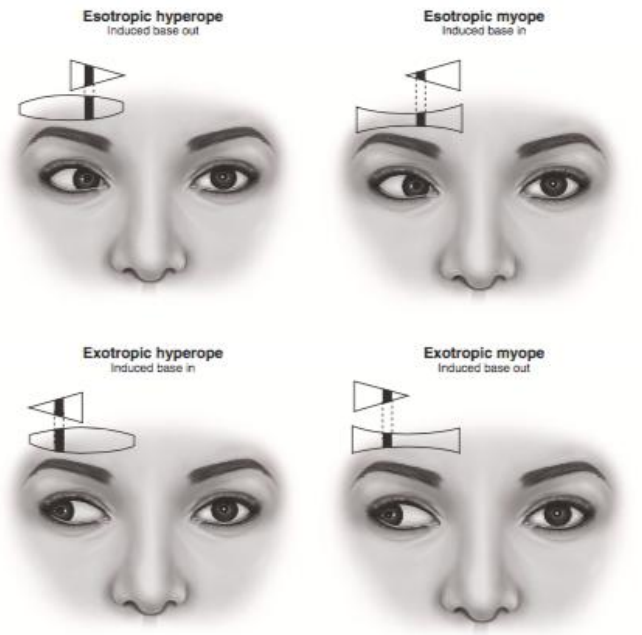
Error significant for more than 20pd deviations and more than ±5D power

r the induced prismatic effect in deviations thru

Table 2.2 Adjustment for spectacle-induced prism: Actual deviation in PD

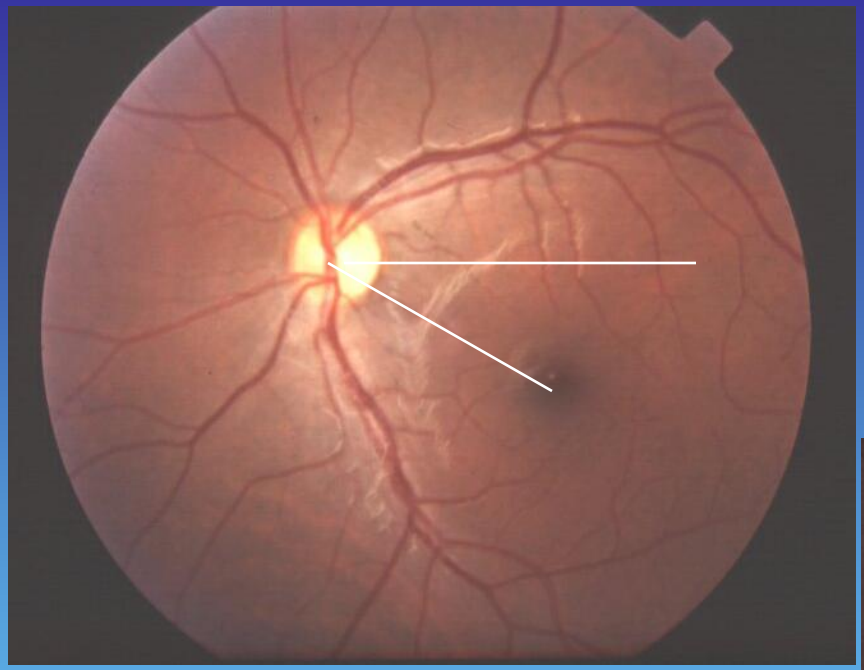
Measured deviation in PD	Myopic spectacle power													
	−1	−2	−3	−4	−5	−6	−7	−8	−9	−10	−12	−15	−20	−30
5	5	5	5	4	4	4	4	4	4	4	4	4	3	3
10	10	10	9									7	7	6
15	15	14	14									11	10	9
20	20	19	19									15	13	11
25	24	24	23									16	17	14
30	29	29	28									22	20	17
35	34	33	33									25	23	20
40	39	38	37									29	26	23
45	44	43	42									33	30	26
50	49	48	47									36	33	29
60	59	57	56									44	40	34
70	68	67	65									51	46	40
	Hyperopic spectacle power													
	+1	+2	+3									+15	+20	+30
5	5	5	5									8	10	20
10	10	11	11									16	20	40
15	15	16	16									24	30	60
20	21	21	22									32	40	80
25	26	26	27									40	50	100
30	31	32	32									48	60	120
35	36	37	38									56	70	140
40	41	42	43									64	80	160
45	46	47	49									72	90	180
50	51	53	54									80	100	200
60	62	63	65	67	69	71	73	75	77	80	87	96	120	240
70	72	74	76	78	80	82	85	88	90	93	100	112	140	260

PD prism diopters

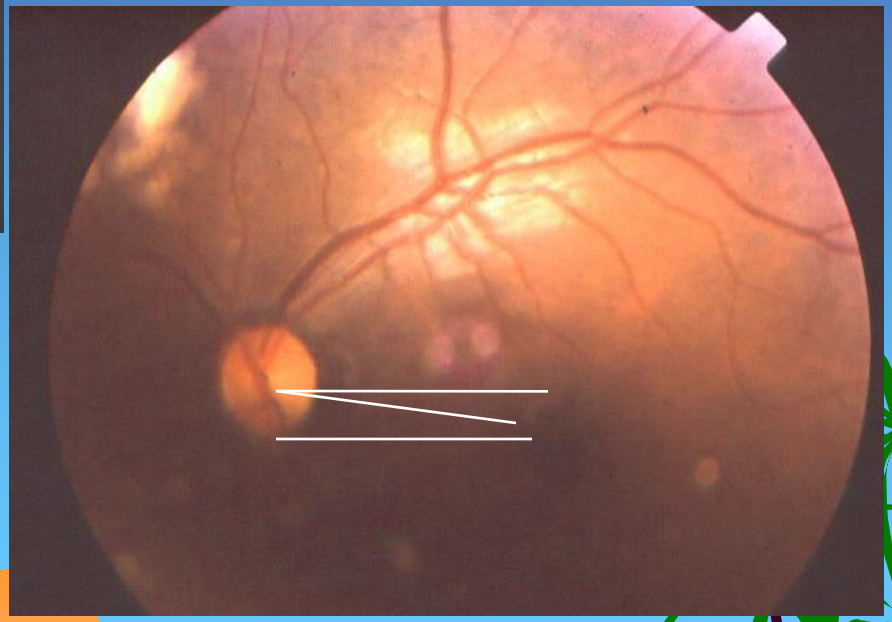


Kushner: Strabismus 2017

Extorsion on fundus examination

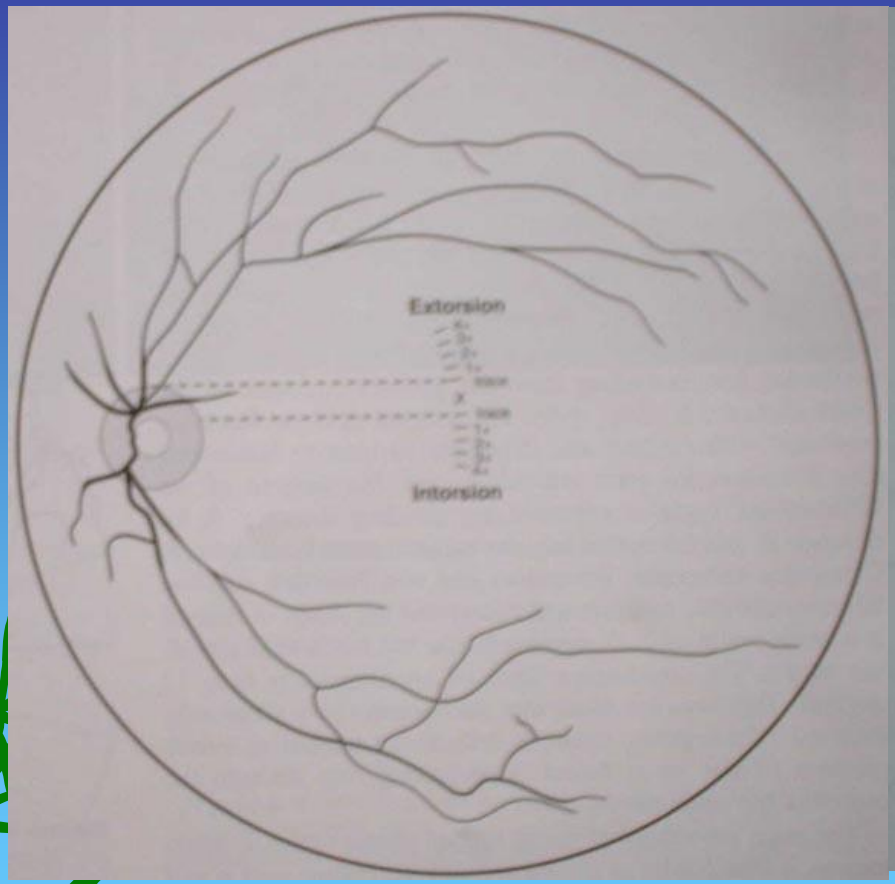


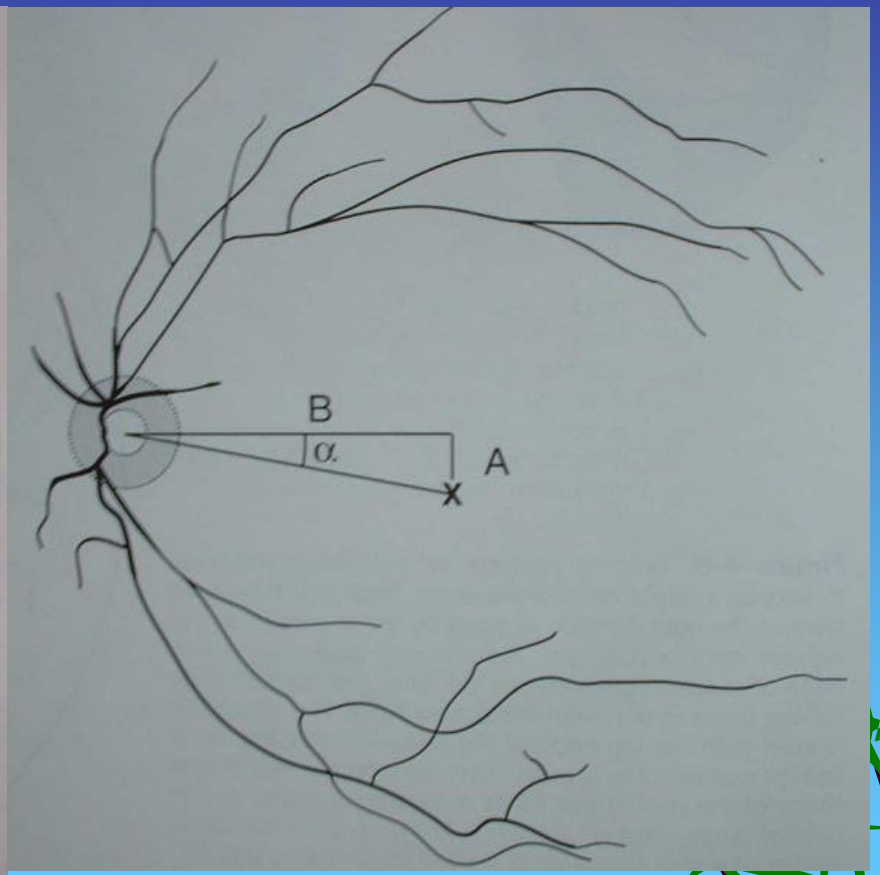
Extorsion with inferior oblique overaction



