

# **NEW CAUSES OF DIPLOPIA.**



**Lionel Kowal RVEEH & CERA Melbourne, Australia  
Scientific Bureau, WSPOS**

**Lionel Kowal RVEEH & CERA Melbourne, Australia  
Scientific Bureau, WSPOS**

**Assisted by past / present orthoptists & RVEEH Fellows**

# FINANCIAL / COMPETING INTERESTS

- All patients paid their accounts



# 21<sup>ST</sup> CENTURY

## STILL NEED ALL THE **OLD DIPLOPIA Qs**

- Does the 2<sup>nd</sup> image go away when you close either eye?
- Is it to the L, R, above, below?
- Is there a position where the doubling is gone? ..is worst?
- Does the L , R, higher, lower image go away when you close the L, R eye?
- Is one image tilted? Which one – L, R, above, below? Tilted in / out?



# 21<sup>ST</sup> CENTURY

- **'New' diplopia Qs**  
for under-recognised  
**SENSORY & MOTOR** barriers to  
fusion



## 'NEW' DIPLOPIA QS

**Is the image seen by the R:**

- **Larger / smaller than image seen by L**
- **Same shape as L**

Are the horizontal and vertical lines on the E as they should be

- **Paler / darker than L**
- **Tilted** [torsion]
- [if vertical] **Does it go away when the head is flat e.g. lying down on your back?** [Skew]
- **Does it wobble?** Heimann Bielschowsky, Sup Obl Myokymia, Ocular myoclonus,...



# COMMON 'NEW' PROBLEM: DIPLOPIA AFTER CATARACT SURGERY

'Old' reasons	'New' reasons : Normal or near-normal muscle function: usually $\geq 1$ 'minor' stresses on sensory & motor fusion
Inf Rectus contracture after Marcaine damage	<b>Anisometropia: Monovision &amp; Aniseikonia</b>
Other muscles damaged by Marcaine	Metamorphopsia 2ary to macular disease
Incidental 4ths and occult Graves' uncovered by cataract surgery	Other sensory issues: Big contrast differences, large field defects.
	Minor acquired motility changes of the elderly: Sagging eye muscles





## 56 YO DR: CAUGHT “KNAPPING”?

- **Axial anisometropia corrected in the spectacle plane *does not* usually cause aniseikonia**
- **if *Axial* anisometropia is converted to *Lenticular* anisometropia, then aniseikonia is to be *anticipated***
- **This is counter-intuitive: reducing spectacle-plane anisometropia *should* make things *better*, not worse**





## 56 YO DR: CAUGHT “KNAPPING”?

- Axial anisometropia corrected in the spectacle plane *does not* usually cause aniseikonia
- **if *Axial* anisometropia is converted to *Lenticular* anisometropia, then aniseikonia is to be *anticipated***
- This is counter-intuitive: reducing spectacle-plane anisometropia *should* make things *better*, not worse



## 56 YO DR: CAUGHT “KNAPPING”?

- Axial anisometropia corrected in the spectacle plane **does not** usually cause aniseikonia
- if **Axial anisometropia is converted to Lenticular anisometropia**, then aniseikonia is to be **anticipated**
- **This is counter-intuitive:**  
reducing spectacle-plane anisometropia **should** make things **better**, not worse



**56 YO DR**

# **CAUGHT “KNAPPING”? \***

○ Axial lengths : R 29.5 mm      L 26.75 mm

○ **Now has 13% R macropsia**

***Likely to have been anticipated by pre-op  
CL testing***

- Galilean system has resolved diplopia by minimising RE image : + CL [start +1.50, with equivalent - to spectacle lens]
- Opposite optical arrangement to LE
- Trial / error, or use **Aniseikonia Inspector** ©

*\*Thank you Logan Mitchell*



# MEASURING ANISEIKONIA

MOST 'REAL LIFE' MEASUREMENT:  
SIZE LENSES UP TO  $\pm 13\%$

**Recommended:**  
**repeatable & leads to a  
precise optical solution**



**56 YO DR**

**2 VERY IMPORTANT QS**

1. How much anisometropia is it safe to surgically **reduce** to try produce spectacle independence?



# Q1: REDUCING ANISOMETROPIA

Some very elegant analyses , but **no** useful clinical data

ARTICLE

## Predicting refractive aniseikonia after cataract surgery in anisometropia

Laure Gobin, PhD, Jos J. Rozema, PhD, Marie-José Tassignon, MD, PhD, FEBO

1-s2.0-S0886335008005014-main.pdf

Find

**APPENDIX A**  
*Predicting Postoperative Aniseikonia in Cases of Refractive Anisometropia (Lenticular or Corneal)*

Aniseikonia induced by correcting refractive anisometropia at another plane than the one causing anisometropia (eg, aniseikonia induced by the spectacle correction of a corneal anisometropia) can be calculated with matrix optics:

