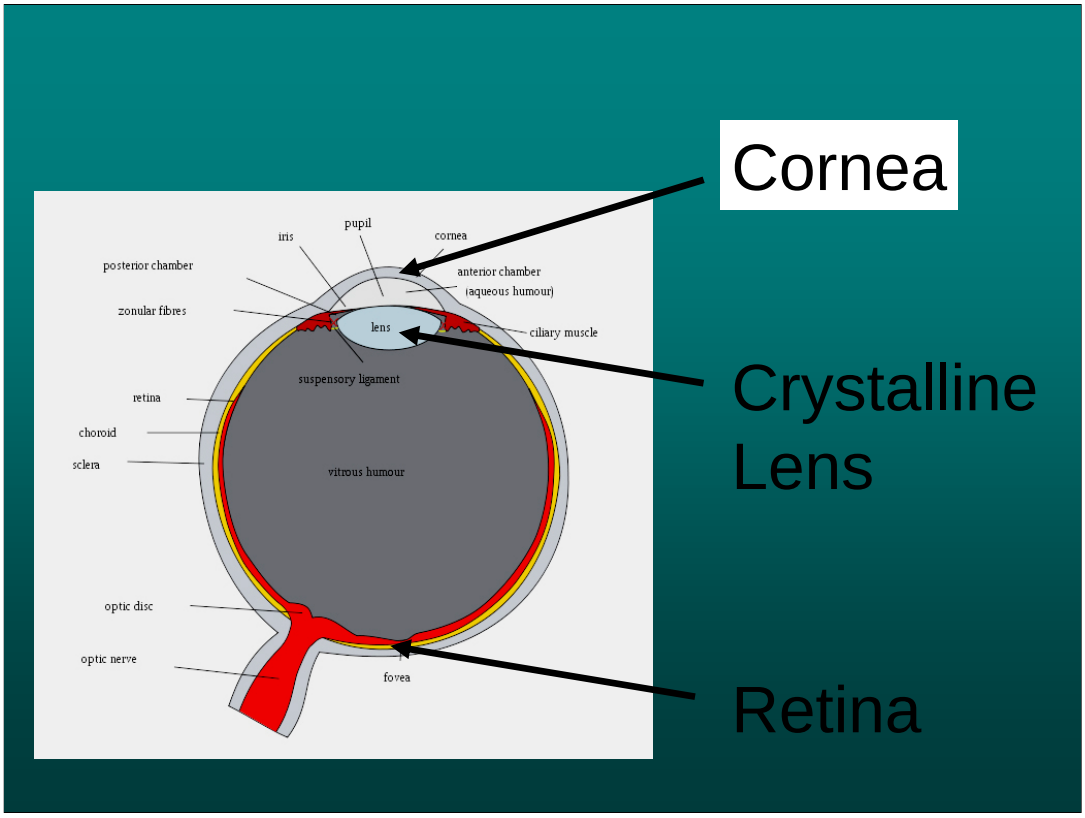
This presentation seek to shed some light on why regular optometry solutions – with spectacles or contact lenses – sometimes fail to provide improvements in vision.

It is classically thought that Albino vision is limited by neurological factors such as a poorly developed retina or a thin optic nerve.

Perhaps, however, albino vision may also be influenced by poor geometric symmetry within the eyeball.

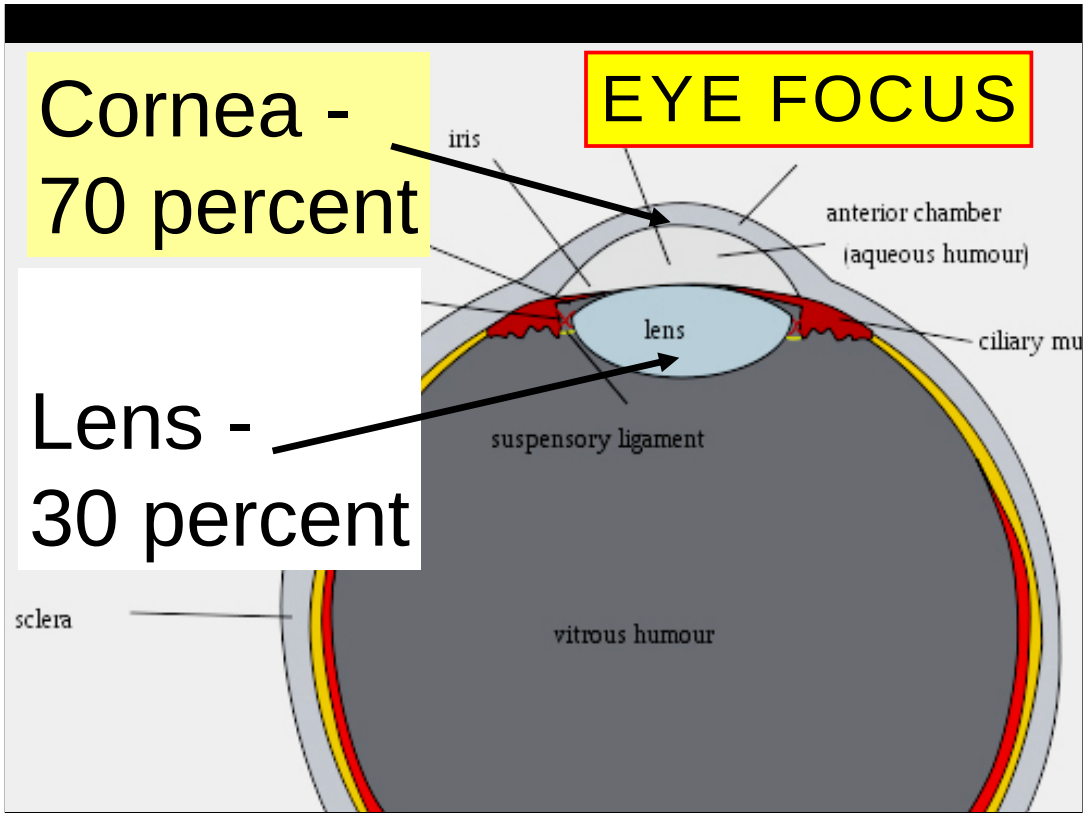


Over the last ten years or more there have been major advances in instruments that can accurately measure the geometry of the front of the eye.

What were once research lab curiosities have been commercially developed to aid laser eye surgery.

It is now possible to measure the shape of different parts of the front of the eye.

Let us start with the cornea - the part you can touch with your finger.



The cornea provides about 70 percent of the power needed to focus a distant object onto a screen (retina) some 22 mm (7/8 of an inch) behind the front of the eye.

It is therefore most important that this surface has the correct shape or contour.

Irregular Astigmatism

Most eyes enjoy a regular contour – but some do not.

Imagine an incompetent construction company who were able to build most of the hotel to the correct dimensions on the plan – but who got some of the dimensions wrong. Most rooms were the correct size – but some were bigger or smaller than expected.

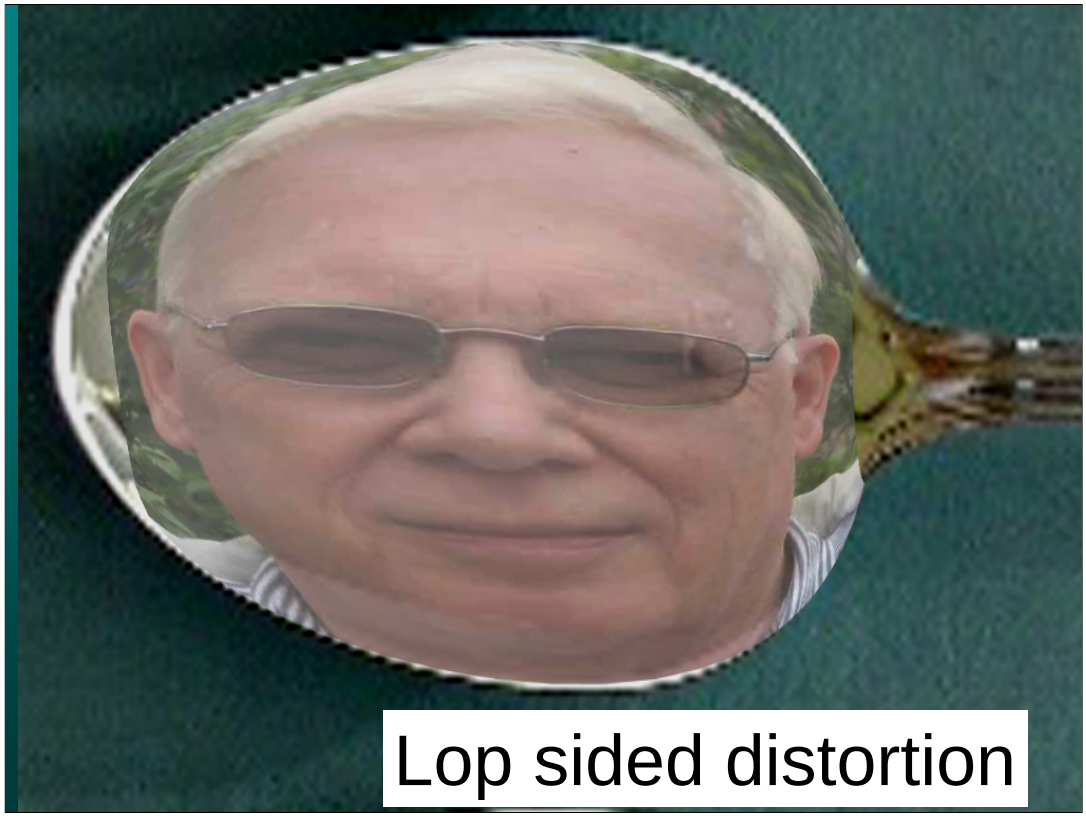
A standard lens can correct an eye that is too big or small overall – but cannot correct unexpected localised variations

Know Your Spoons

The slide shows table spoons on the left and soup spoons on the right.

The soup spoon is symmetrical but the table spoon is not.

If the spoons are new and shiny then you can see your face in their “mirror”.



If I look into a table spoon “mirror” the reflection of my face is distorted.

If the shape of my eyeball is not perfect but has a sag then the mis-shape in the lenses in the eye will distort and defocus the image reaching the retina.

Irregular Astigmatism

- > Cataract Surgery
- > Keratoconus
- > Albinism

Twenty or more years ago cataract surgery produced a lot of unwanted irregular astigmatism .

Irregular astigmatism is also caused by keratoconus and albinism.