Extorsion corrected after inferior oblique surgery

Torsional position: fovea & disc

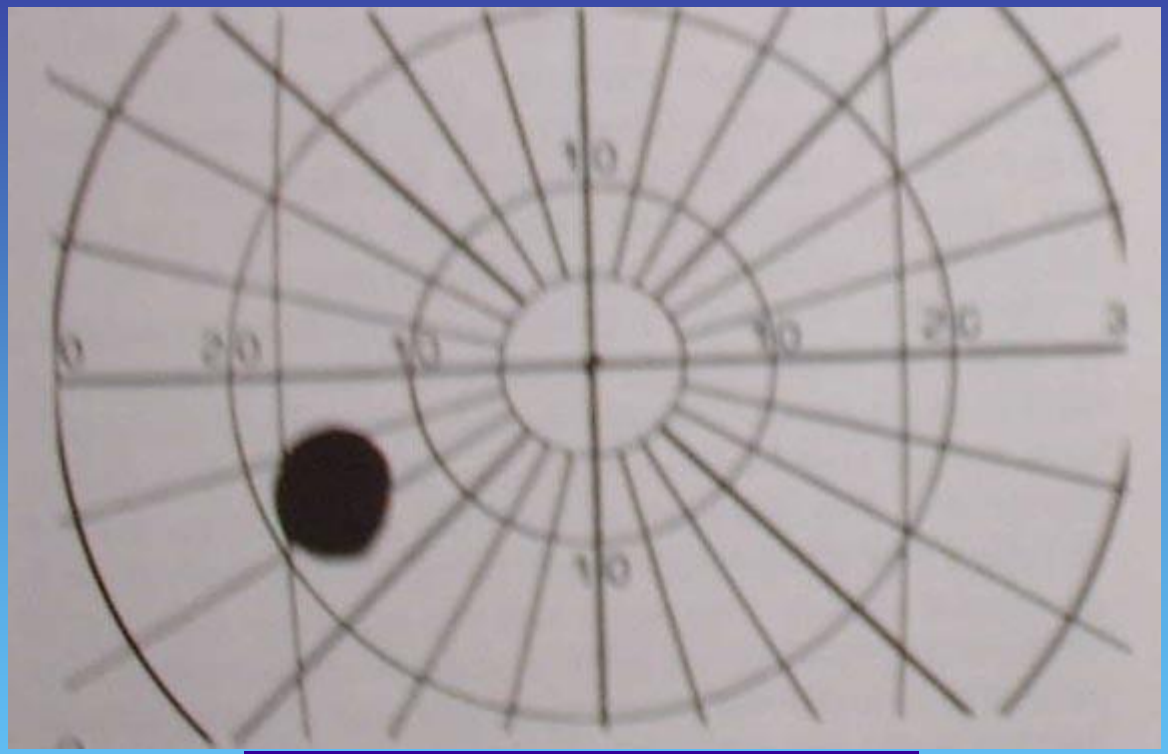




Indirect ophthalmoscopy

Fundus photography

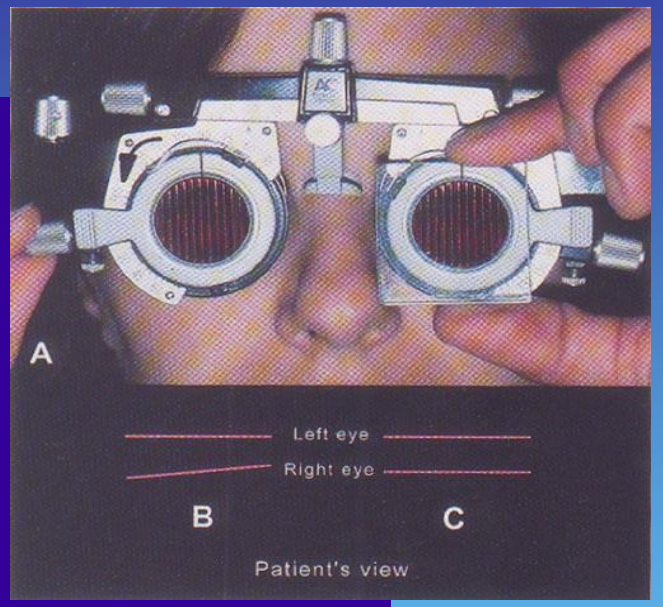
Blind spot charting



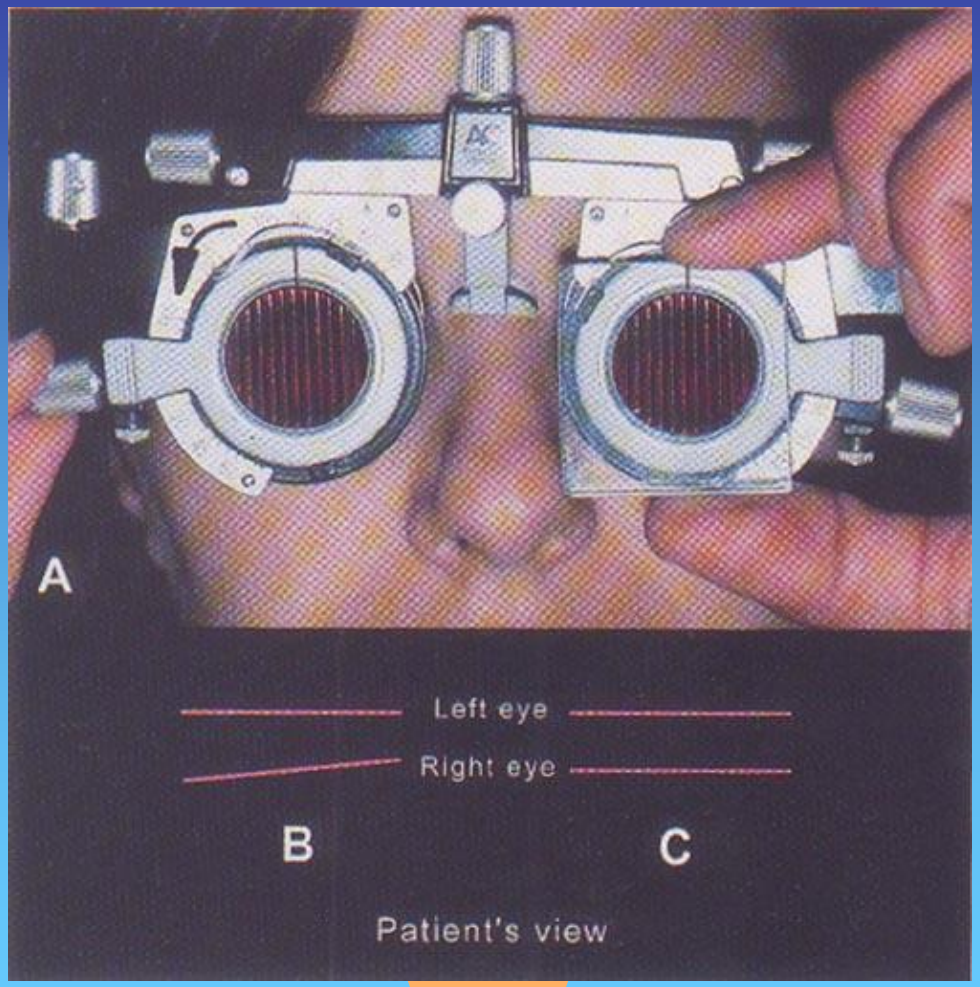
Showing extorsion of 15°

Measurement of torsion

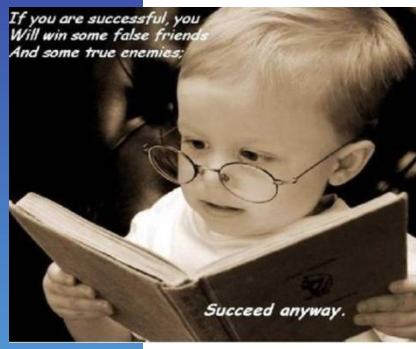
- Subjective torsion
  - Diplopia charting
  - Lancaster red-green chart
  - Double Maddox rod test
  - Bagolini(loose) glasses
  - Synoptophore with after image slides
  - Polaroid stereoprojector



Double Maddox Rod test



A story of two kids



Strabismus: A Decision Making Approach. St Louis, Mosby–Year Book, 1994, p 95.)

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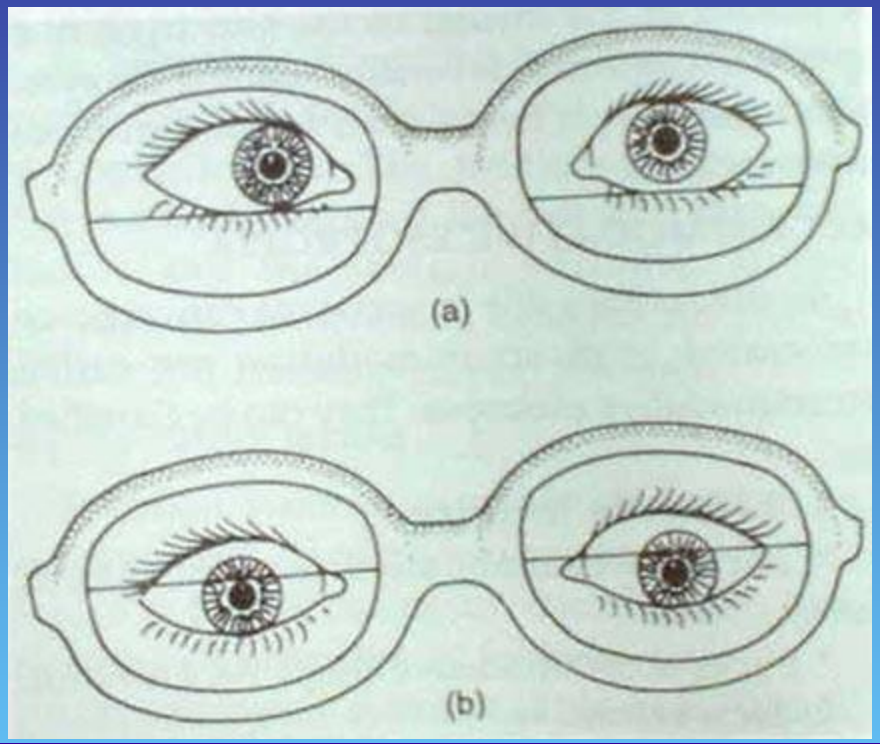
Accommodative esotropia

Accommodative Convergence excess

Accommodative esotropia



improper

proper

If convergence excess: check for Bifocals: executive type.