$$\text{Aniseikonia} = \frac{f_{OD}}{f_{OS}}$$

with

$$\frac{1}{f_{OS}} = P_{OS} + P_{L0S} + K_{OS} - (c + v)P_{OS}P_{L0S} - vP_{L0S}K_{OS} - cP_{OS}K_{OS} + vP_{L0S}P_{OS}K_{OS}$$

where

$$c = \frac{ACD}{n}$$

ACD is the anterior chamber depth,  $n$  is the aqueous humor refractive index, and  $v$  is the vertex distance from the anterior cornea estimated at 12.0 mm.

This complicated formula is easy to implement in a worksheet to compare the aphakic preoperative corrected by spectacles with the pseudophakic situation corrected by IOL (Figure A1).

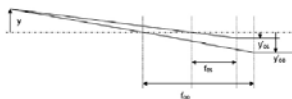


Figure A1. Ray tracing of the left and right eye using only the focal and principal plane positions and the object size  $y$

**CONCLUSIONS:** Anisometropia is not a rare condition and should be assessed before cataract surgery. A comprehensive method to calculate the objective aniseikonia and to measure the subjective aniseikonia in anisometropia was proposed. If cataract surgery is considered in anisometric patients, a postoperative aniseikonia of 4% or more may be induced in the case of emmetropization. A method to calculate the intraocular lens power resulting in an acceptable postoperative aniseikonia, especially in axial anisometric patients, is also proposed.

*J Cataract Refract Surg* 2008; 34:1353–1361 © 2008 ASCRS and ESCRS

**56 YO DR**

**2 VERY IMPORTANT QS**

2. How much anisometropia is it safe to surgically **introduce** in order to give monovision MV?

○ Some data from cataract / refractive surgery



## TEMPORARY MV NOT A [BIG] PROBLEM

- 3 month MV [early PRK days] :  
1/50 pts asymptomatic  
reduction in fusional reserve

White J. Excimer laser photorefractive keratectomy: the effect on binocular function. In Spiritus M ( Ed): Transactions, 24th Meeting, European Strabismological Association. Buren: Acolus Press, 1997; 252 – 56





# SURGICAL / PERMANENT MV AFTER REFRACTIVE SURGERY

118 RS patients. 48 planned MV.

**'Abnormal binocular vision' (ABV)** in 11/48 (22%),  $\geq 1$  of

- *Intermittent / persistent diplopia*
- *Visual confusion*
- *'Binocular blur requiring occlusion to focus comfortably'.*
- 70 pts did not have MV, 2 had ABV (3%).

Average anisometropia in

- **13 pts with ABV: 1.9 DS**
- **105 pts with normal BV: 0.5 DS** ( $p < 0.001$ ).

Kowal L, De Faber J, Calcutt C, Fawcett S. 'Refractive surgery and strabismus' (Workshop in 'Progress in Strabismology').

In: de Faber JT, ed. Proceedings of the 9th Meeting of the International Strabismological Association, Sydney, Australia.



“UNPUBLISHED INTERNAL AUDIT DATA FROM AN AUSTRALIAN MULTI CENTER REFRACTIVE SURGERY PRACTICE”

- Need for repeat refractive surgery after planned monovision surgery:
- 15% after CL trial, **50%** without.



## THIS MV STUDY WILL WORRY YOU

- 3 pts with MV IOLs who developed ET with diplopia  $\geq 2$  y after IOLs
- Rx: Reverse the MV

*Pollard et al Am J Ophthal 2011*



# CASE 2: 65 YO MECHANICAL ENGINEER 25% MICROPSIA AFTER R RETINAL DETACHMENT SURGERY.

NOW PLANNING CATARACT SURGERY

- 2yrs ago: transient vertical diplopia after prolonged near work.
- 6 mo ago: R retinal detachment. Blurred [nuclear cataract] & double since.
- **VA R -2 : 20/125.** Retinometry **20/35.**
- **VA L +1.25 20/30.**
- **He estimates 25% R micropsia.**
- The most I can measure with Size lenses is 13%, and he estimates an extra 10%.