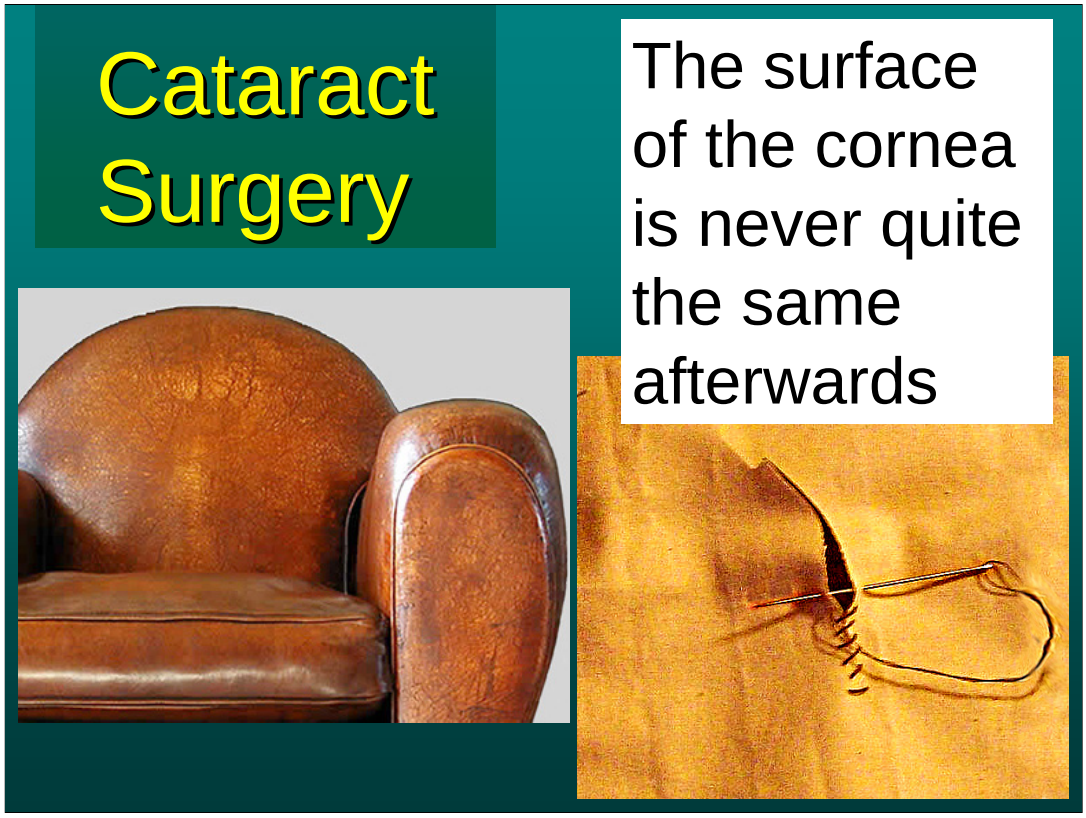
Irregular Astigmatism

- Cataract Surgery
- Keratoconus
- Albinism

Was a common problem

Cataract surgery requires a cut to be made in the side of the eye, The crystalline lens – which has become opaque with age - is replaced with a synthetic one.

In the 1980s the surgery introduced a large degree of irregular astigmatism that usually wore off after some months.. The patient did not complain because his eyesight was much better once the cataract has gone – though his sight may not have been as good as 10 years previously.



The swapping out of the old lens for a new one has been done successfully millions of times.

Nowadays most surgeons make a small 3 mm cut in the corner of the eye in order to swap the lens. Some surgeons, however, prefer to make a cut further away from the iris so that the resulting dimple in the surface of the cornea is further away from the pupil / iris area.

This alternative procedure, however, does cause more bleeding and a longer recovery time.

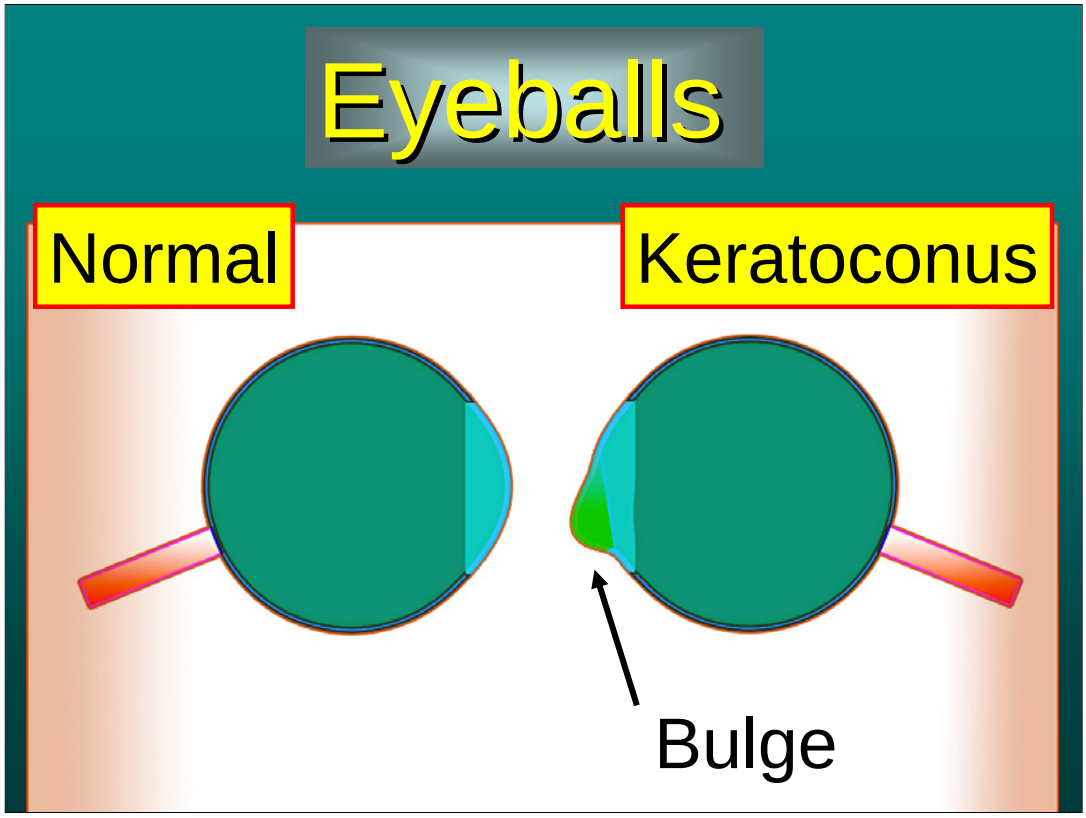
Irregular Astigmatism

- > Cataract Surgery
- > Keratoconus
- > Albinism

Incidence - 1 in 2,000

About 1 in 2,000 people suffer a distortion of the front of the eye termed keratoconus (Cone Eye). This typically can start to occur between teenage and 40 years of age.

It is difficult to treat.



The bulge in the cornea has a big impact on the ability to see clearly.

In the past the treatment has been a special contact lens or a corneal graft (from a donor)

Disclaimer

Much of what I am about to describe might be termed as ‘experimental’ or “early”. I am not endorsing any of these procedures.

If, however, these procedures become necessary for other clinical reasons then it is useful to understand their possible benefits.

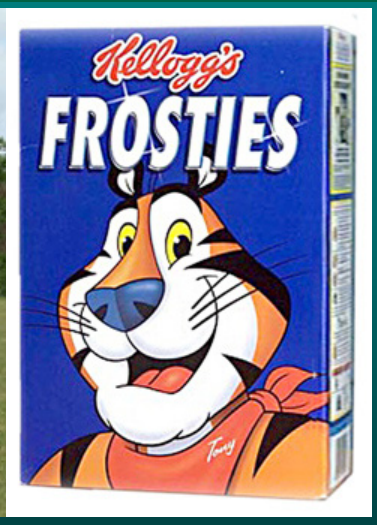
Know your Cheese

Tough Smooth Surface

Keratoconus is being treated in a new way. It is believed that the bulge in the cornea is a result of a structural weakness in the front of the eye.

This technique aims to produce a transparent tough coating on the front of the eye – just like the rind on a cheese.

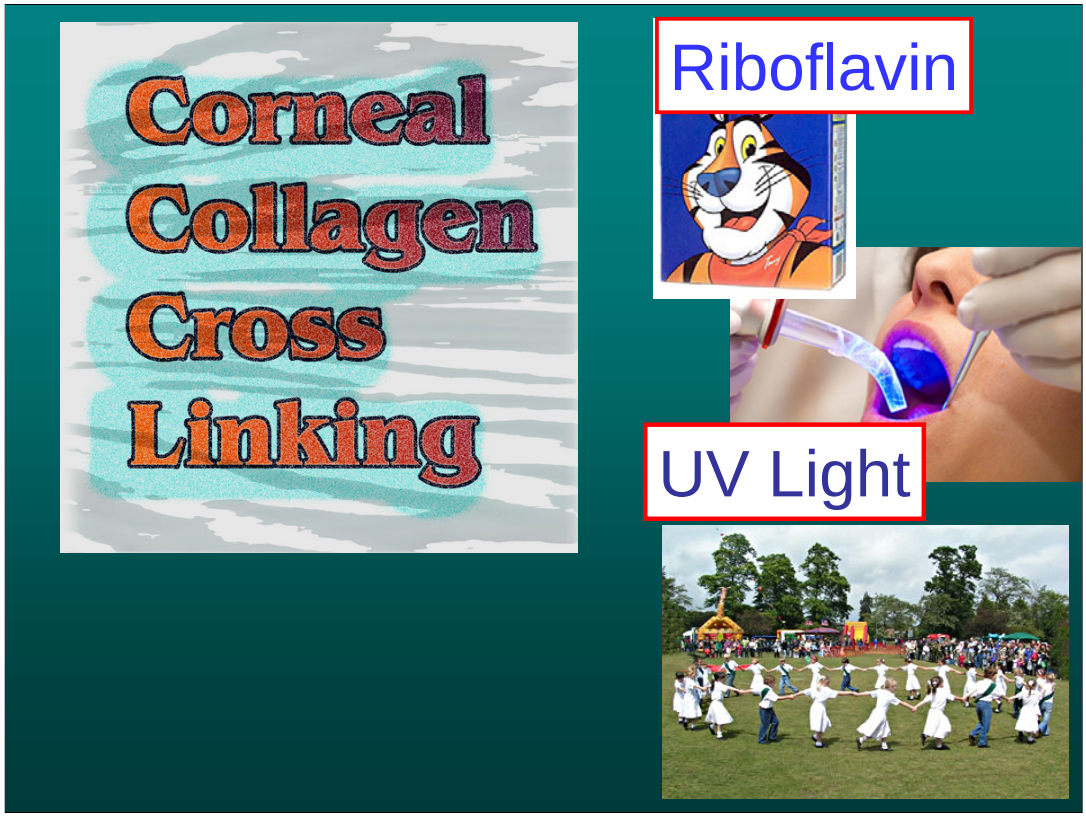
Quiz Time --



What's the connection ?

Quiz Time.