Partially Accommodative Esotropia

Esodeviation for distance despite full correction

AC/A ratio: Heterophoria method

$$AC/A = IPD + \frac{\Delta n - \Delta d}{D}$$

Example: IPD = 5.5cm, Δn= 30 PD base out, Δd= 25 PD base out

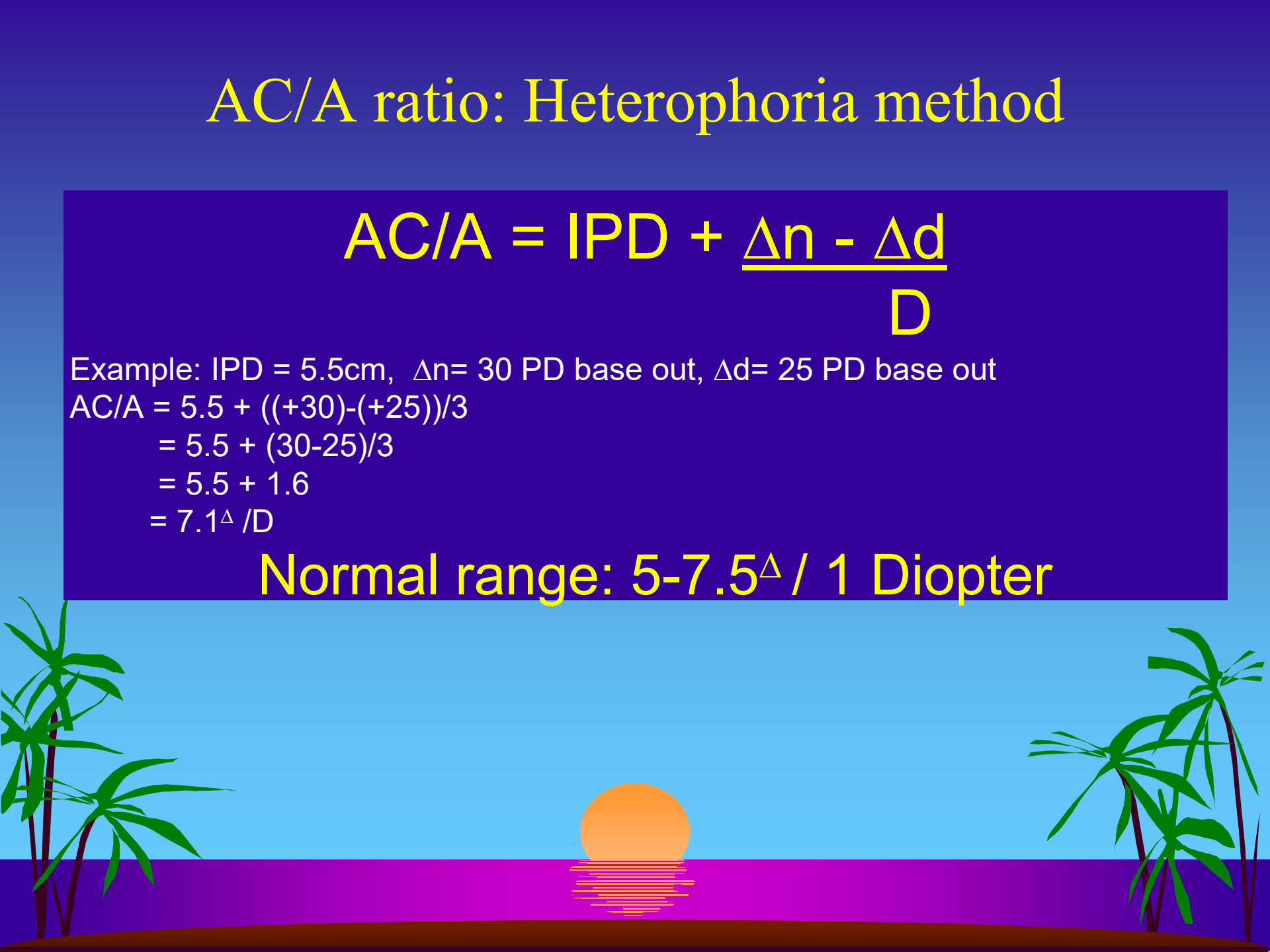
AC/A = 5.5 + ((+30)-(+25))/3

= 5.5 + (30-25)/3

= 5.5 + 1.6

= 7.1$^{\Delta}$ /D

Normal range: 5-7.5$^{\Delta}$ / 1 Diopter



AC/A ratio: Gradient method

$$AC/A = \frac{\Delta_G - \Delta_0}{G}$$

Example: Δ_0 = 15 PD base in, Δ_G = 7 PD base in, G = -2.00Dsph

AC/A = (-7)-(-15)/2

= (-7 + 15)/2

= +8/2

= 4^{Δ} /D

Normal range: 3 – 5^{Δ} / 1 Diopter

Use Minus 2D glasses for distance
And Plus 3D glasses for Near

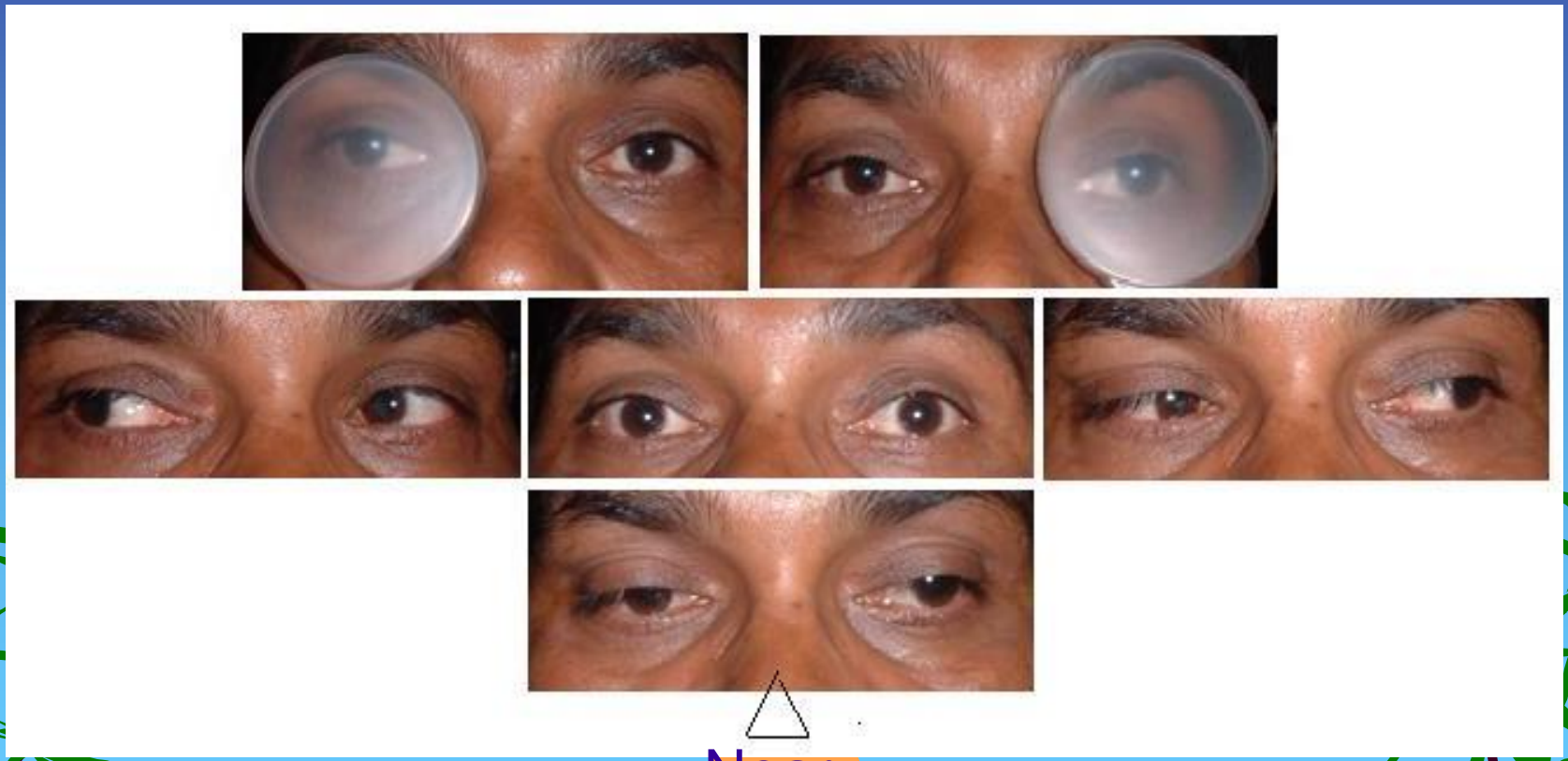
Divergence excess Exo

Distance

Near

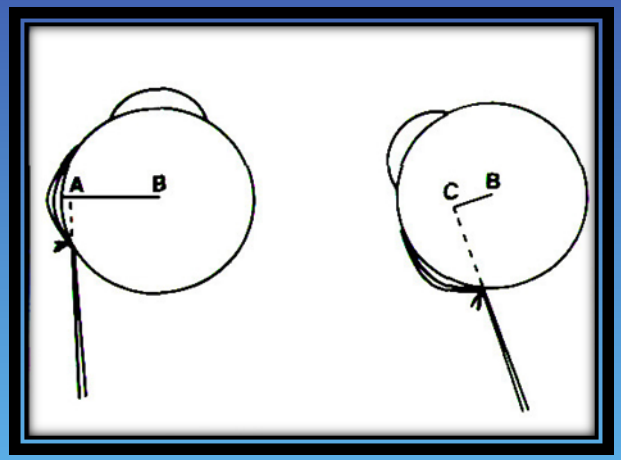
X(T) convergence insufficiency

Distance



Near

Tackling Near Distance Disparity



Faden operation

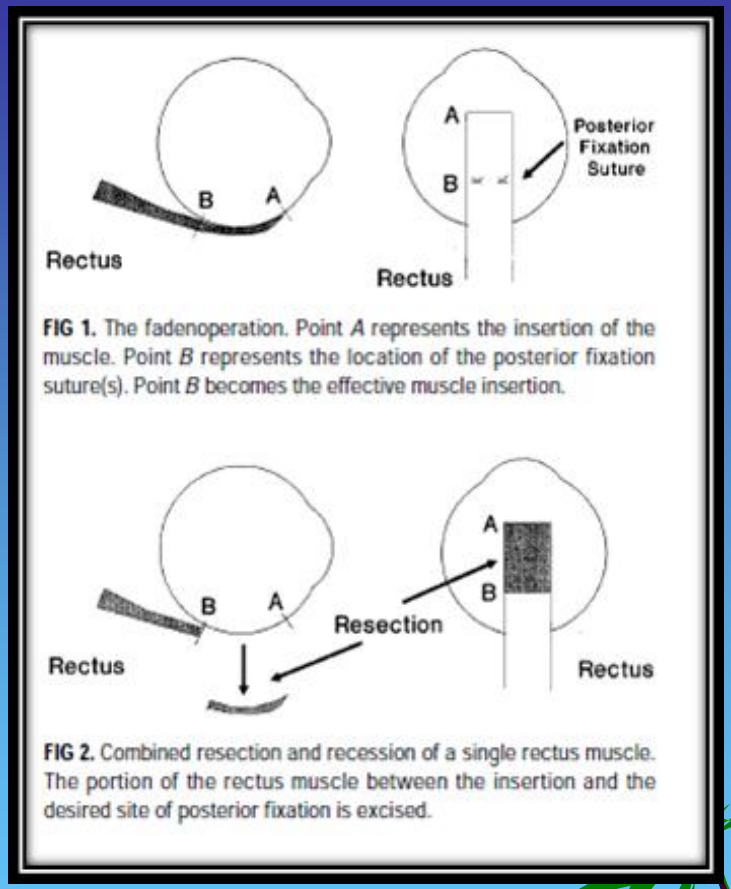


FIG 1. The fadenoperation. Point *A* represents the insertion of the muscle. Point *B* represents the location of the posterior fixation suture(s). Point *B* becomes the effective muscle insertion.

FIG 2. Combined resection and recession of a single rectus muscle. The portion of the rectus muscle between the insertion and the desired site of posterior fixation is excised.

Combined resection and recession

Different inferences of measurement

(1) Difference between distance and near fixation to determine its nature as to:
esotropia: basic/convergence excess/divergence insufficiency.
exotropia: basic/ convergence insufficiency/divergence excess.

(2) Deviation in nine different gazes to determine any incomitance (paralytic, restrictive or spastic).

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Different inferences of measurement

3) Deviation in up gaze and down gaze for A-V patterns.

(4) Deviations with each eye fixating for primary and secondary deviation in cases of paralytic squint.

(5) Deviations with subjective method and objective method to determine the type of retinal correspondence (normal or anomalous).

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Different inferences of measurement

(6) Deviations after prolonged cover to differentiate a true divergence excess type from the simulated divergence excess exotropia as also to determine the fully dissociated deviation

(7) Deviations with and without glasses: Basic vs dynamic (Accommodative ratio)

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Diagnosis of significant V- pattern

Difference between up and down gaze: over 15 pd for V pattern

V-Exotropia

Diagnosis of significant A- pattern

Difference between up and down-gaze :over 10 pd for A pattern

A-Esotropia

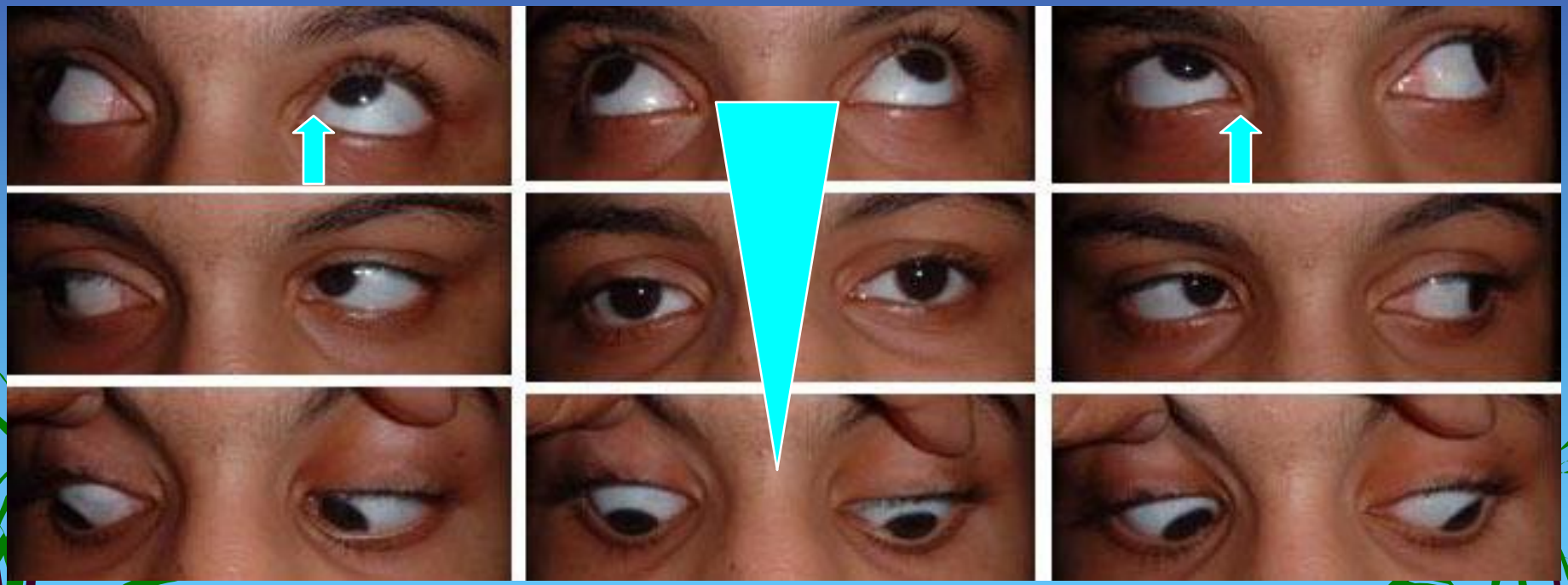
Diagnosis of significant A-V pattern

- Measure the horizontal deviations with PBCT
  - in primary position
  - in 25deg up-gaze
  - in 25/35deg down-gaze