## 25% MICROPSIA - PLANNING CATARACT SURGERY

- For distance [20/400 E] : crossed diplopia of  $4\Delta$ .
- At ~1m : crossed diplopia  $1\Delta$ .
- Within 0.5m & with near glasses: fuses [Brian Arthur's] polarised 4 dot test, Fly and 1/9 Titmus circles.

**Blurred vision & retinal & refractive aniseikonia has allowed a 'trivial' exodeviation of  $1-4\Delta$  to become symptomatic.**

**Retinal aniseikonia is not expected to go away**



10 M



GOOD LEFT  
EYE



RIGHT (BLURR & SMALLER)  
EYE

FERN LEAF  
10 m. AWAY

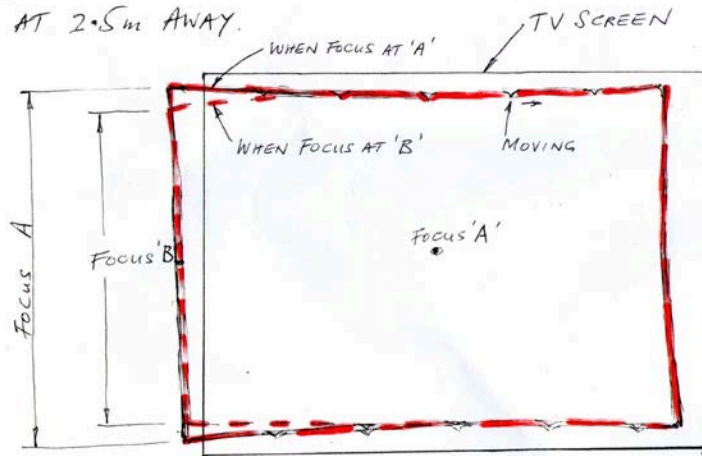
17 DEC 2011  
V Kwan



# 2.5M

1<sup>st</sup> JAN 2012

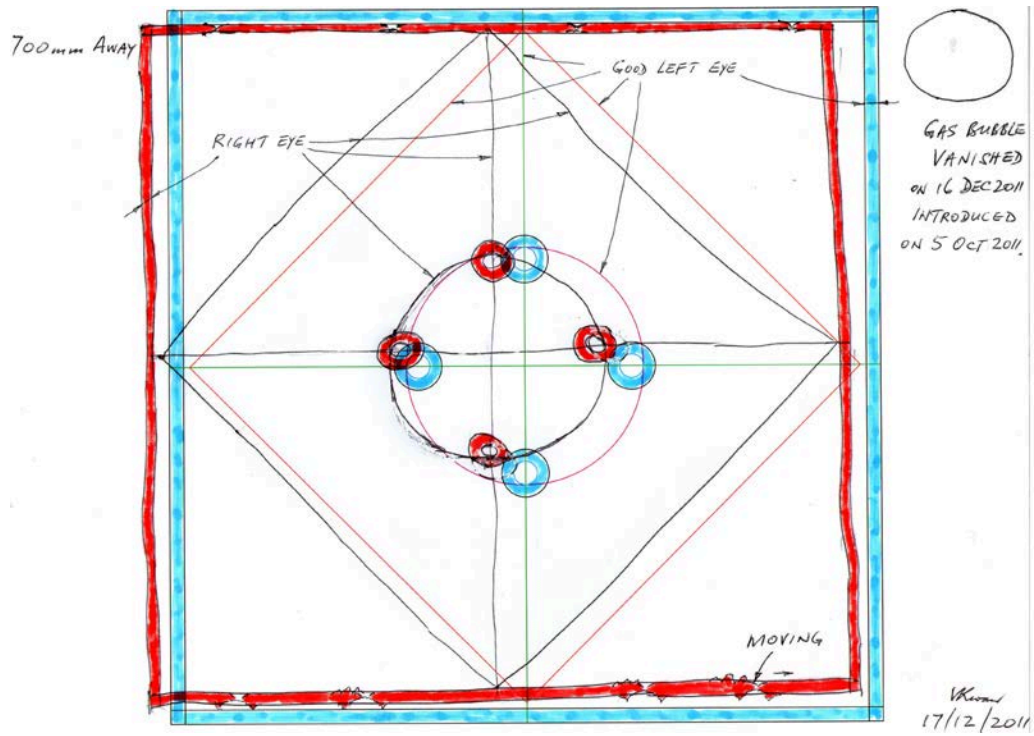
TV SCREEN 420 V x 550 H  
AT 2.5m AWAY.