What is the connection between a breakfast cereal and a group of dancers holding hands?



Researchers have discovered that the front surface of the cornea can be strengthened by increasing the number of cross links between the cells of collagen. This can be achieved by painting the eye with Riboflavin – Vitamin B – and fusing it just below the surface of the eye by means of low energy UV light.

Unlike the high energy dental filling procedure - exposure time is 30 rather than 3 minutes .

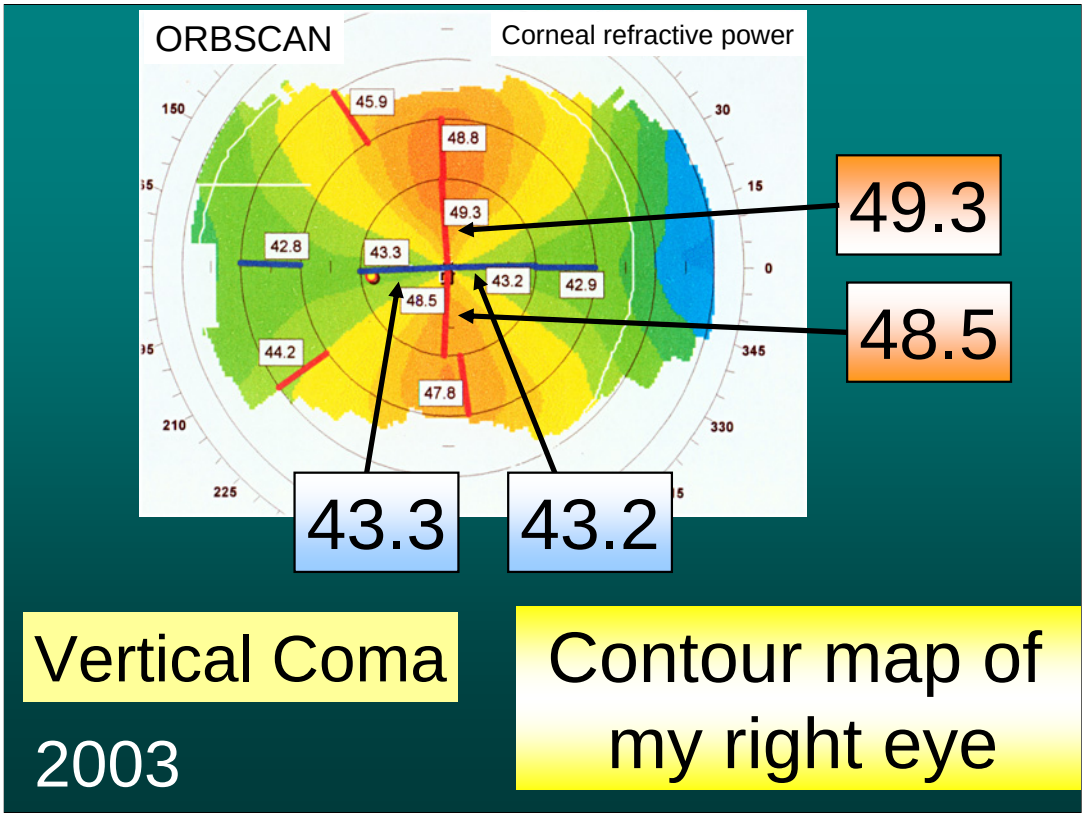
This produces the required collagen cross linking. At present it is not known whether the effect of cross linking will wear off with the passage of time after the procedure.

Irregular Astigmatism

- > Cataract Surgery
- > Keratoconus
- > Albinism

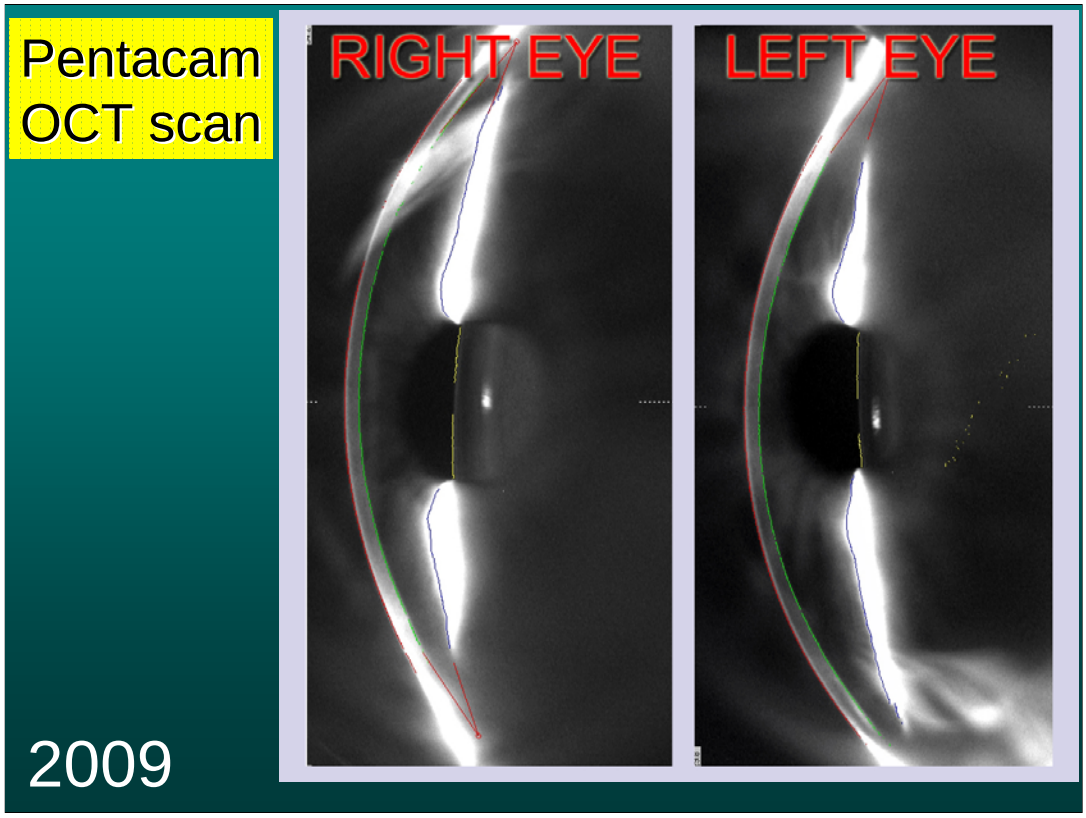
Many albinos have it

If the number of unused pairs of glasses is anything to go by – albinos have irregular as well as regular astigmatism.



This slide shows an Orbscan contour map of my right eye. It shows that the top of my eye has a corneal surface power of 49.3 Dioptres whereas the bottom of my eye has a power of 48.5 Dioptres. They should be the same value.

This shows that I have an irregular astigmatism of 0.8 of a Dioptre – which cannot be fixed with regular glasses but MIGHT be fixed with rigid contact lenses.

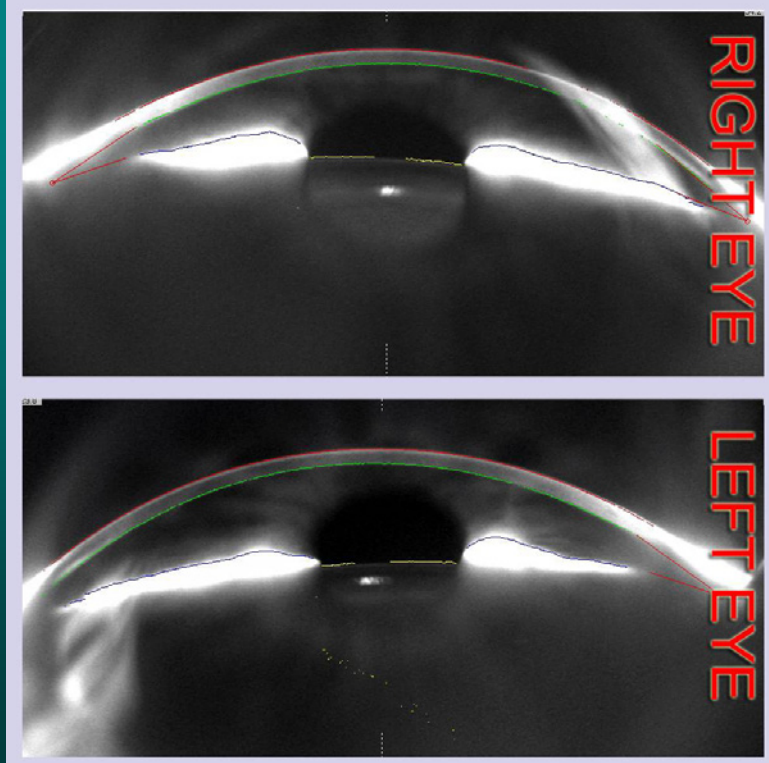


This picture shows the surface contour of my Right and Left corneas. The OCT scanner is similar to the ultrasound B scanner used for ante natal baby care – but is optimised for eyes not abdomens.

You will notice that the contour of my right eye is a little different to the contour of the left eye.

In other words – the right eye has the table spoon effect described earlier whereas the left eye is more symmetrical (soup spoon shaped).

Pentacam OCT scan



This is the same OCT view – but rotated through 90’ to make the table spoon contour easier to see – or not!

Why not -

Changes the Eye Shape

Poke a Finger in your Eye ?

Can reduce irregular astigmatism

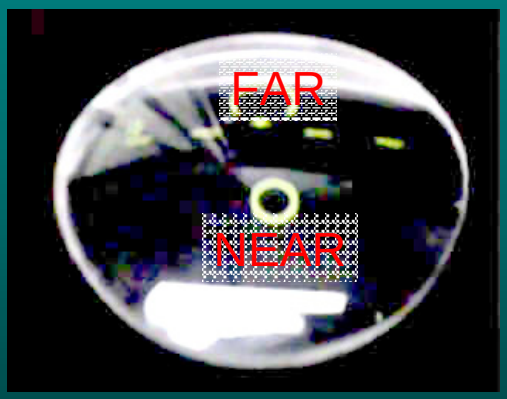
Have you ever pressed your finger against the side of your eye.

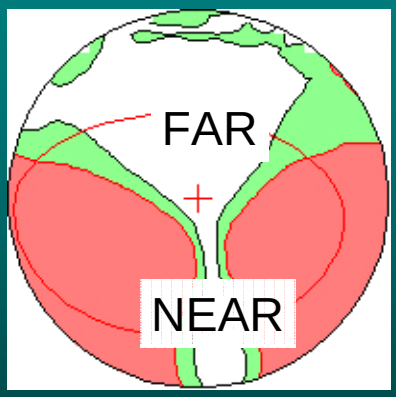
You will notice a rotation and a change in vision.

If you have no irregular astigmatism then ANY press will make your vision worse.