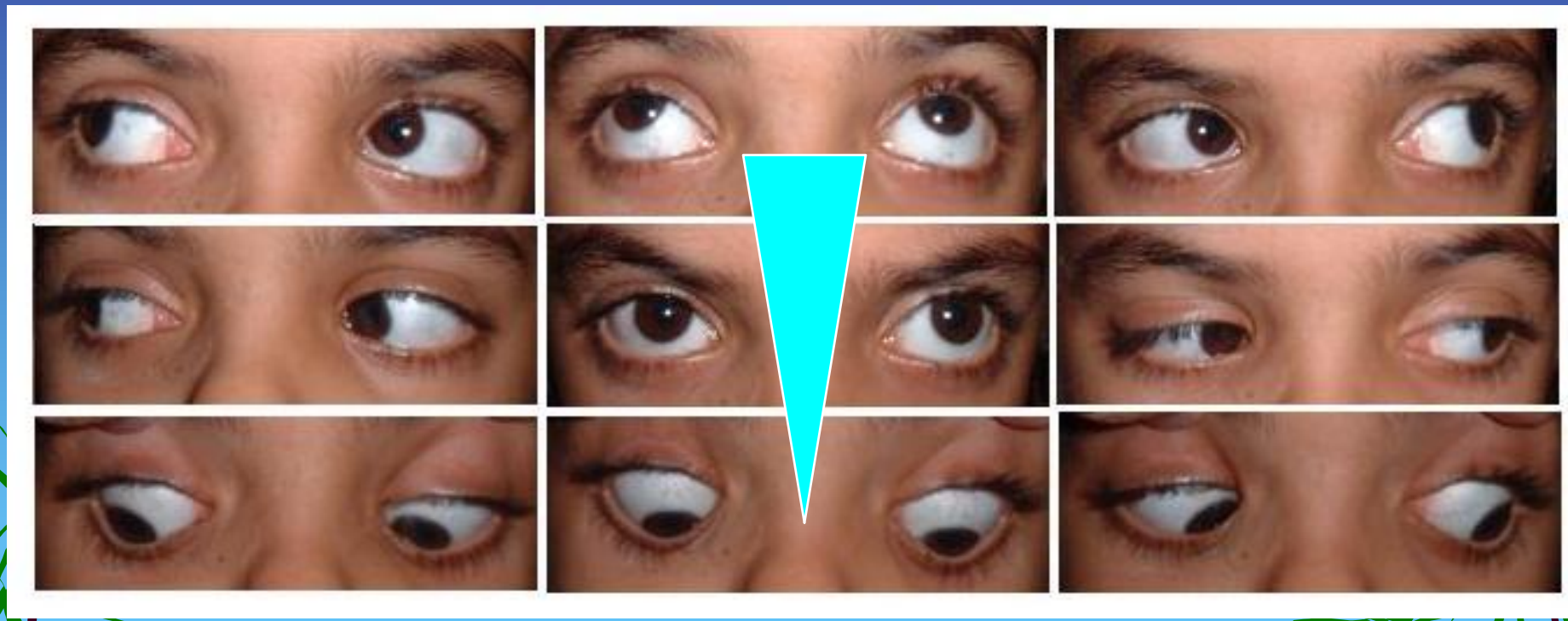
Cephalodeviometer

Scale and protractor

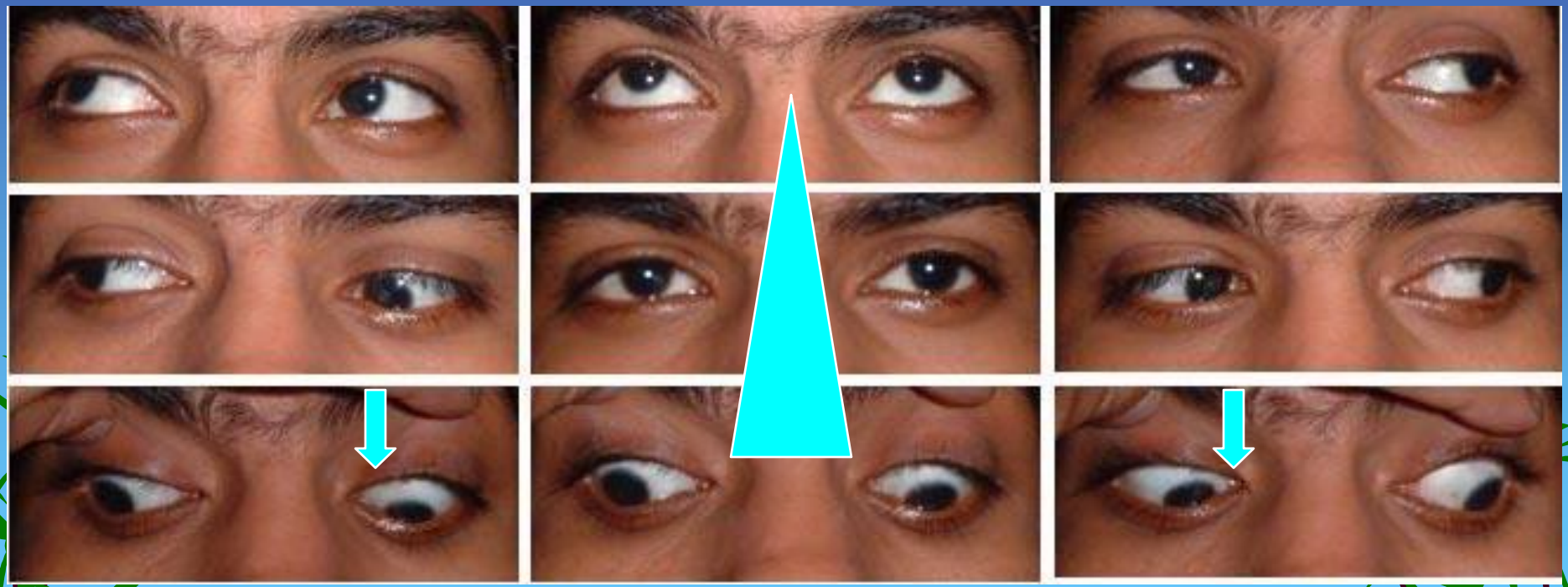
V-Exotropia with IOOA



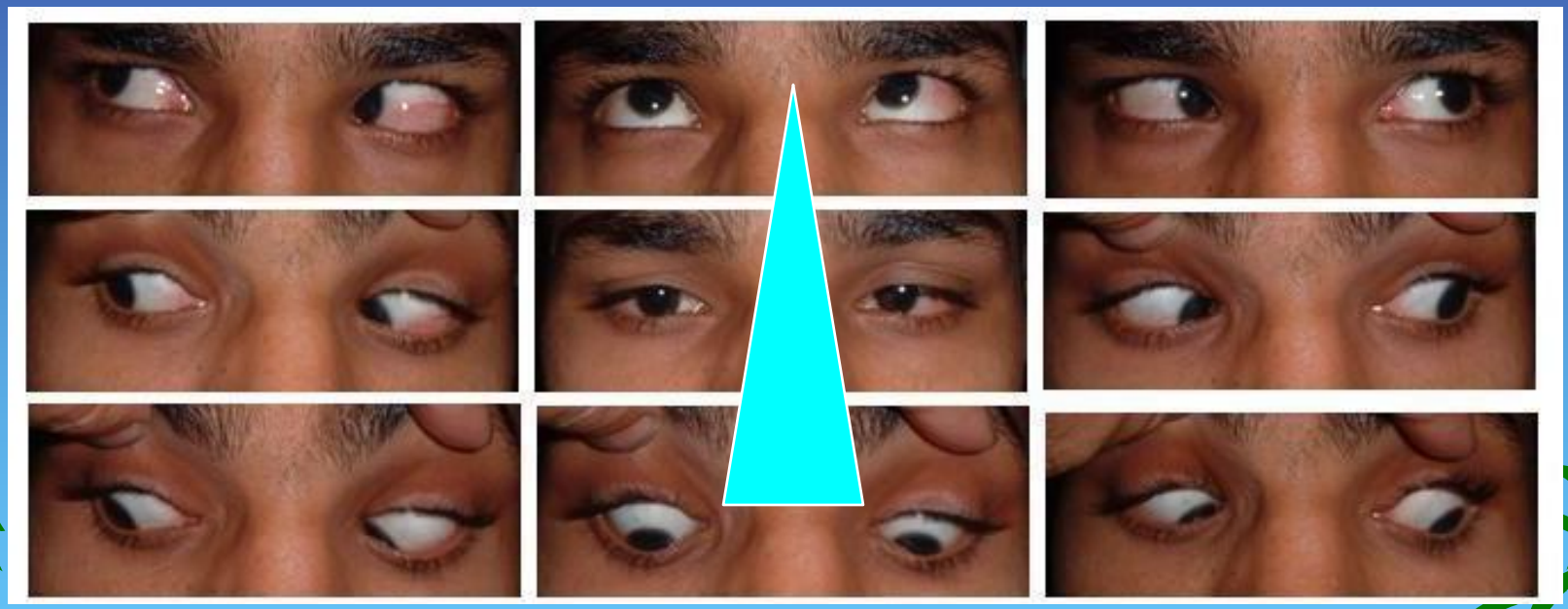
V-Exotropia without IOOA



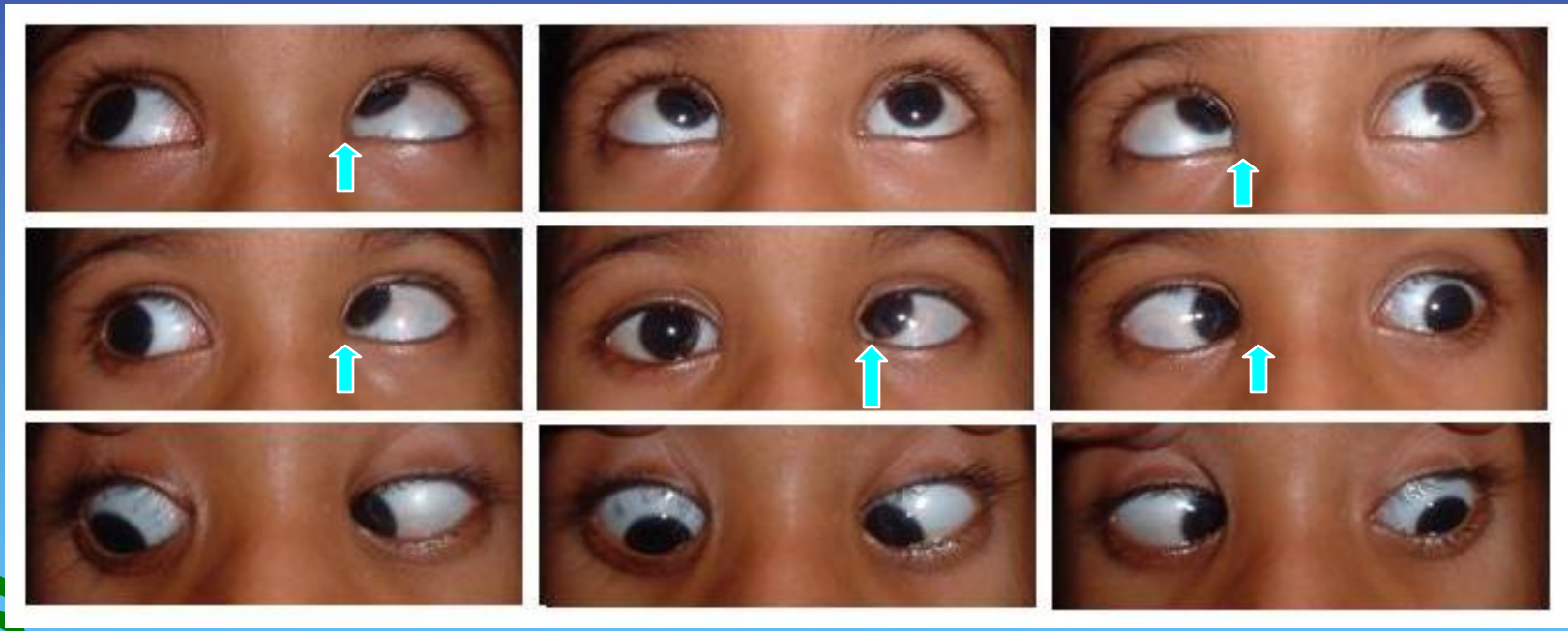
A-Exotropia with SOOA



A-Esotropia without SOOA



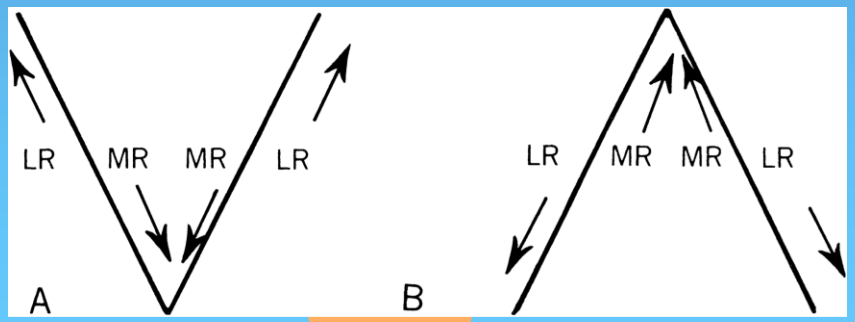
V-Esotropia with Asymmetric IOOA
Left more than Right



How much surgery should I do?

Horizontal muscles recession/resection
decided on the horizontal deviation in the primary position (as per the surgical norms)

For the collapse of extent of A V pattern
weaken the obliques along with the horizontal surgery (20 to 30pd)
or differential R&R (20pd)
or slanting reinsertions (15pd)

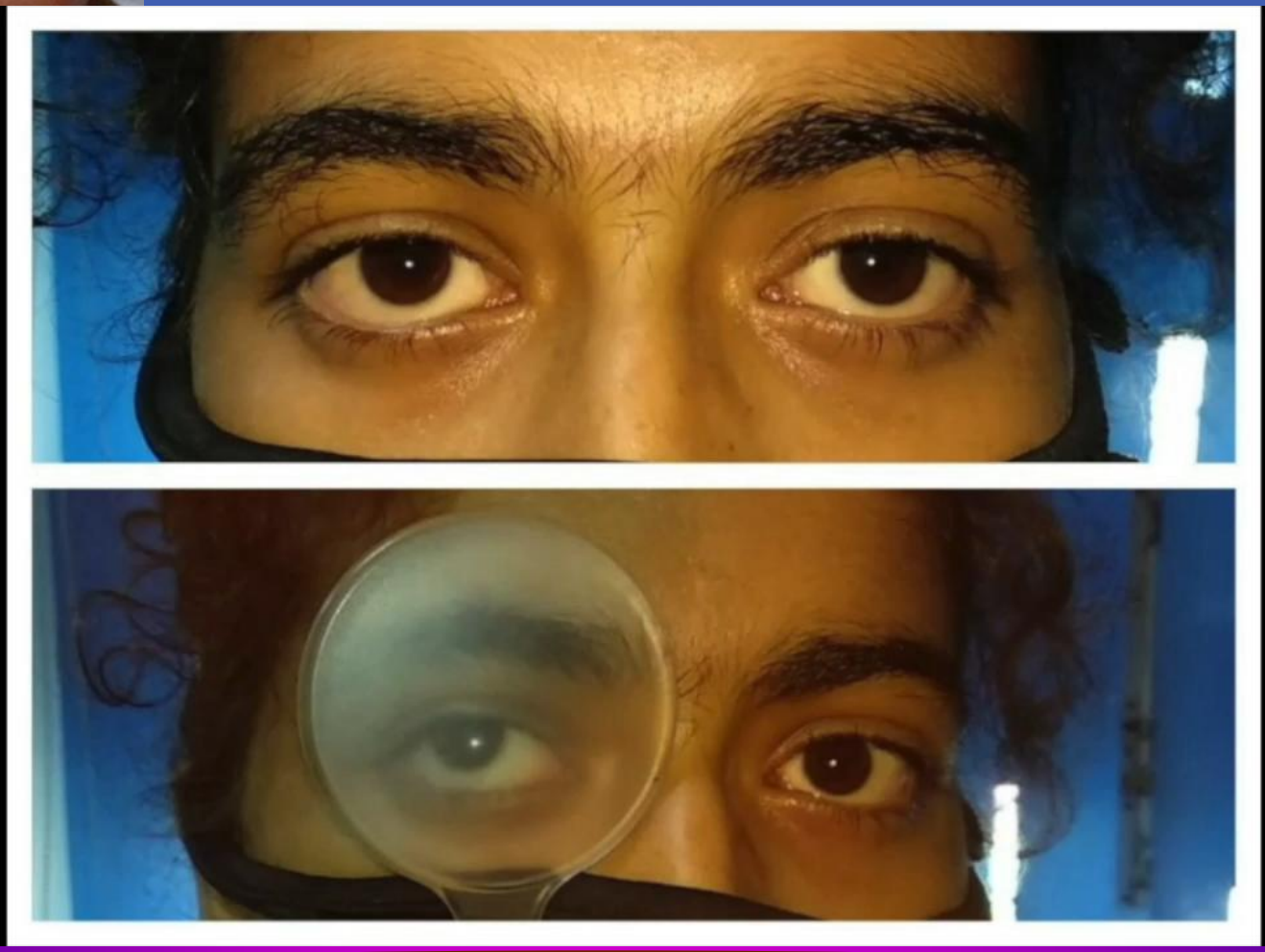


Pure V pattern: Exo -upgaze and Eso -downgaze with bilateral inferior oblique overactions