- RIGHT EYE VISION  
**(IN RED)**
- LINES ILL DEFINED.
  - LINE BECOMES SHORTER WHEN FOCUS ON OR MOVES TO.
  - COLOUR IS OKAY.



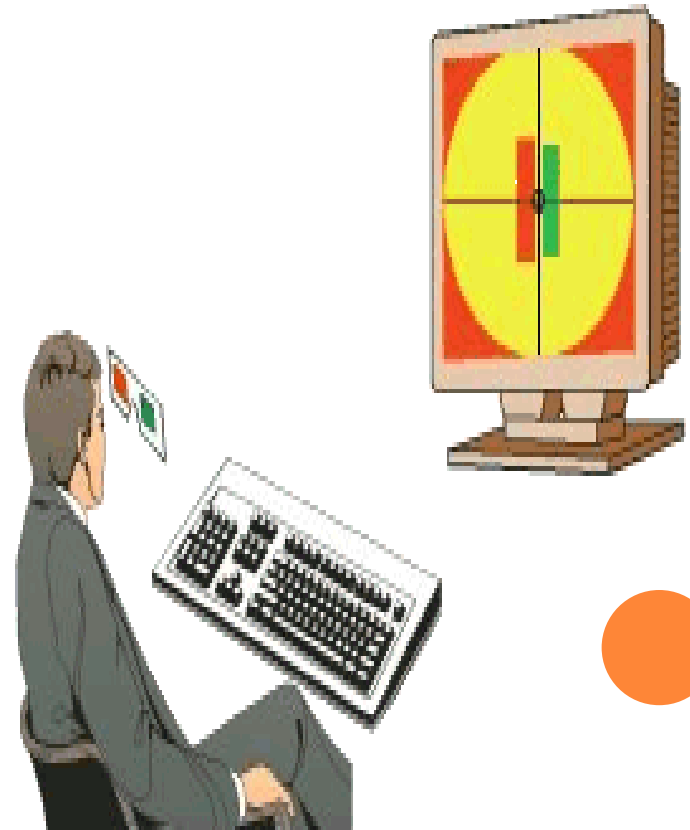
0.7M





# ASK THE ANISEIKONIA INSPECTOR

- Gerard De Wit's clever software
- Direct comparison method of the perceived images
- Elegant computer software that interacts with patients
- **Dr De Wit generously looked @ data of this engineer with micropsia**



# Q: HOW TO RESOLVE RETINAL ANISEIKONIA WITH CHOICE OF IOL POWER

## G DE WIT

- .....the 25% cannot realistically be corrected.....

### IOL refraction aim

- +1.25 in spectacle plane: 6% aniseikonia correction
- +3 in spectacle plane: 10% aniseikonia correction
- +4.75 in spectacle plane: 14% aniseikonia correction



## WHAT DID THE CATARACT SURGEON DO?

- R IOL to make him plano - **Happy pt**
- No complaints of aniseikonia.....?yet
  
- THIS IS A DATA – FREE ZONE
- **THERE ARE ‘ SENSIBLE’ PSEUDO-SCIENTIFIC PREDICTIONS, BUT NO RELIABLE +ve / -ve PREDICTIONS**



# CASE 3: MRS A. DOB 1936

## SUCCESSFUL LUCENTIS TREATMENT

- Lucentis 12 wkly R
- Geographic atrophy L

### Distance Rx:

- R +1.5-1x90 6/9+, L +1.75-1x90 6/9+
- Wearing 3.5 $\Delta$  BI split

### Near +3 add

- Wearing 15 $\Delta$  BI split

**...still gets frequent diplopia**



# MOTOR FINDINGS MRS A $\Delta$

## Up gaze

X4, LH 1

## Right gaze

X2, LH 1

## Primary position

X3, LH 1

Excyclo 5°

## Left gaze

X2, LH 1

## Down gaze

X4, LH 1

## Torsion

Is it a motor abnormality that has contributed to loss of fusion, or is it a manifestation of loss of fusion?