If you do have an irregularity then pressing the eye MAY improve your vision.

Progressive FUN





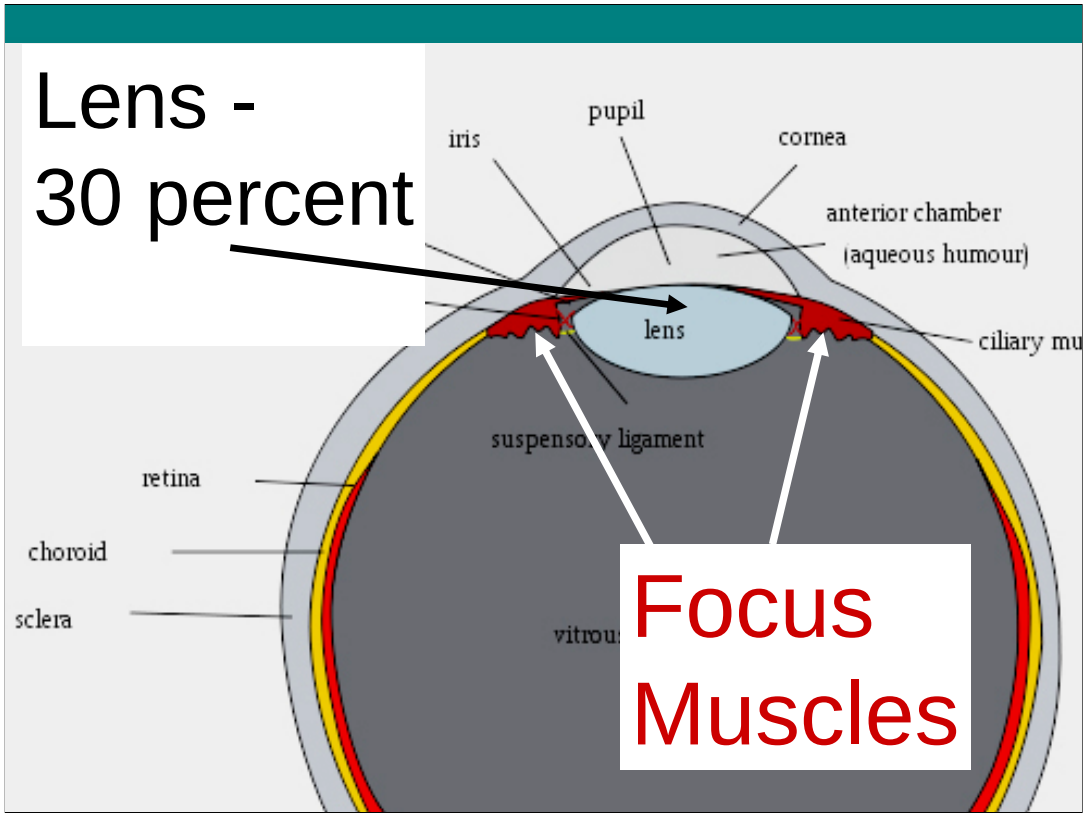
Opthonix glasses

Rigid Contact lenses

Progressive or varifocal lenses have been around for some time. The top of the lens is designed to give good distance vision whereas the bottom of the lens is designed to provide added power for reading.

The white area provides excellent vision (for pigmentos), the green area provides fair vision but the no-go red areas provide poor vision and are to be avoided.

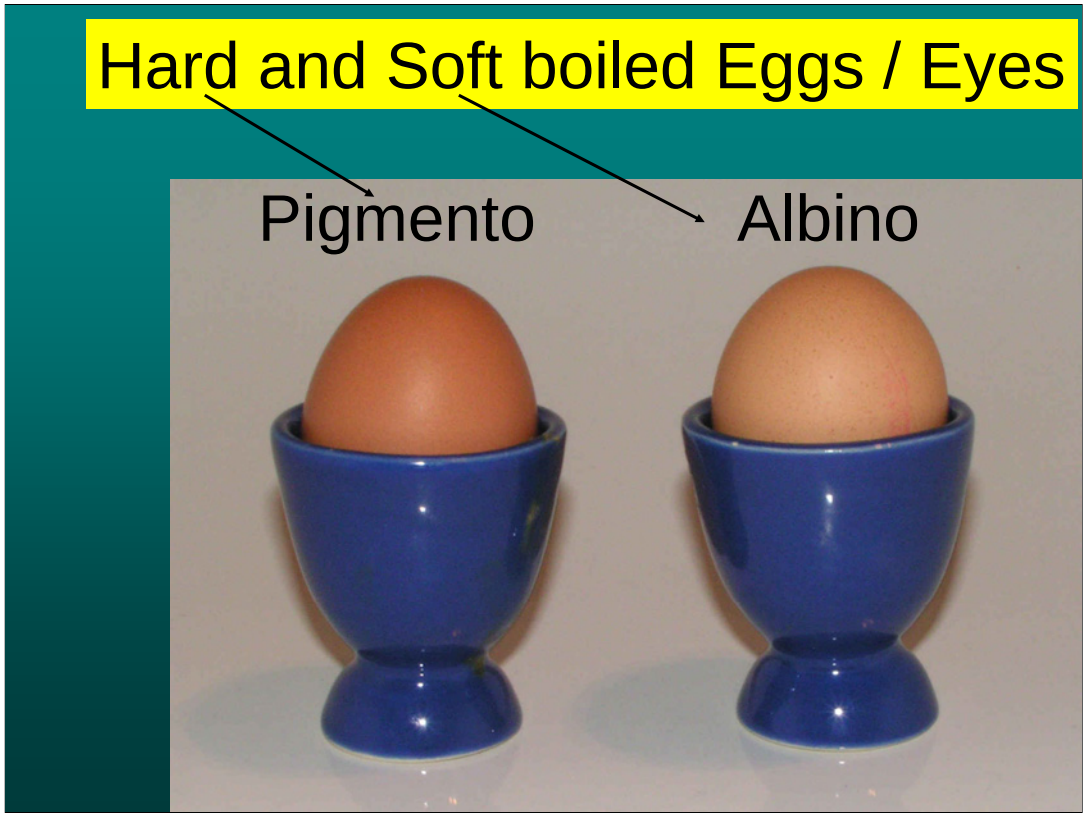
It is the red areas that interest me – because they provide distortion. With trial and error (and a bit of luck) a number of people with albinism have noticed a distinct improvement in their vision when looking through the red no-go areas of a progressive lens.



Whereas the cornea at the front of the eye does two thirds of the focussing, the crystalline lens is responsible for the remaining third.

Focussing muscles change the shape of the crystalline lens in order to allow us to focus from near to far.

One end of the focus muscles is attached to the crystalline lens and the other end is attached to the firm tissue (the ciliary body) just inside the shell (the sclera) of the eye.



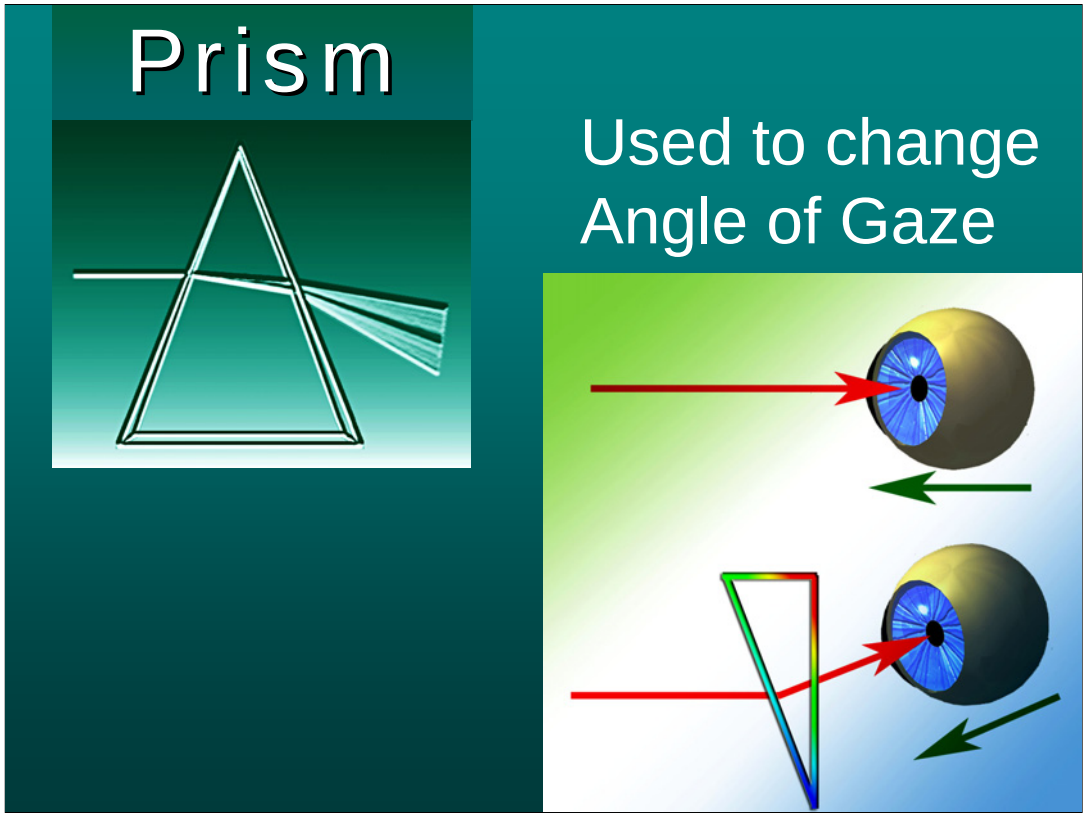
Hypothesis.

What if the cliliary tissue inside the albino eye is softer and less firm than a regular eye – just as a soft boiled egg is softer than the hard boiled one.

Would this explain the major changes in refraction within my eye as I try to focus on different objects.

When some of you were children perhaps you used a magnifying glass to start a fire or burn your friend's arm. Do you remember how difficult it was to get the size of the spot really small. Tilting the lens away from its best position would make the spot change its shape from a dot to a line.