Pure V after Inferior oblique recession and anteropositioning

Dissociated Vertical Deviation

DVD: Dissociated vertical deviation



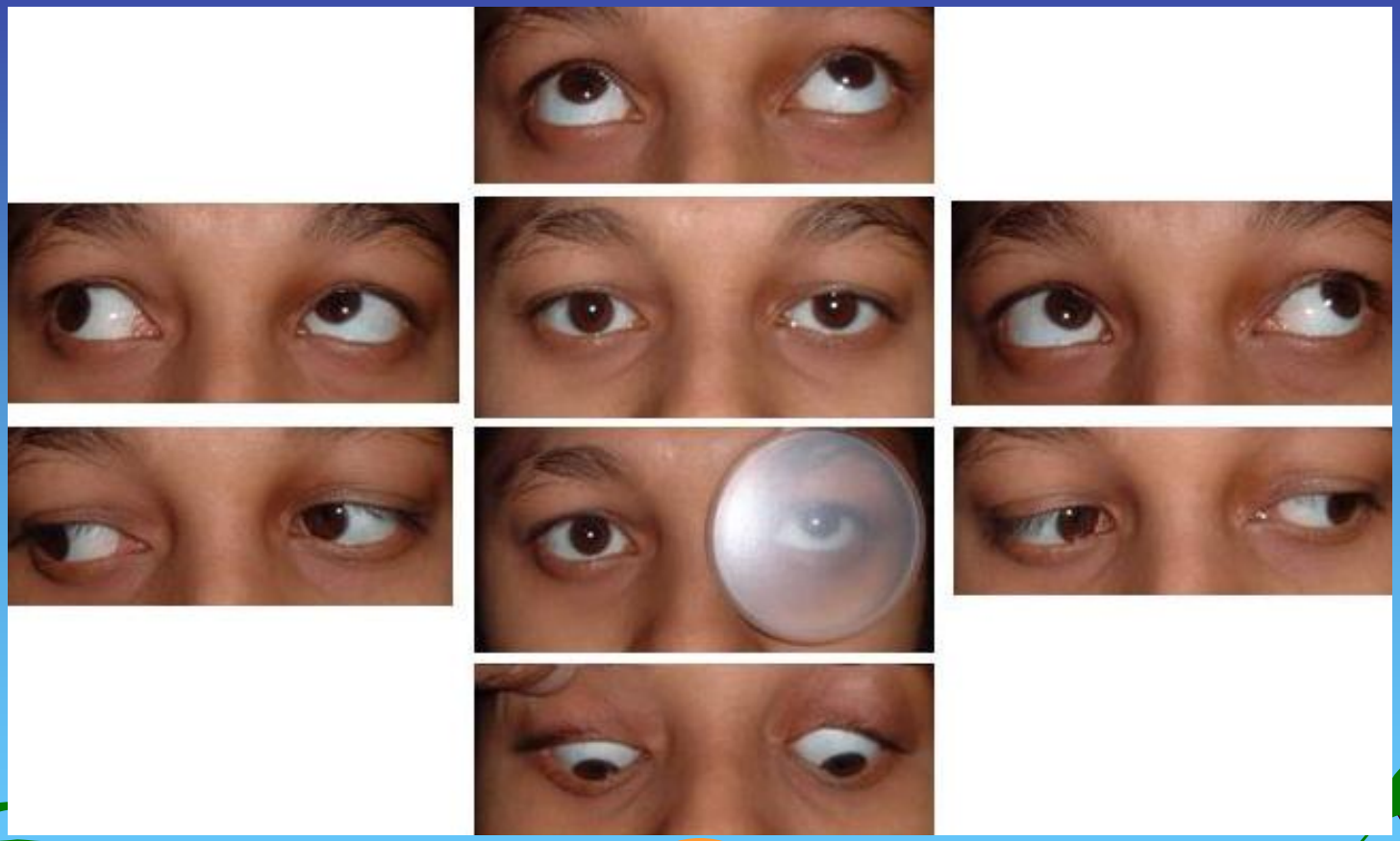
Depth of suppression in DVD

DVD latent

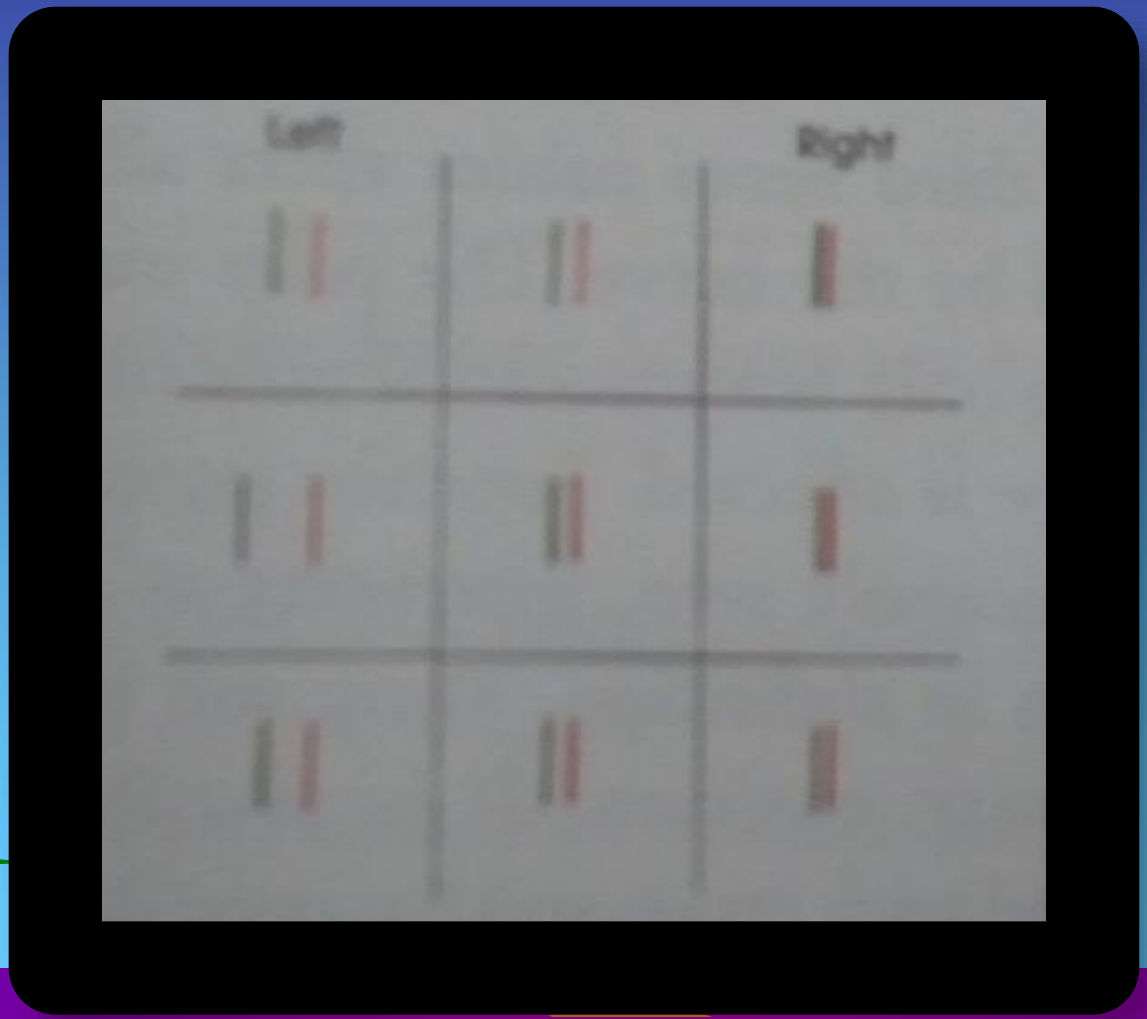
DVD LE manifest
Spielmann occluder

Effect of Graded density filter bar

DVD: left eye with IOOA



Diplopia charting of Left LR palsy



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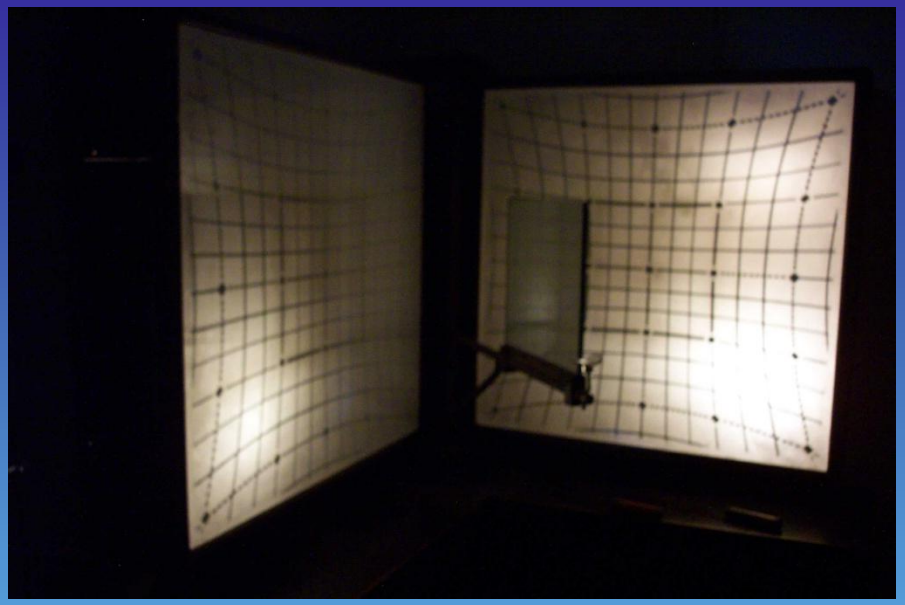
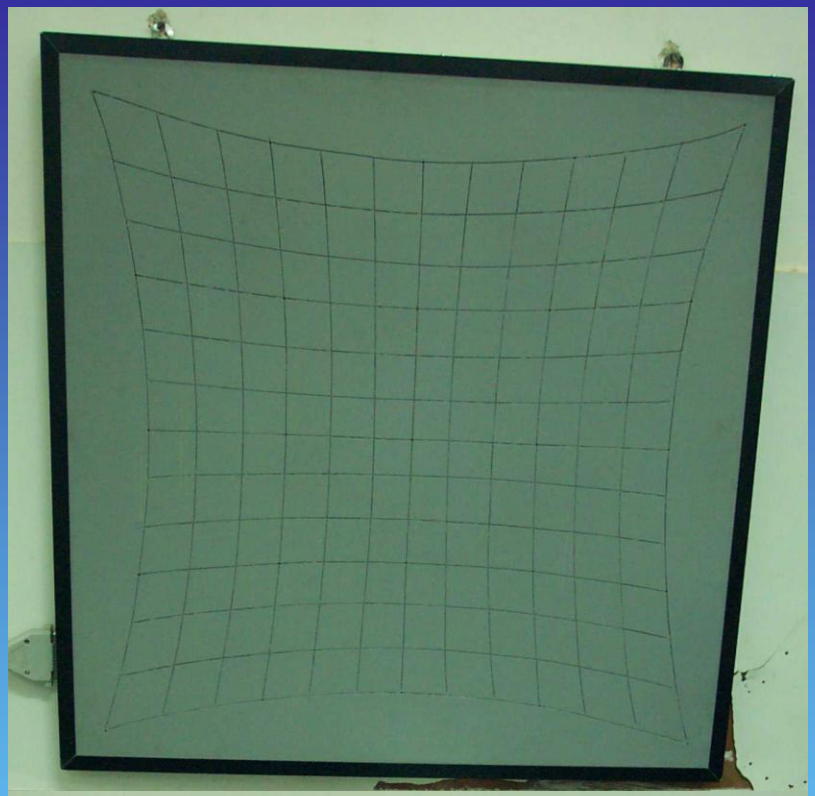
Paralytic strabismus:investigations