# HOW FRAGILE IS THE ALIGNMENT?

- Wearing  $3.5\Delta$  BI split

With this:

- Horizontal fusion range BO  $<1\Delta$ , BI  $1\Delta$
  - Vertical fusion range BD R  $<1\Delta$ , BD L  $2\Delta$
- ....i.e. VERY fragile

Practical guide: add  $1\Delta$  BD L to BI $\Delta$



# WHY IS MOTOR FUSION SO POOR?

## SENSORY BARRIERS TO FUSION

### Metamorphopsia

- 6/30 F
- Horizontal bars are double, bits missing

### Aniseikonia

- 4% R macropsia



## OVERVIEW MRS A'S DIPLOPIA 1

- Motor deficits: Objectively trivial
- Sensory deficits: aniseikonia, metamorphopsia
- Regular lenses &  $\Delta$ s may work & should be tried





# OVERVIEW MRS A'S DIPLOPIA 2

## Aniseikonia:

- Can modify refractive index, BVD, lens thickness
- Thick [aniseikonic] lenses: few/ no lens labs make these
- 'Shaw' lenses [Canada] claim to compensate for aniseikonia & have won over many Australian optometrists: marketing more impressive than science so far

MODIFYING SPECTACLE LENSES TO LESSEN ANISEIKONIA (03/05)

TO MAXIMISE IMAGE SIZE:

INCREASE:

REFRACTIVE INDEX  
LENS THICKNESS  
FRONT BASE CURVE

TO LESSEN IMAGE SIZE:

DECREASE:

REFRACTIVE INDEX  
BASE CURVE  
LENS THICKNESS



# RETINAL ANISEIKONIA

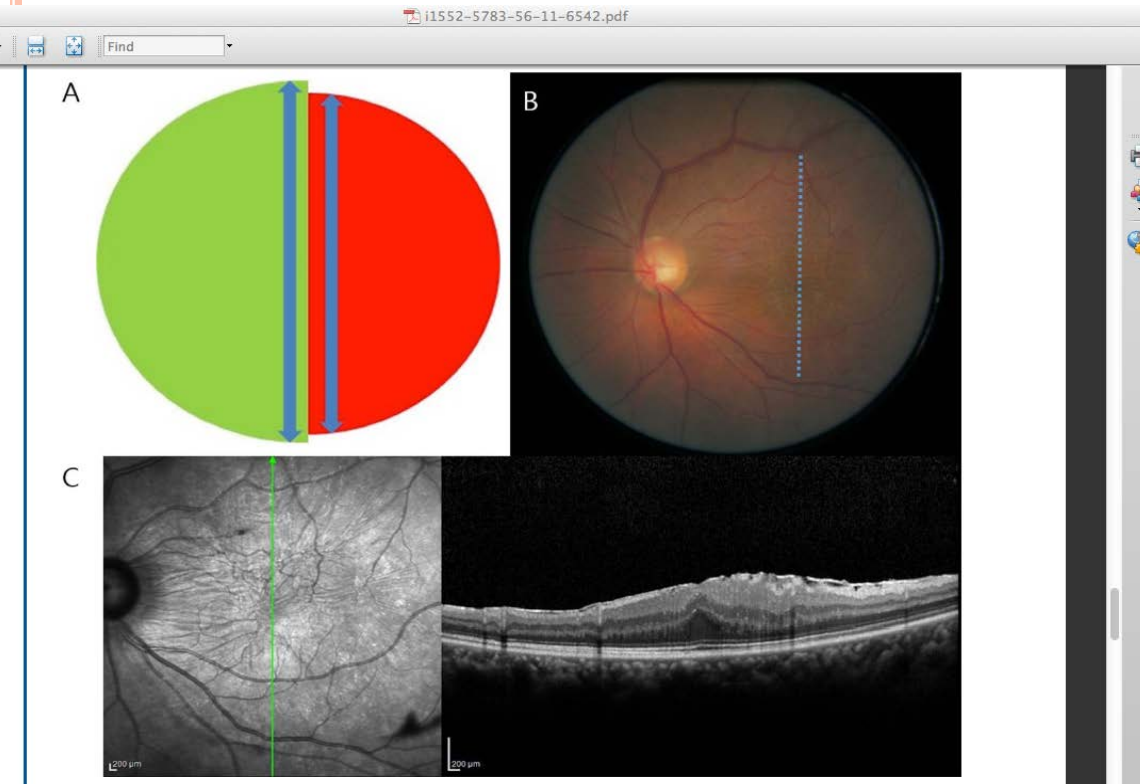
Multidisciplinary Ophthalmic Imaging

## Relationship Between Vertical and Horizontal Aniseikonia Scores and Vertical and Horizontal OCT Images in Idiopathic Epiretinal Membrane