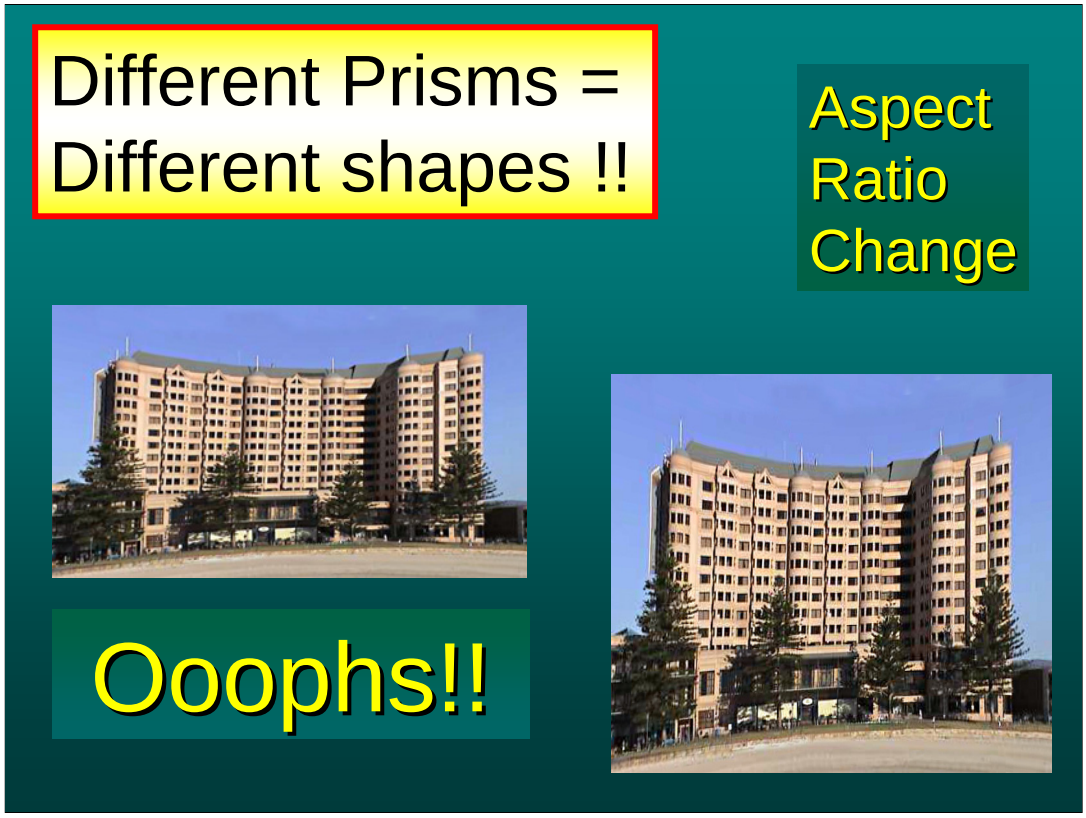
Within the eye it is important that the crystalline lens does not move out of alignment



I have a squint (strabismus) so I tried some experiments with prisms.

A prism bends light.

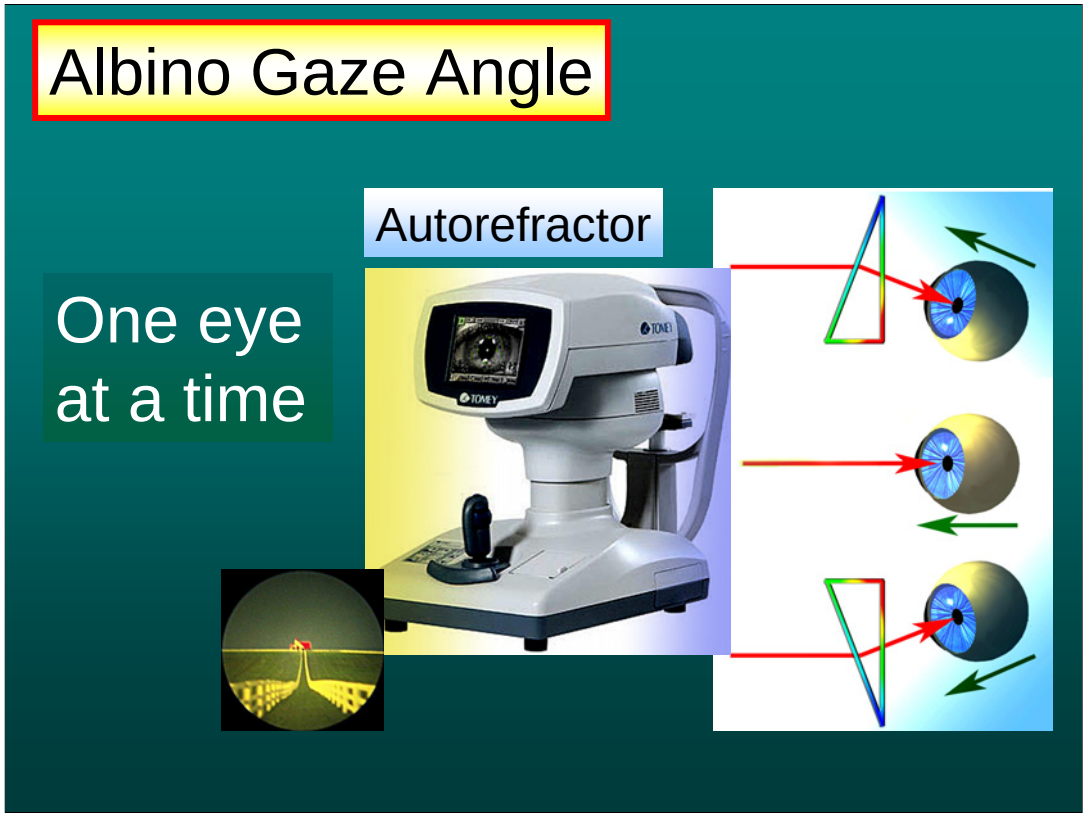
If we hold a prism in front of one of our eyes then the eyeball will rotate in order to correct the bend that was introduced by the prism.



I began to realise that when I looked through some prisms objects became unexpectedly wider or taller.

I took the prisms back to the lens lab to have them checked – they were perfect at bending light – nothing else.

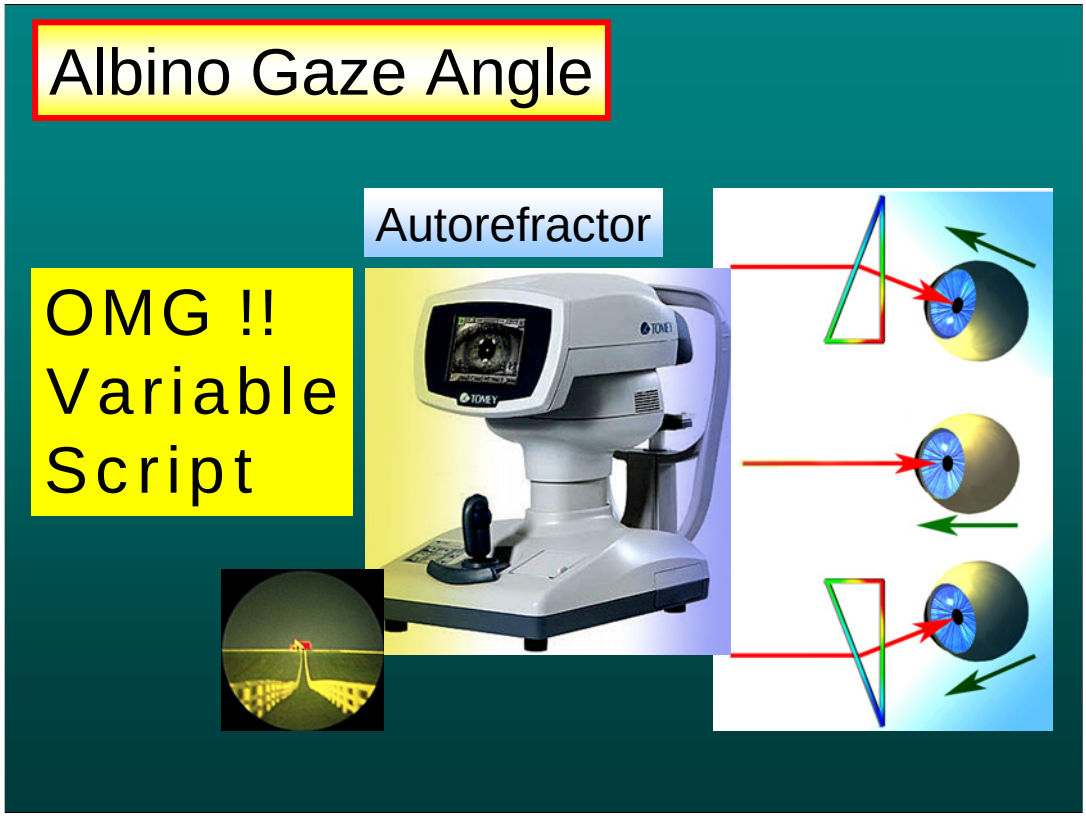
So why was I experiencing a change in the shape and size of things when I looked through the prisms ?



With the help of my local optometry practice I had my eyes tested on a regular autorefractor.

The first test was to look straight into the machine.

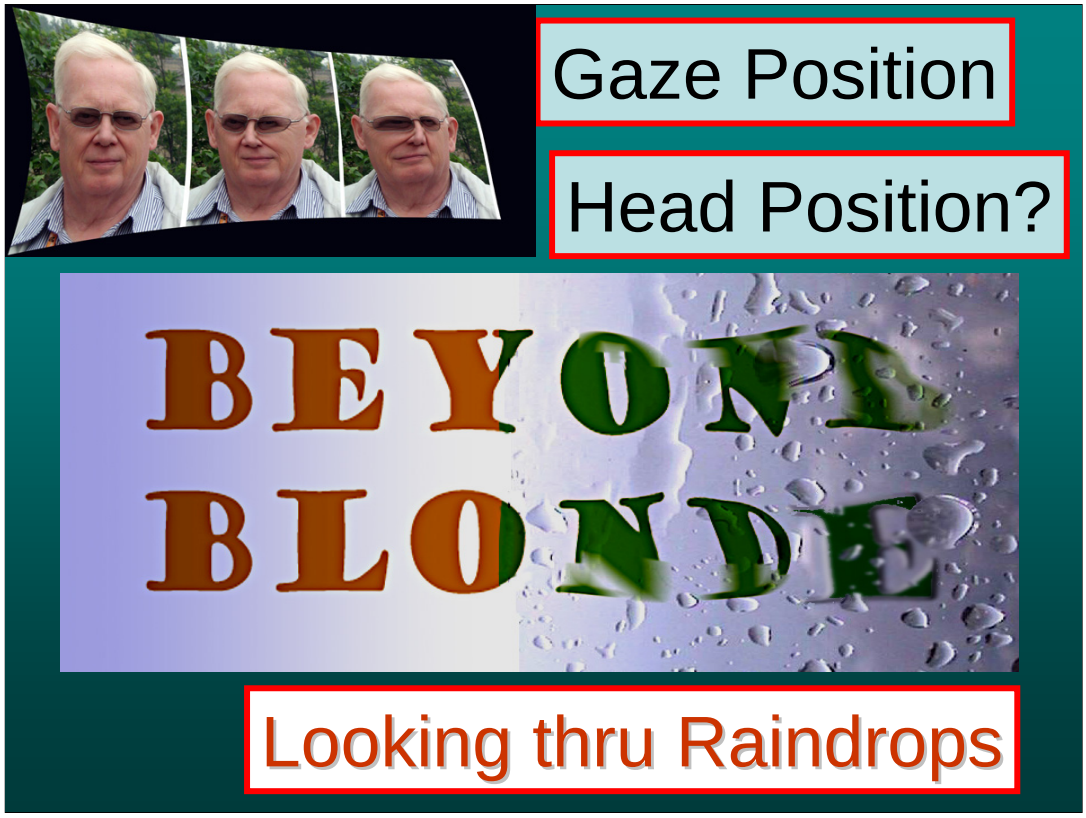
In the subsequent tests I was naughty. I held a prism between my eye and the machine. The machine was kidded into thinking that I was still looking straight – but my eye was, in fact, looking sideways.