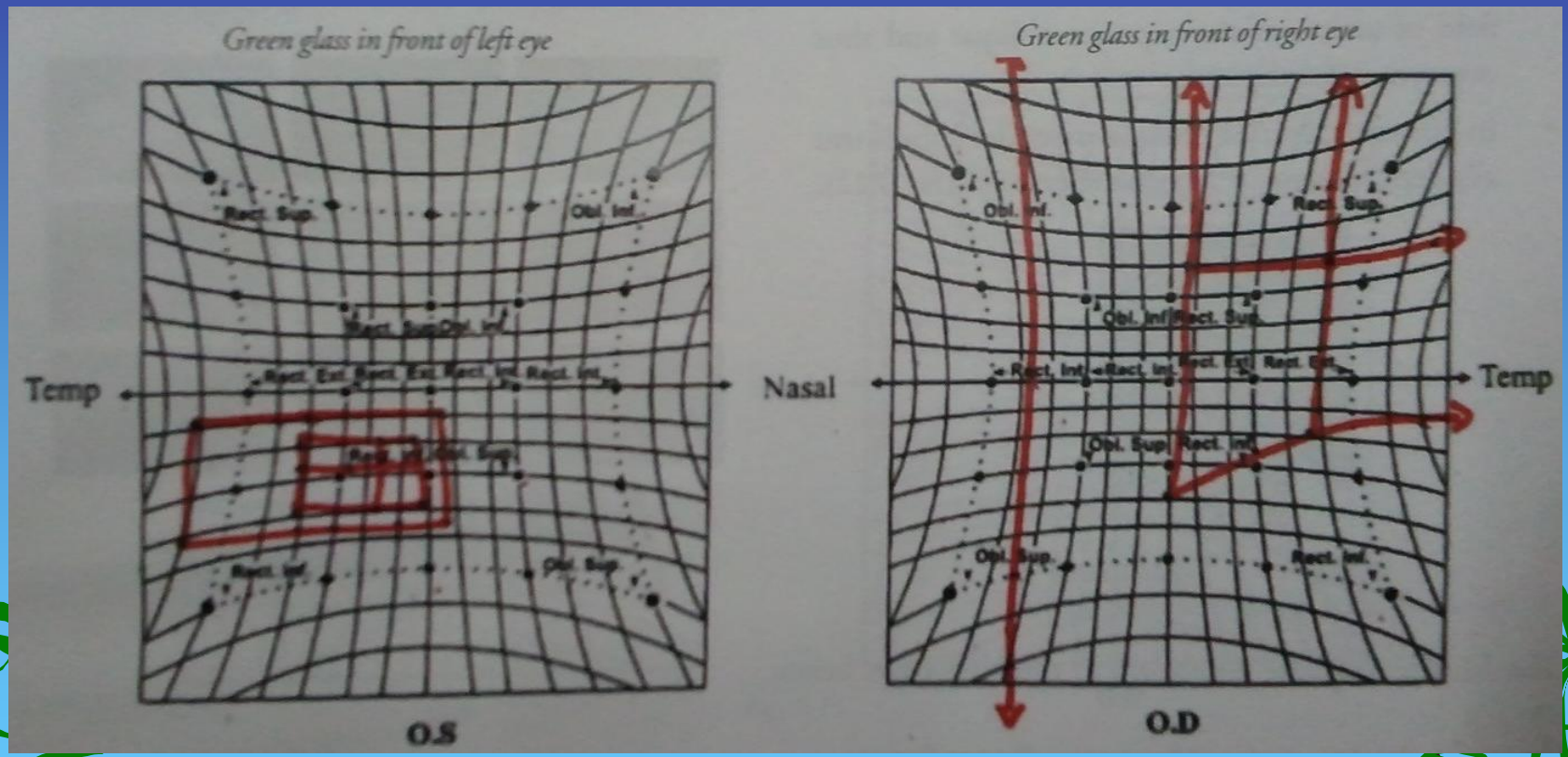


Lees charting



Hess charting

Hess charting: Left eye III N palsy:
Left MR,SR,IR,IO underaction



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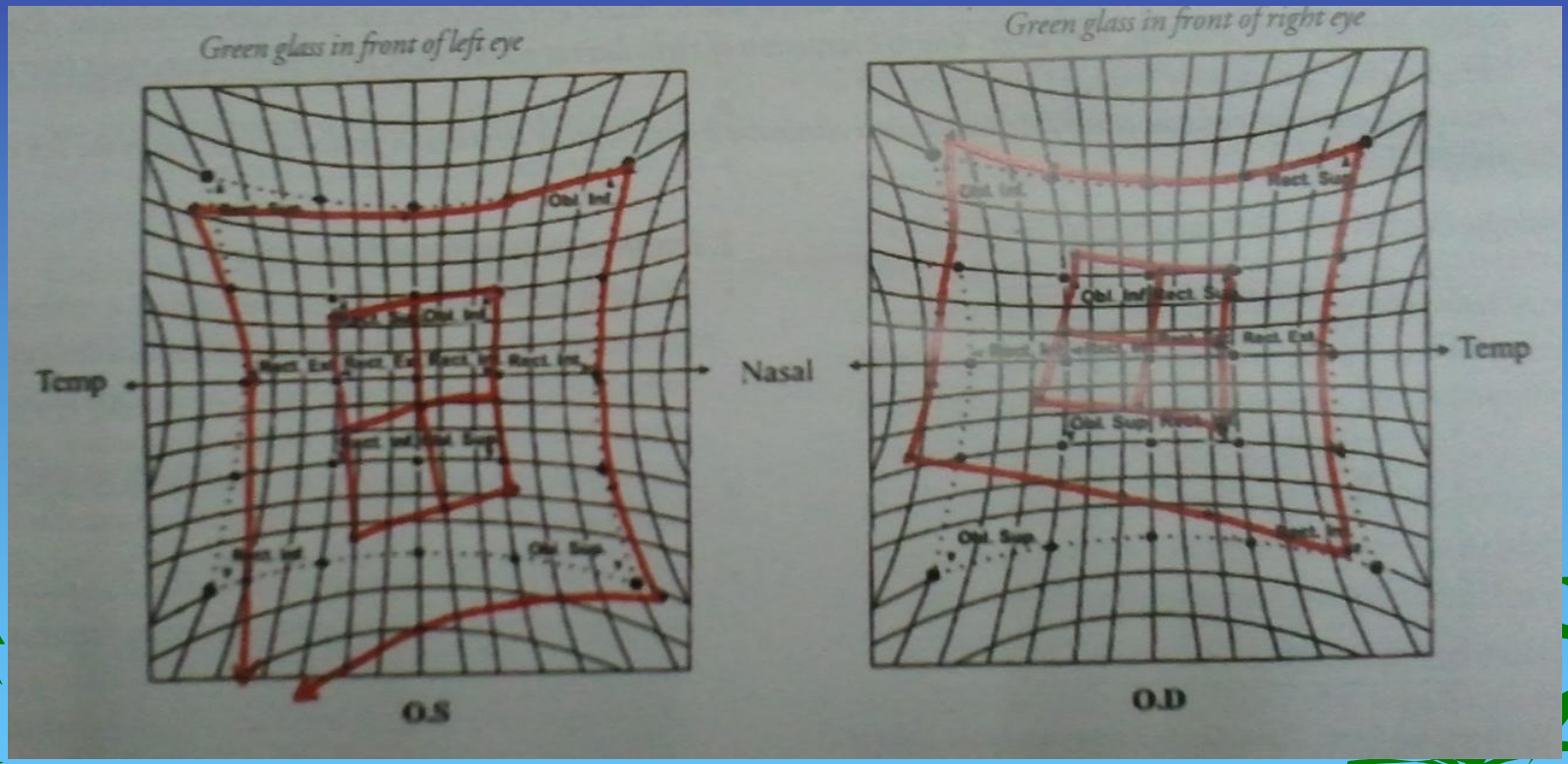
Hess charting: Right eye IV N palsy: RSO underaction: recent onset



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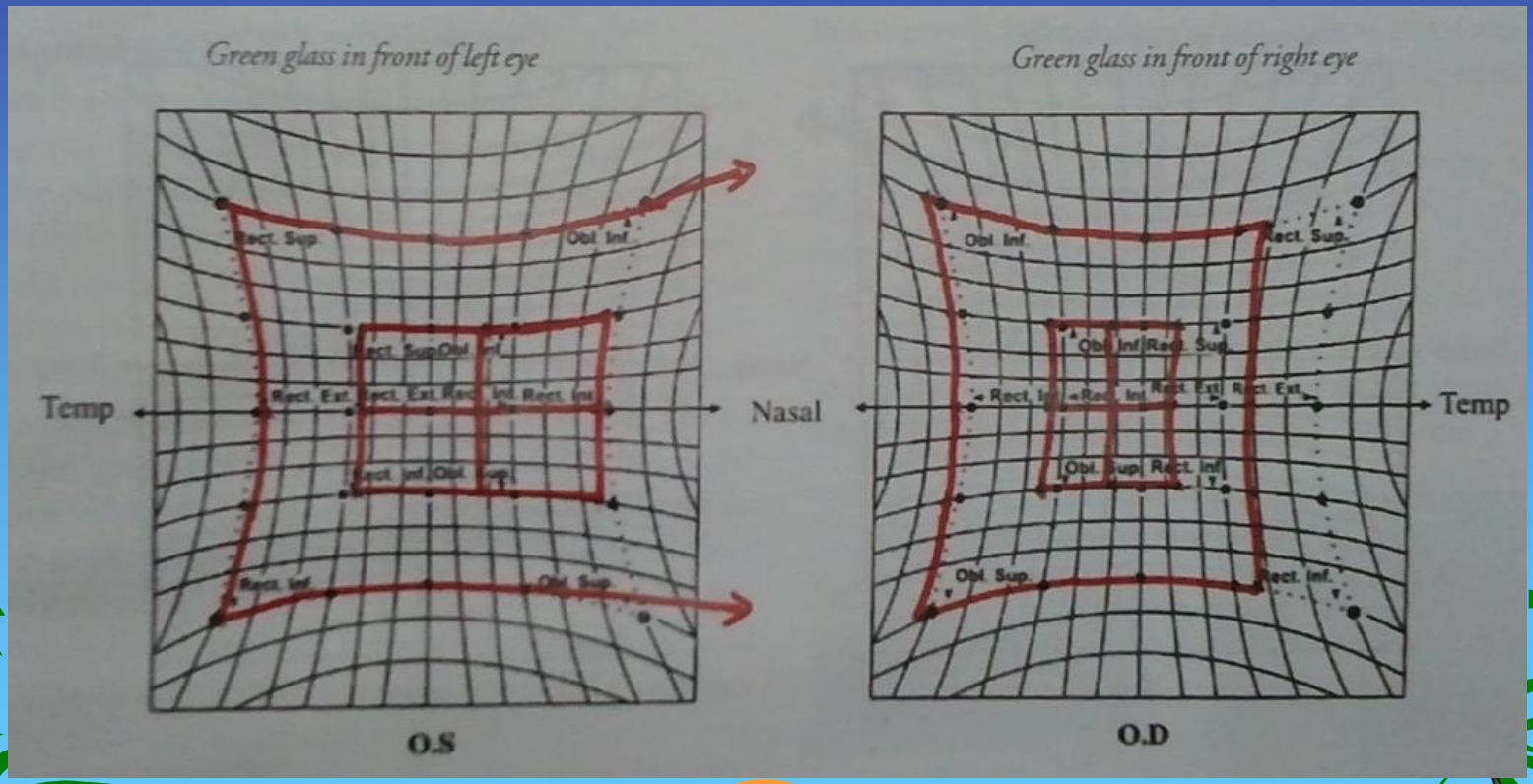
Hess charting: Right eye VI N palsy: LR underaction recent onset



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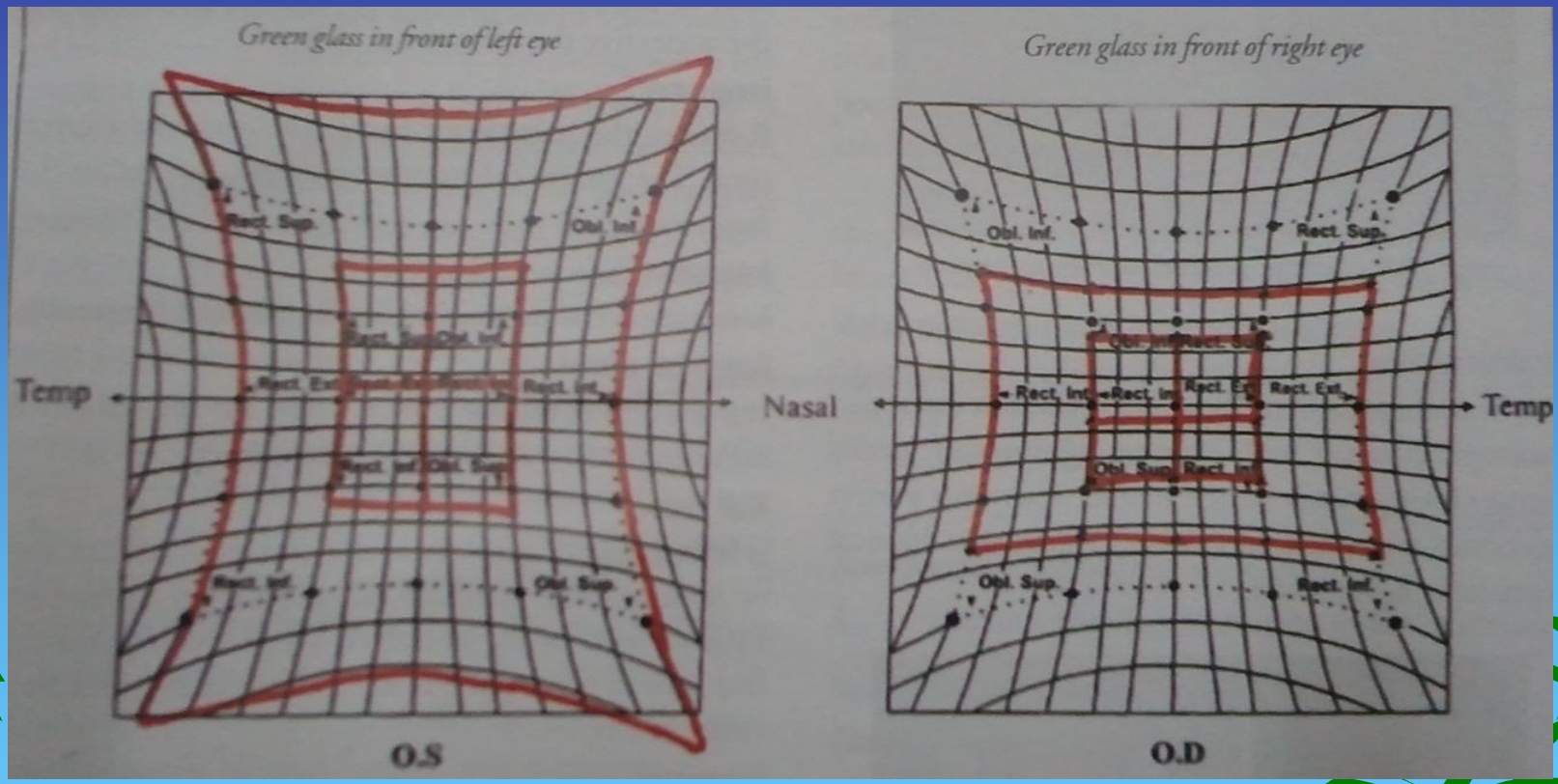
Hess charting: Blow out Fracture Right eye



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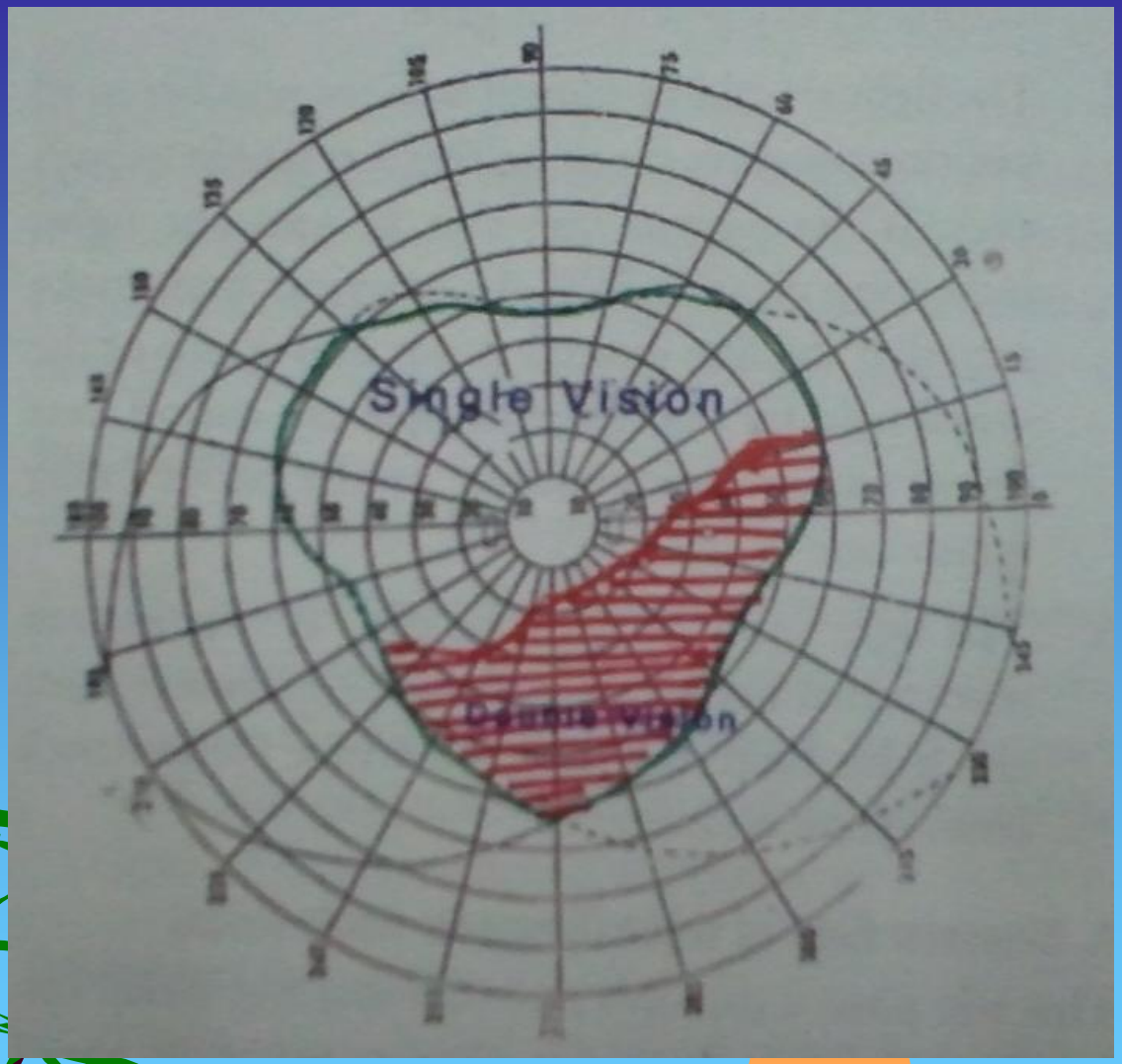