Heeyoung Chung, Gisung Son, Duck Jin Hwang, Kyungmin Lee, Youngsook Park, and Joonhong Sohn

Department of Ophthalmology, HanGil Eye Hospital, Incheon, Korea

IOVS 2015; 56:6542-8



Epiretinal membrane usually causes macropsia



# CASE 4: SMALL ANGLE HORIZONTAL AND VERTICAL DIPLOPIA : A NEWLY RECOGNISED MECHANISM FOR DIPLOPIA IN THE ELDERLY: **SAGGY EYE SYNDROME**

- 82 y o Intermittent Horizontal diplopia, mainly on left gaze, since cataract surgery 4y ago
- R 6/9, L 6/6

Horizontal Deviation:

0  
0 ← 6ET → 12ET  
6ET

Small L hypo in primary

- Prescribed glasses:  
8Δ BO, 2Δ BU LE → single vision





**Restricted  
depression  
on L. aBduction**



Image size: 512 x 512  
View size: 1141 x 635  
WL: 355 WW: 710  
X: 165 px Y: 368 px Value: 372.00  
X: -44.11 mm Y: -69.73 mm Z: -65.18 mm

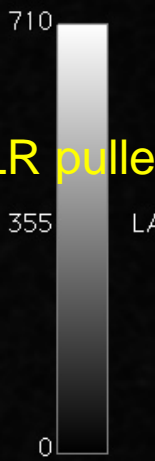
072571 ( 83 y , 83 y )  
Orbits -Exclude Patholo - Cor T1 (Thin)  
27408  
8

**'better' SR - LR  
tissue sling**

**some atrophy of  
LSR - LLR tissue sling**

**Sagging of LLR pulley**

**Not directly related to cataract surgery, but  
happens in same age group and will be attributed  
by patients to cataract surgery**



Zoom: 270% Angle: 0  
Im: 5/24 A (A -> P)  
Uncompressed  
Thickness: 3.00 mm Location: -57.83 mm

TE: 14.512 TR: 440  
FS: 1.5  
7/03/11 3:23:58 PM  
Made In OsiriX

# LR-SR INTER-MUSCULAR SLING

Degeneration of the LR-SR sling may occur in elderly

Inferior displacement of the LR Pulley.

LR is now a less capable abductor, & now has an infraduction vector as well

ET & Hypotropia

Demer JL et alii "Heavy Eye" Syndrome in the Absence of High Myopia: A Connective Tissue Degeneration in Elderly Strabismic Patients [J AAPOS. 2009 February; 13\(1\): 36-44.](#)

SES

- In myopes, different to / confused by me with Heavy Eye
- **?Overlap with Prostaglandin Associated Periorbitopathy**



# SOME 'OLD' CAUSES THAT NEVER BECAME WELL KNOWN 1

- **Prolonged downgaze** causing corneal aberration & 2ary monocular diplopia
- Loss of fusion after **prolonged unilateral acuity loss** eg diplopia after 'successful' keratoconus surgery





# SOME 'OLD' CAUSES THAT NEVER BECAME WELL KNOWN 2

- Loss of fusion from any cause can develop a 2ry **motor torsional** component
- Motor torsion can cause / contribute to loss of fusion
  
- Loss of fusion and the development of A or V patterns.
- Miller MM, Guyton D JPOS . 1994 Jul-Aug;31(4):220-4
  
- Up- and downshoot in adduction after monocular patching in normal volunteers
- A. Liesch; H.J. Simonsz (Huib) Strabismus (London), Vol. 1, No. 1, p.25-36.



## 'NEW' **SENSORY** CAUSES OF DIPLOPIA

- If **sensory fusion is subtly disrupted**, then pre-existing small asymptomatic horizontal  $\pm$  vertical **phoria** will become symptomatic small angle **tropia** with diplopia

### ***Sensory Suspects –***

- **Aniseikonia** – retinal, IOL-induced, refractive surgery monovision
- **Metamorphopsia** - after modern macula treatments



# 'NEW' **MOTOR** CAUSES OF DIPLOPIA

- Acquired & often subtle mechanical or neurological changes affecting the EOMs disrupt motor fusion

Suspects –

- **Sagging Eye**
- **Occult Graves'**
- **Sup compartment LR paresis**  
– *need good radiology and familiarity with recent literature*