I had chosen prisms that I knew made a big difference to the shape of objects.

When I used the prisms the autorefractor said that my astigmatism varied quite a lot. (2 Dioptres)

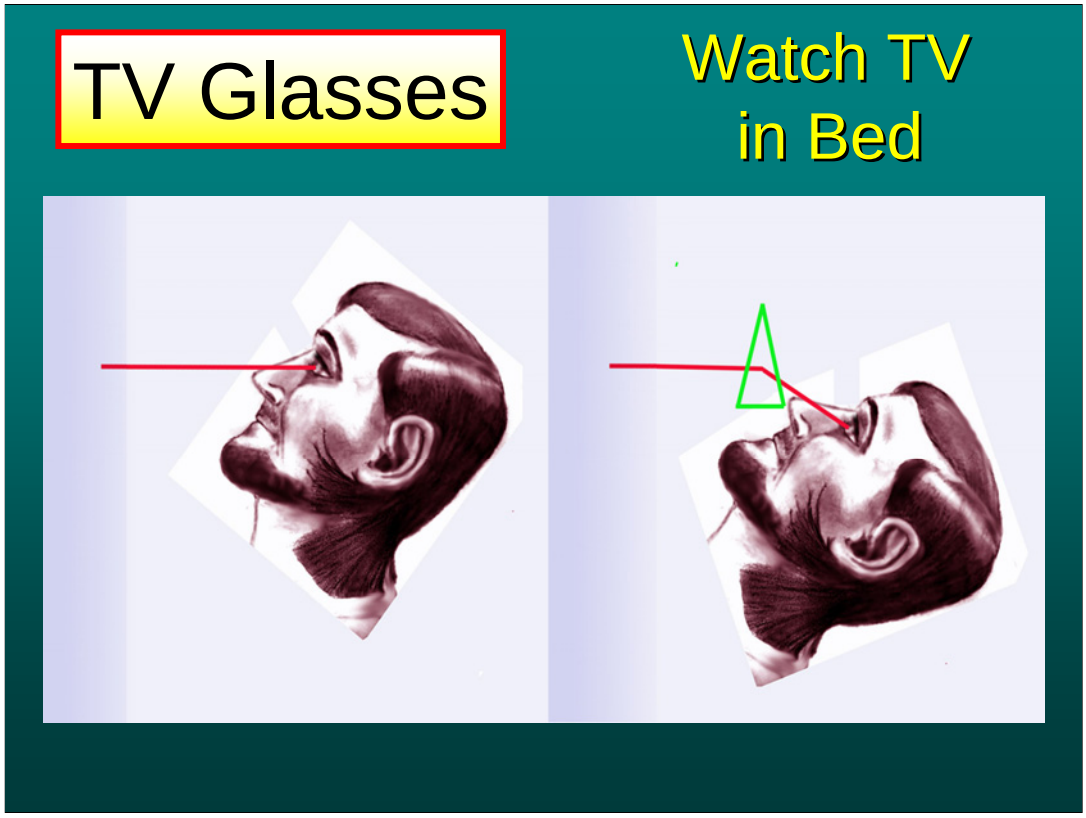
In other words - my script was changing significantly when I looked sideways.



From the way I move my head and eyes it seemed that I was trying to look through a pane of glass with raindrops on it.

A slight change of gaze angle seemed to make a big difference to my vision.

I knew that a change in gaze angle altered my script – would a change in head angle do the same?

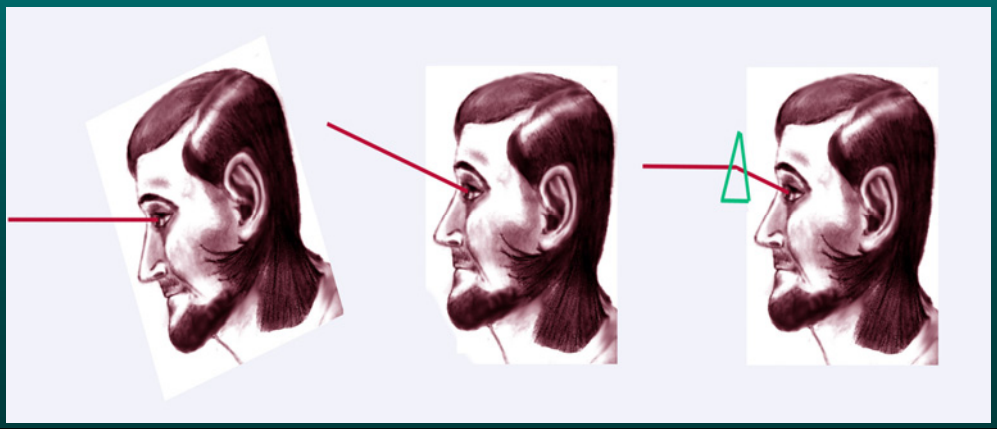


In some parts of the world you can buy prism glasses that allow you to watch TV in bed without straining your neck.

The prism bends the image from the TV set so that you need only one pillow rather than three.

Would these glasses work OK on an albino eye ?

Same Gaze – different Head Position - 1



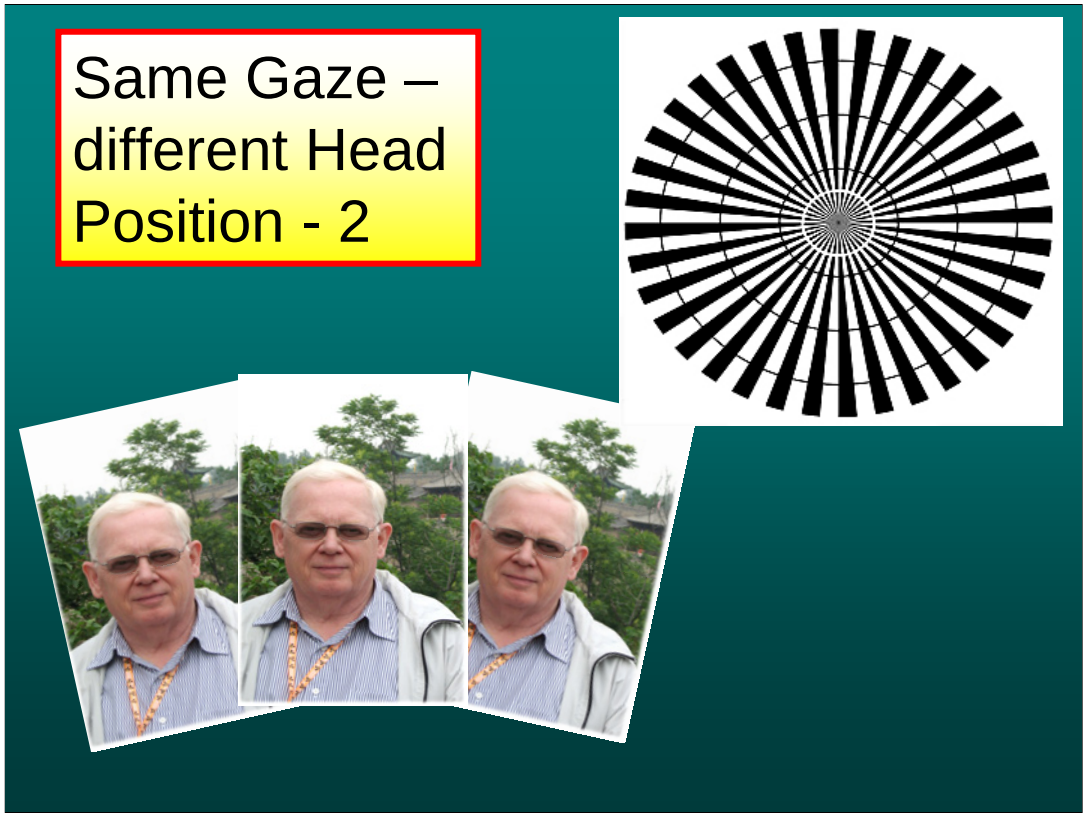
The classic albino null position is head down – gaze up. Can we fix that ?

What happens if we raise our head and then use our TV glasses to straighten the gaze?.

Will the vision be the same as at null point?

For Pigmentos – Yes

For Albinos - Maybe not



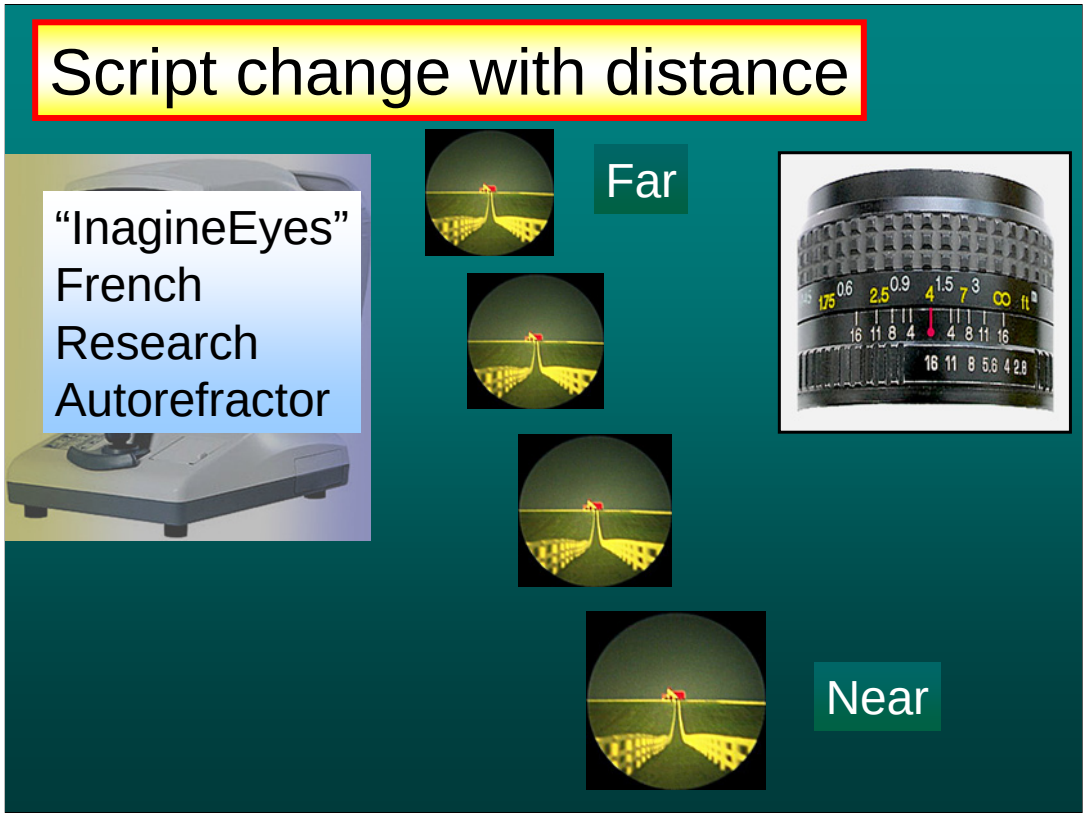
My script changed if I moved my head up and down.