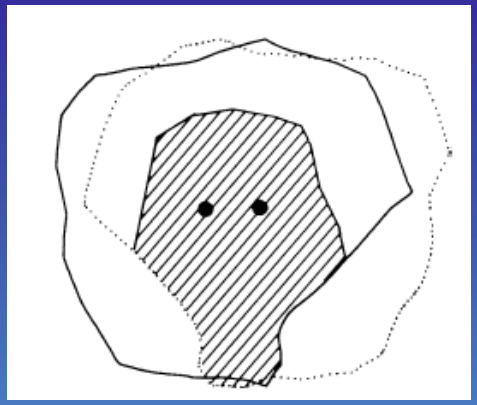

Binocular fields of fixation:

Charting fields of binocular single vision

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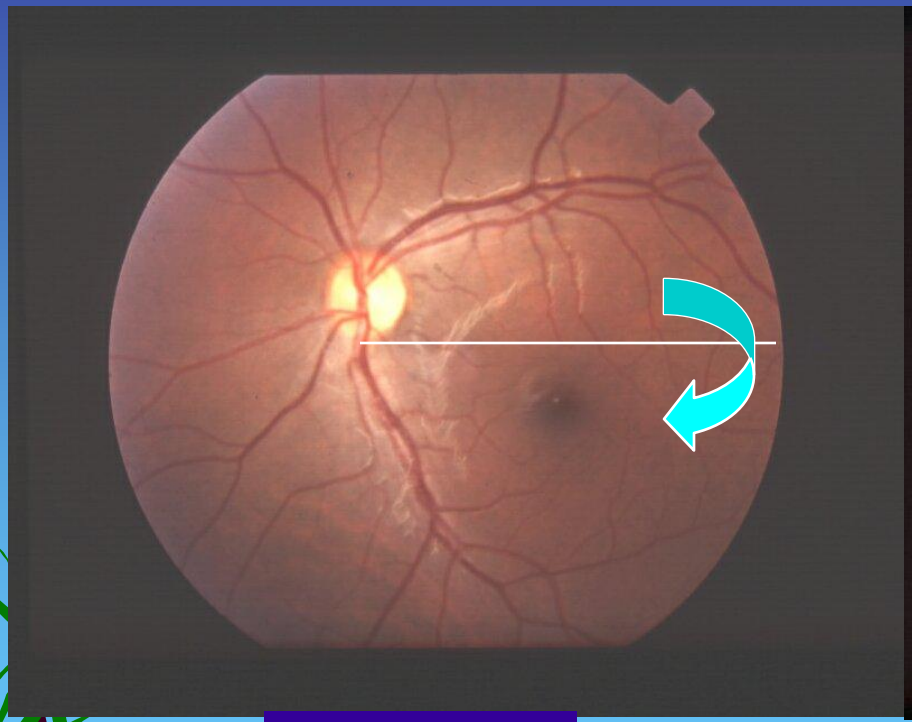
Non Surgical Management

- Glasses: Even hyperopes gain
- Amblyopia therapy
- Orthoptic exercises:
  - Synoptophore/Antisuppression
  - Sustenance/Pencil pushups
  - Prismbar/stereoscope

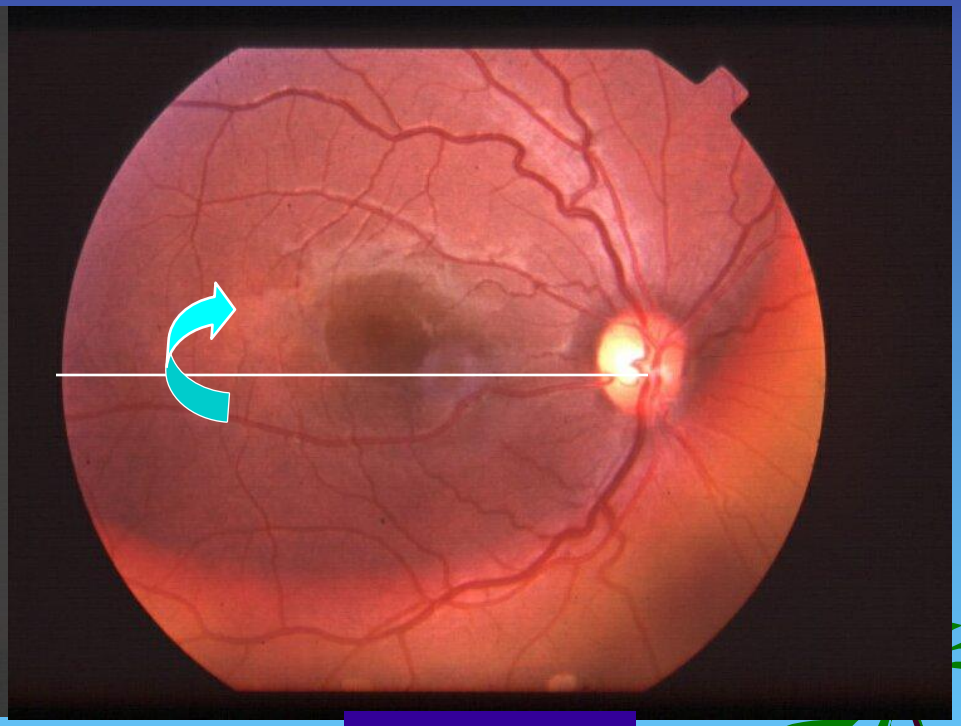
- Overminus lenses
- Fresnel and ground prisms

Infer

Role of torsion

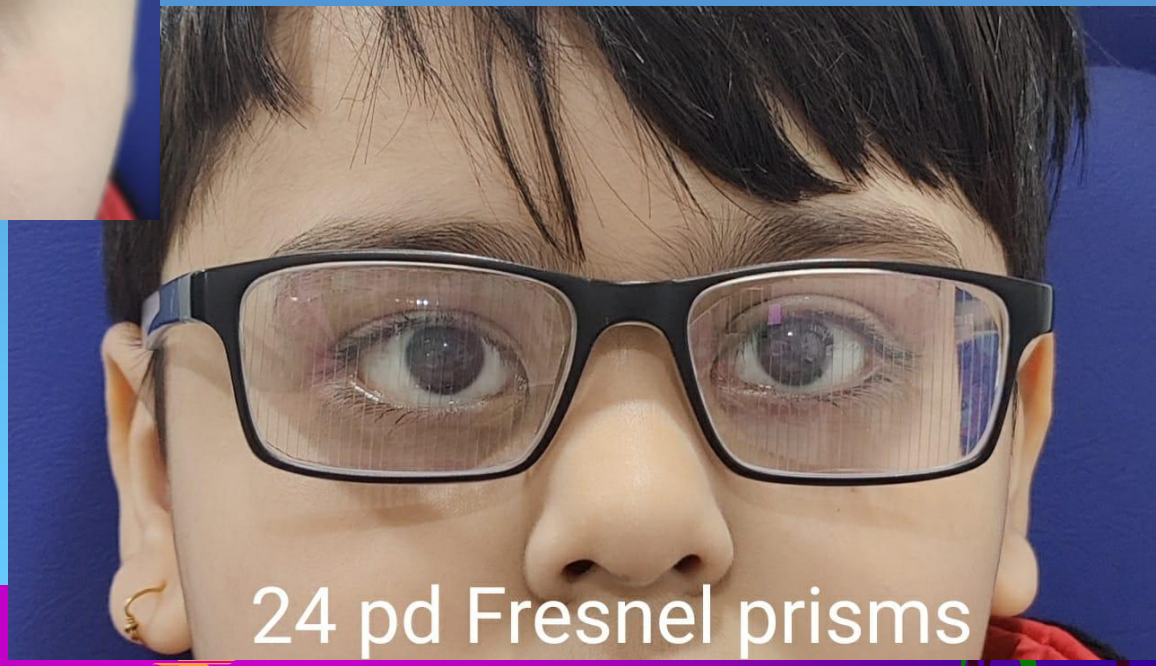


Extorsion



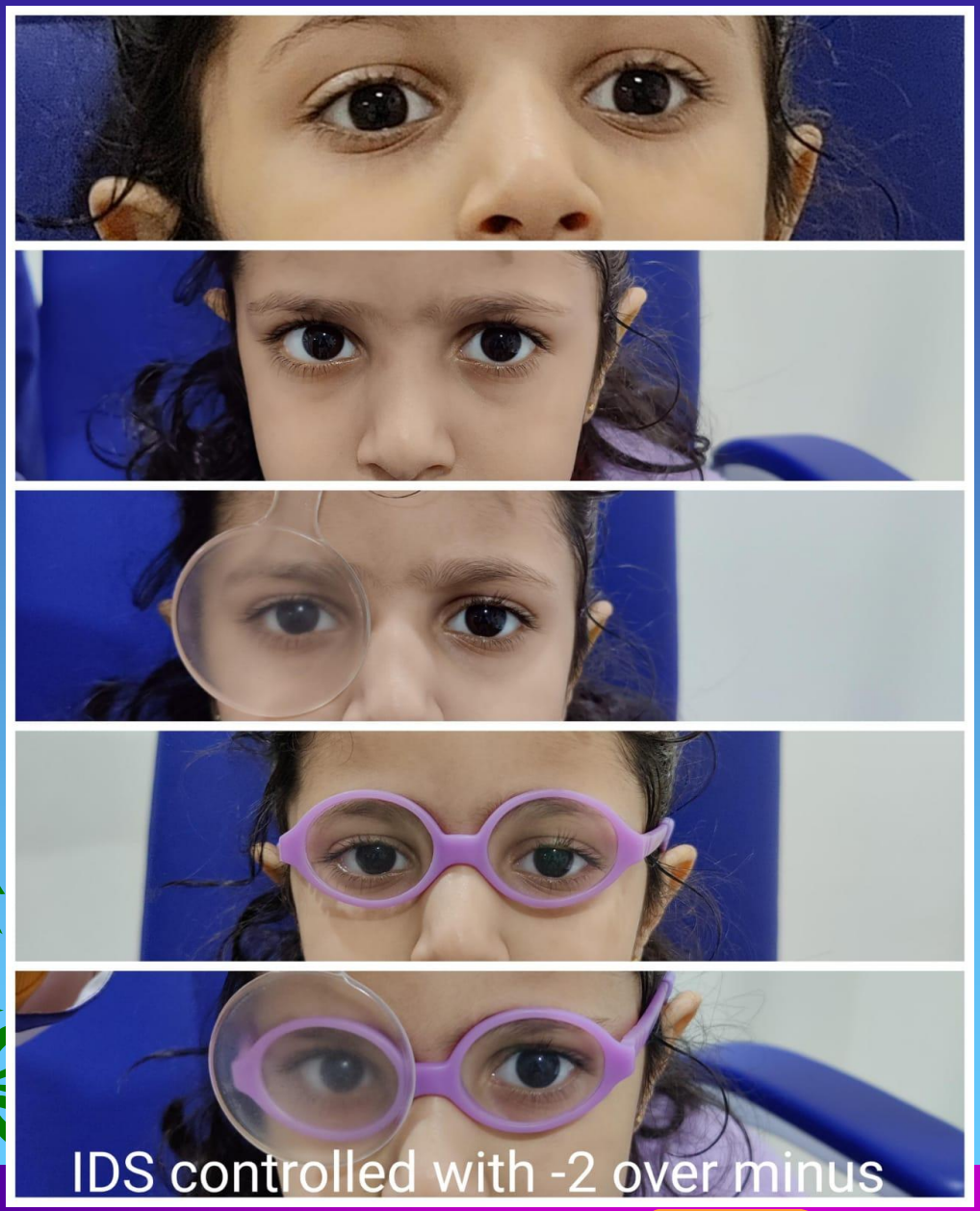
Intorsion

Fresnel prisms



Improve fusional convergence: Making them aware of Physiological diplopia

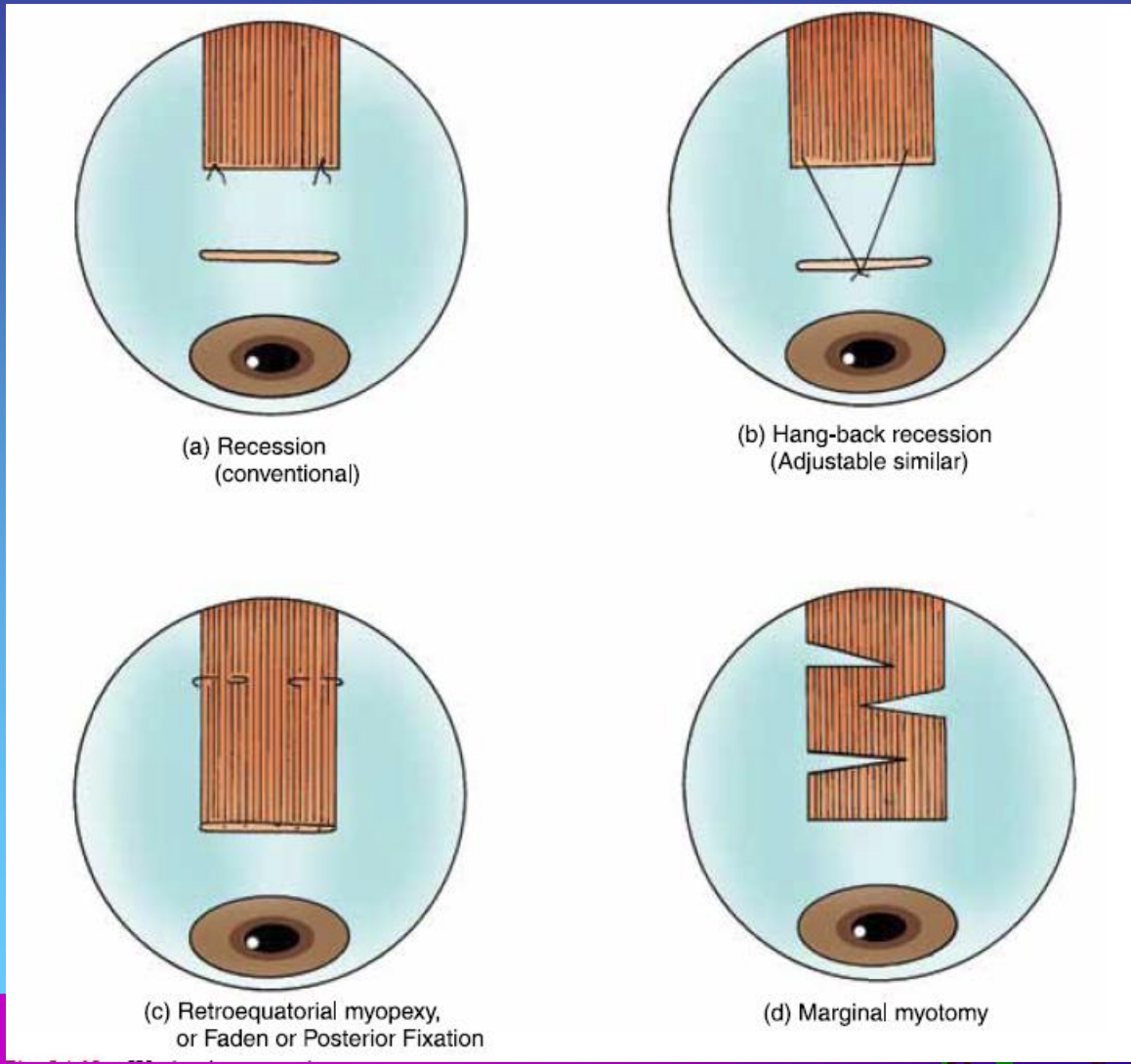
Otherwise ‘pencil push-ups’ only improve the Biceps!



Over Minus lenses in IDS

Strabismus Surgery: Weakening procedures

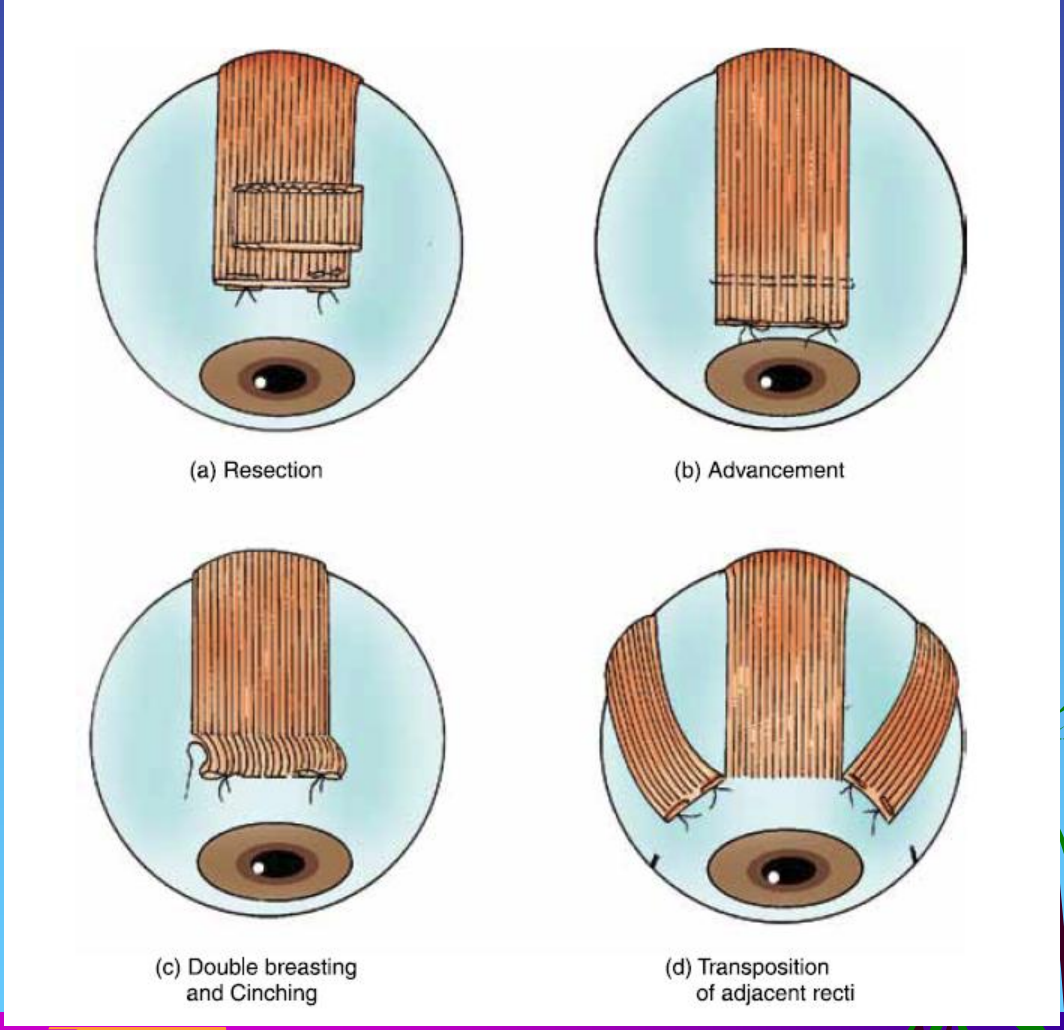
- Recession
  - conventional
  - hangback
  - Adjustable
- Retro-equatorial myopexy(Faden)
- Marginal myotomy



From Pradeep Sharma's Strabismus Simplified. CBS Publishers Delhi

Strengthening procedures

- Resection
- Advancement
- Plication/ Double breasting/ cinching
- Transposition of other muscles.
- Tucking (SO)



From Pradeep Sharma's Strabismus Simplified. CBS Publishers Delhi

Recession Surgery

A case for **early alignment**: KW Wright's son then and later

From KW Wright's Pediatric Ophthalmology and Strabismus

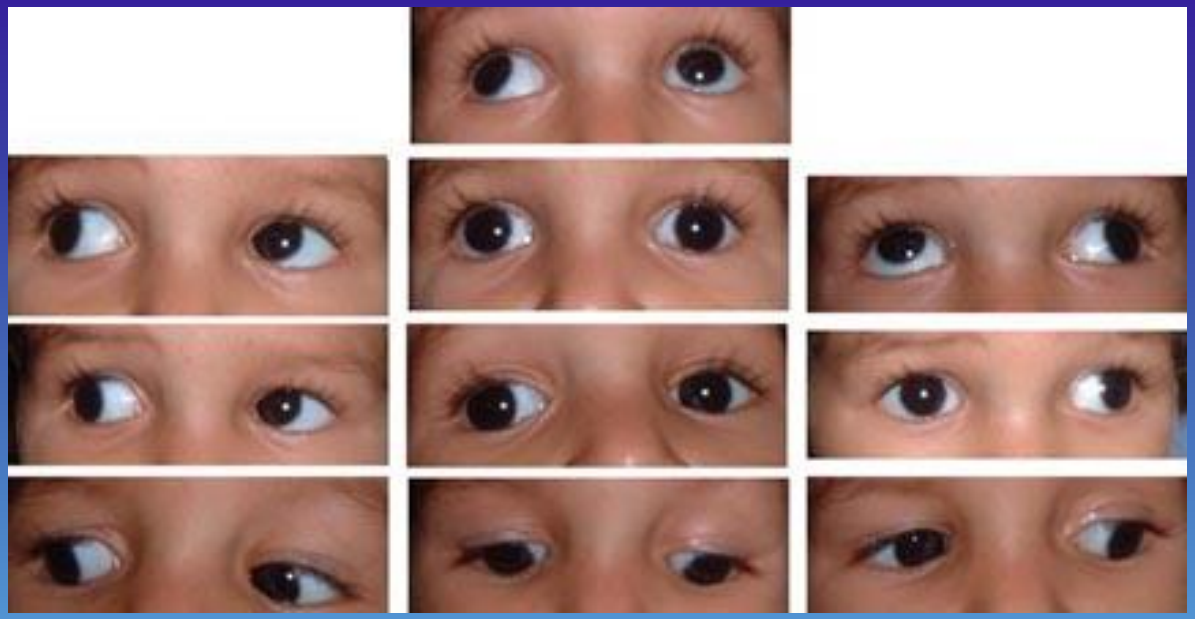
Critical periods to remember for treatment : Cricket's rule of 4s & 6s

4-6 weeks : Congenital cataract
4-6 months: Infantile esotropia
4-6 years: Intermittent exotropia
Nystagmus etc

Timing of surgery: Exotropia

- Exotropia: if constant operate early.
  - Wait and watch only if intermittent.
  - Observe distance/near stereopsis.

Remember Exotropia may be a lesser evil than Esotropia But only for Amblyopia! but equally detrimental for BSV!



Child with exotropia with V pattern with B/E IOOA

Postop V -Exotropia after B/E LR rec IOOA rec& ap

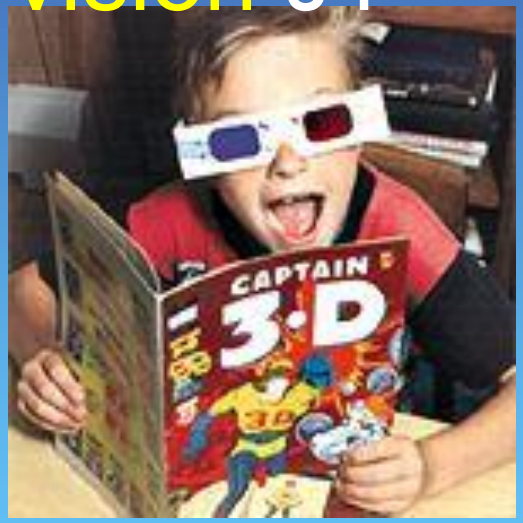
Be a Squintellectual!

Pre op

Post op

The Pursuit of Stereopsis: The new Goalpost

The goal is not just 20/20 or 6/3 vision with good near vision J1 in each eye
but also
good stereopsis
and good fusion



We are not just treating Strabismus, but Restoring Binocular Vision and Stereopsis!!

Our Mission

Spreading Sight and Happiness
For kids the world across!
Maintaining the stereopsis
And restoring the loss!

drpsharma57@yahoo.com

Strabismus Simplified

Second Edition

Strabismus is a subject that has always been looked with awe and fear due to its complexity. But the problems of binocular vision and ocular motility are the most common to be confronted by the ophthalmologist. Next to cataract surgery, squint surgery is the most common surgery performed by ophthalmic practitioners. We cannot evade it. In fact, we would love it, for it is the least demanding except for a little understanding. There are far fewer facts to memorise by rote compared to other specialities. It is more or less like mathematics, which serves all our life, provided we comprehend it. The attempt of this book is to simplify strabismus, demystify the myths surrounding it and make strabismus understood. That is why the title *Strabismus Simplified*.

The author had the great fortune to learn the tricks of the trade from Dr Prem Prakash, one of the pioneers of strabismology in India and further fine tune that skill with the stalwarts in the United States. He has performed over 25,000 squint procedures and he is sharing his rich experience with the readers to restore and promote binocular vision of each and every child.

This edition features a thorough revision of text, profusion of images, and full colour diagrams and clinical pictures. Also included is a CD containing the videos of important surgical procedures on horizontal rectus and the oblique muscles.

Pradeep Sharma MD FAMS

Is currently Professor of Ophthalmology at Dr. Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi. He has had the privilege of being first an undergraduate medical student and then the postgraduate student at the prestigious AIIMS, where he continues to serve as a faculty, an association of over 38 years. He has to his credit over 150 scientific publications in various inter-national/indexed national journals in addition to presentations at various conferences. He was awarded Col. Rangachari Gold Medal, Dr. Athawale Award of All India Ophthalmological Society, 1984 and 2001, and several orations and awards from several state ophthalmic societies. He is a faculty for ORBIS, the Flying Eye Hospital. He was awarded International fellowship of International Strabismological Association for advanced training in Jules Stein Eye Institute, UCLA, Los Angeles, Wills Eye Hospital, Philadelphia, and Richmond Eye Institute, Richmond, VA in USA. He has also written another book *Essentials of Ophthalmology*.

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Thank You for your love and affection

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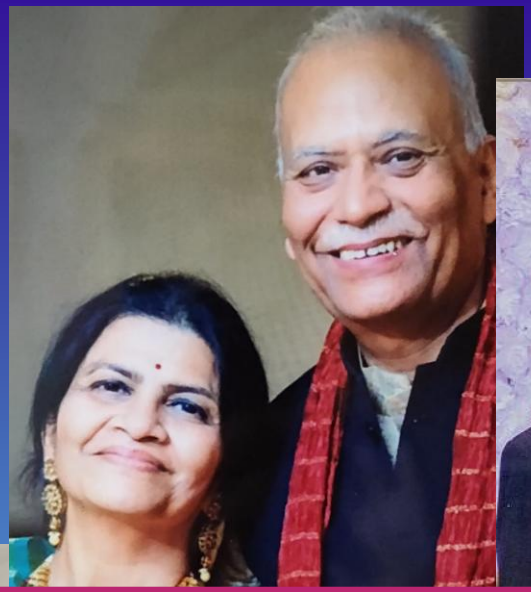

Thanks

Dhan dhan Satguru tera hi aasra

Thank You for your love and affection

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Every eye deserves the best
A Mahindra Collaboration

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