Would my script change if I tipped my head from side to side?

I used the star chart because it is symmetrical.

I did indeed notice that my script changed as I rotated my head.

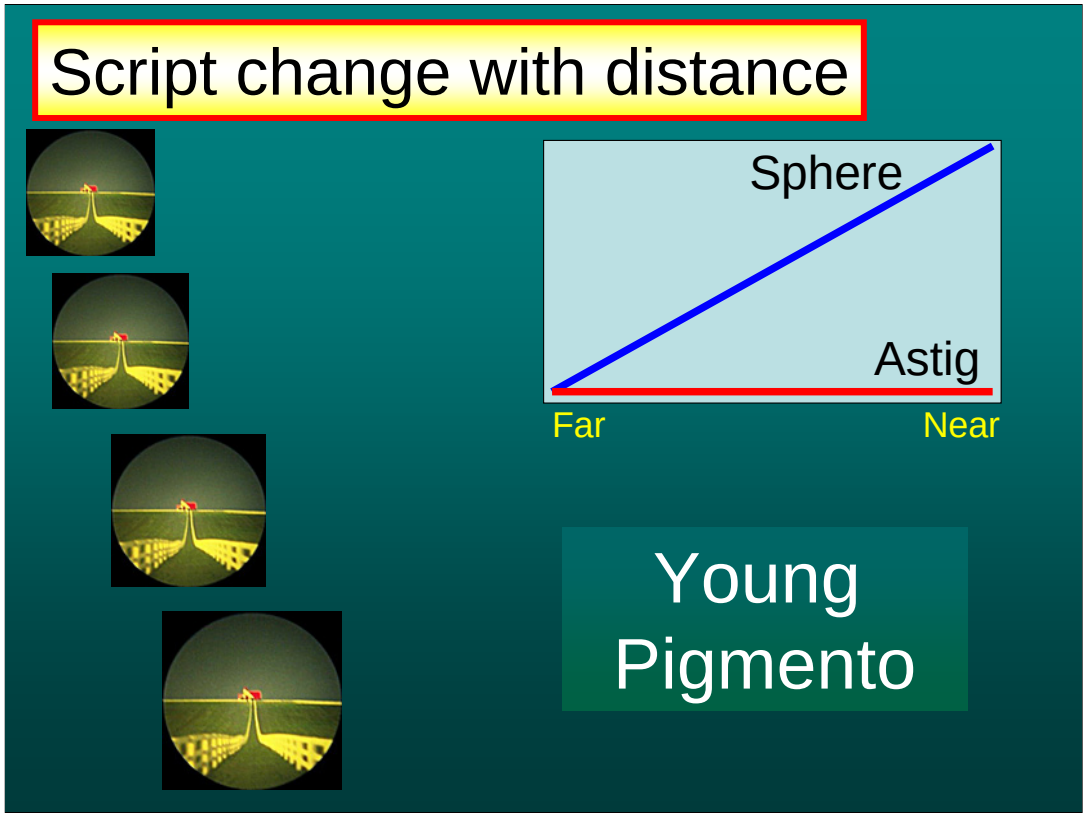
Would my scrip change unexpectedly if I focussed on objects at different distances?



Distance eyesight is usually tested at a distance of 20 feet. (6 metres) Regular autorefractors are set up to test at that distance.

The French Imagineyes refractor is different. It allows eyesight to be tested at various distances – from a few inches to beyond 20 feet. (15 cms to infinity)

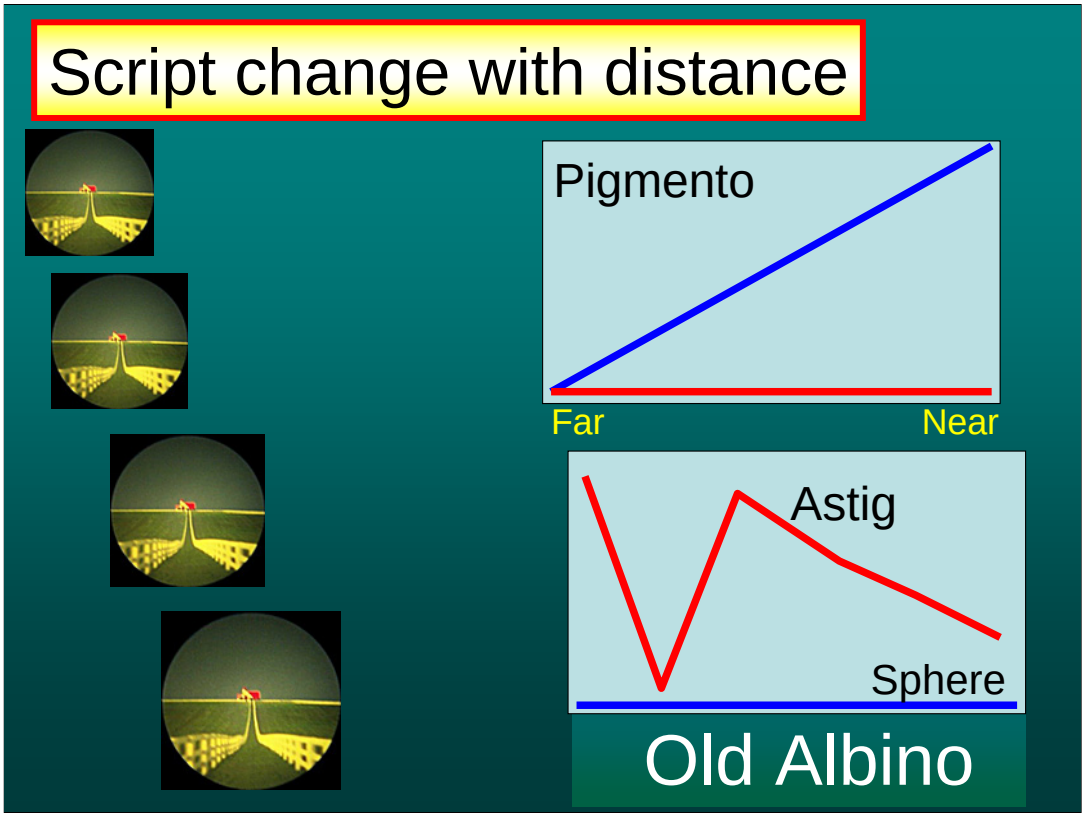
In order to accommodate these distance changes the regular eye will change the power of the crystalline lens – just like a camera lens focus adjustment.



As the image is brought forward from 20 feet to maybe 6 inches away the crystalline lens gently increases in power. (6 metres to 15 cms)

This is shown in the blue ‘Sphere’ line on the graph of a young pigmento eye.

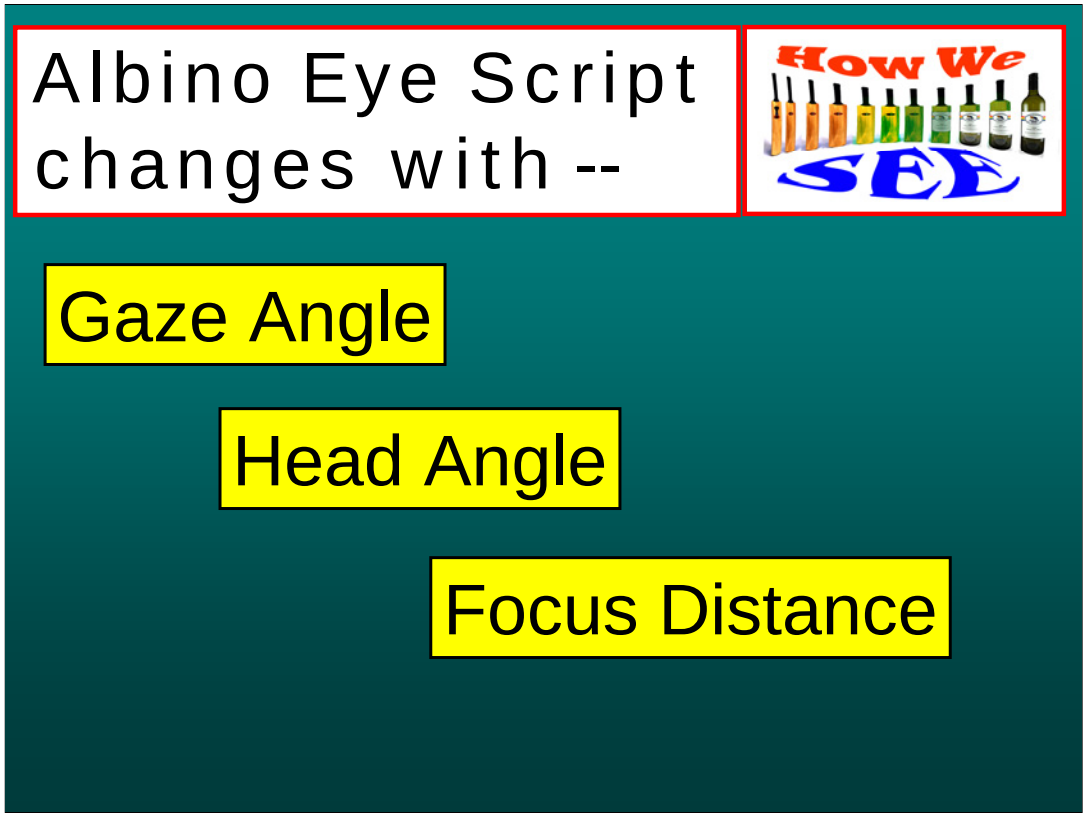
Any Astigmatism that might also be present in the eye (red line) remains the same – it does not change in value.



When I took the test my ‘sphere’ reading did not change. This was fully expected since I am well past the age that I need reading glasses.

What was far more interesting was that my crystalline lens astigmatism (red line) went wild.

When the test was repeated a few more times the astigmatism changed over the same 1 Dioptre range – but in a different fashion.

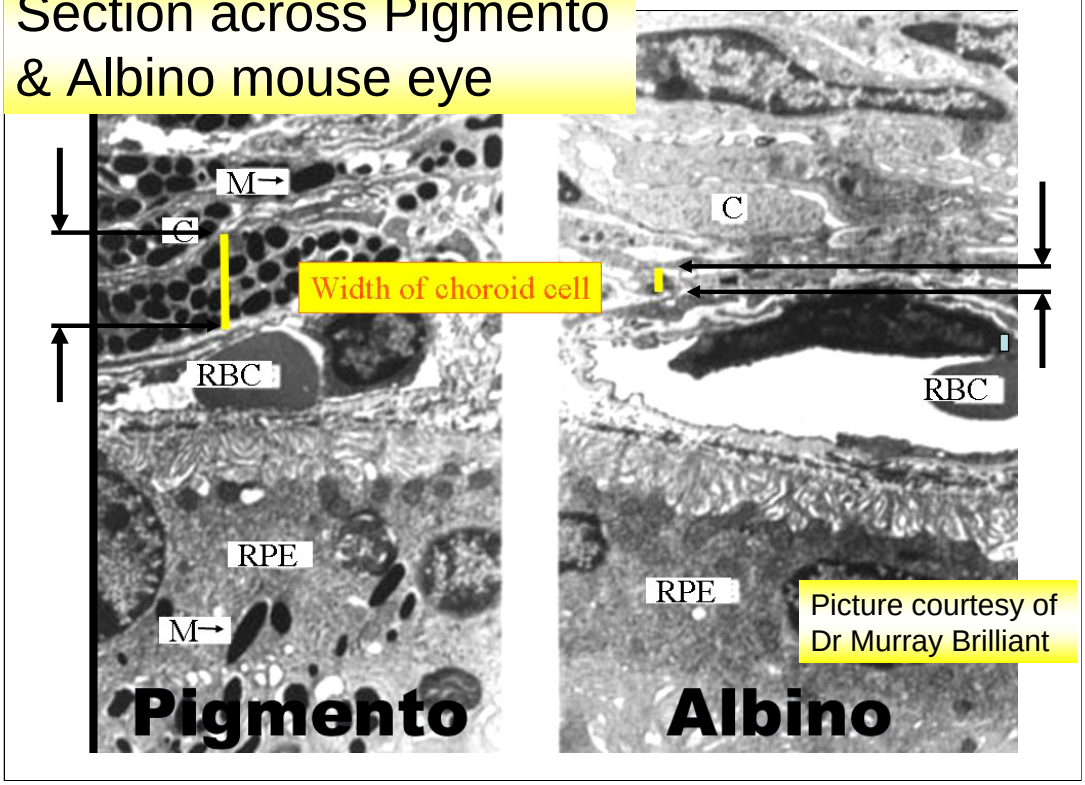


I have shown that my astigmatism script changes with

Gaze angle, Head angle and Distance

The significant changes in astigmatism can only be caused by a change in the orientation or shape of the crystalline lens. Perhaps the internal support structure (ciliary body) surrounding the crystalline lens is warping when the focus muscles start to pull. Dr Murray Brilliant (next slide) may offer an explanation.

Section across Pigmento & Albino mouse eye



Dr Brilliant's electromicrograph shows a section of the choroid through a pigmento and albino mouse eye.

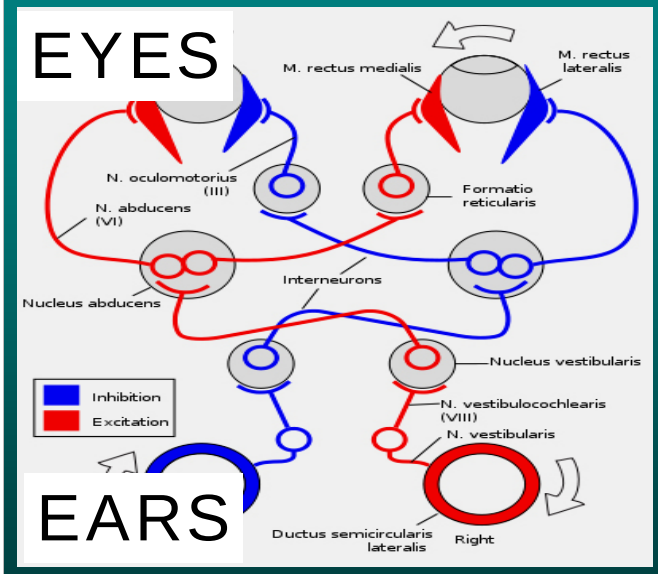
The pigmento eye shows rows of "bricks" of melanin that might stiffen the structure.

There are no melanin cells in the albino eye and the structure is only a third of the size.

Perhaps this weaker structure distorts under the action of the ciliary focussing muscles.

Alternatively: the structure around the albino crystalline lens may still be strong enough – but the focus muscles are receiving wrong nerve signals from the brain – a congenital wiring error.

Vestibular Ocular Reflex V.O.R.



Dynamic - Head Turn

Static – Head position

Simplified diagram !

The Vestibular Ocular reflex (VOR) is a clever control system in our brain that uses the semicircular canal balance mechanism in our ears to keep our eyes pointing in the right direction as our head and our body moves. It is a sort of auto pilot for the eyes.

It allows us to track moving objects with ease.

It can easily go wrong if the control signals are disturbed. The eye no longer tracks smoothly but develops a tremor – a nystagmus.

Trimmed for level flight

The VOR tells the eyes where to point in order to track objects dynamically. It also advises the head muscles on how to maintain static posture – level gaze – with eyes steady, pointing forward – and with no head tilt or rotation.

In other words the VOR provides the “trim” for our head’s regular level flight.

If the VOR receives corrupted signals then the three parameters of minimum eye tremor, head position and eye gaze may no longer provide “level flight”. The combination might instead produce a head down -gaze up posture that is primarily intended to minimise nystagmus – hence the off centre null point.

How to Fix it -- Perhaps

>> Cut the nerves

Swap out the lens

In effect the eye muscles themselves are fine – the problem is that they are receiving incorrect instructions from the nerves – which, in turn, get their instructions from the VOR software in the brain.

Some researchers have used Gabapentin)a relatively mild anti epilepsy drug) to sooth the nerves and reduce nystagmus.

Other researchers have surgically cut nerves in an attempt to alter the performance of the VOR feedback mechanism.

Prof Lou Dell'Osso thought that the external eye muscles were responding to unwanted extra "whisper" signals that caused nystagmus. His surgeon, Richard Hertle, disconnected more muscles than is usual for strabismus surgery and reconnected them in the same place. The nystagmus was often reduced - presumably because the nerves that were embedded in the muscle remained disconnected after the muscles were re-attached.

This research was first carried out on Briand dogs who often suffer congenital nystagmus.

How to Fix it -- Perhaps

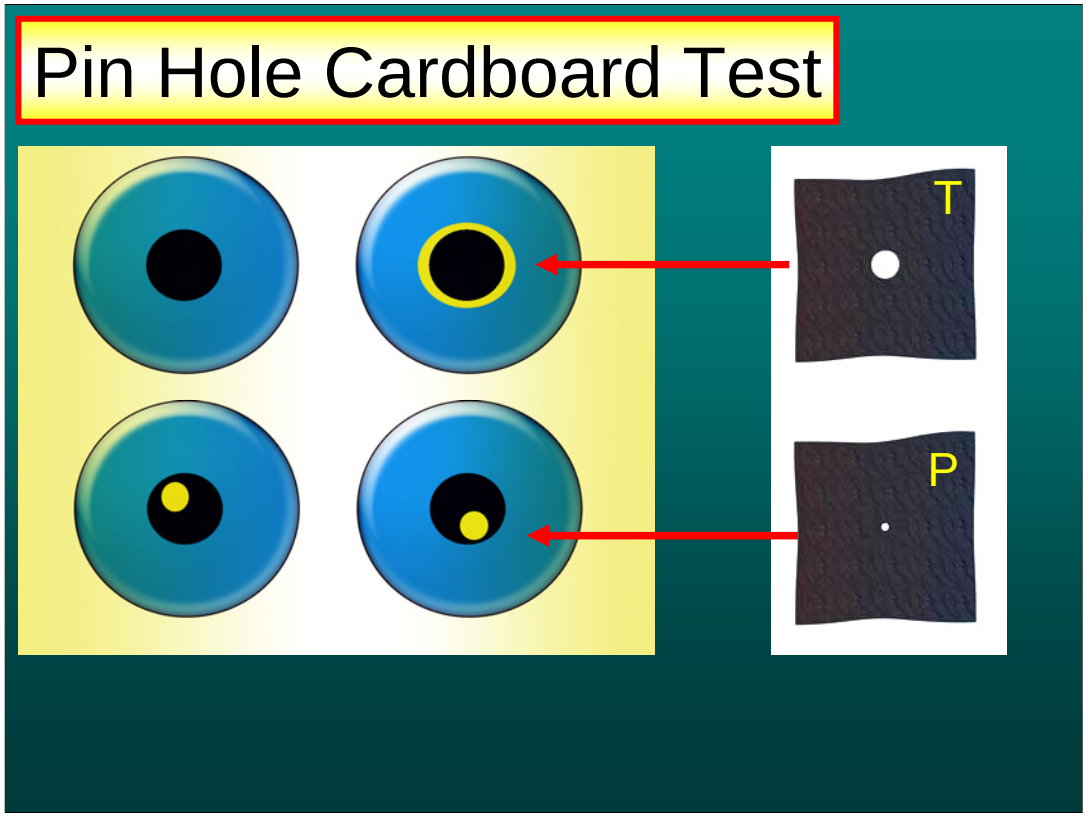
Cut the nerves

>> Swap out the lens

An alternative way to fix the focus problem is to take away the troublesome crystalline lens and replace it with a fixed focus plastic one. This swap-out is done every day in cataract surgery. Millions of operations have been performed and the risks are low.

Even though I had no cataract (or did I ??) should I consider the surgery.

Swapping out the mis-performing natural lens for a plastic one should fix my variable astigmatism issue. But it was a big step to take.



Did I have a cataract ? No Eye Doc had ever detected one in my eye – but was it just not showing up on their instruments ? I tried a variation of the pinhole test

My earlier black cardboard test (T) used a quarter inch (6 mm) hole. The pin hole test (P) uses a hole about a tenth of an inch in diameter.(<1 mm) I looked through the pinhole set to the top, bottom and sides of my pupil. I noticed that my vision changed markedly as I moved the pinhole around.

This response was wrong – moving the pinhole in any direction away from the centre should have the same distorting effect – but moving my pinhole up or down had a completely different effect.

I suspected a cataract.

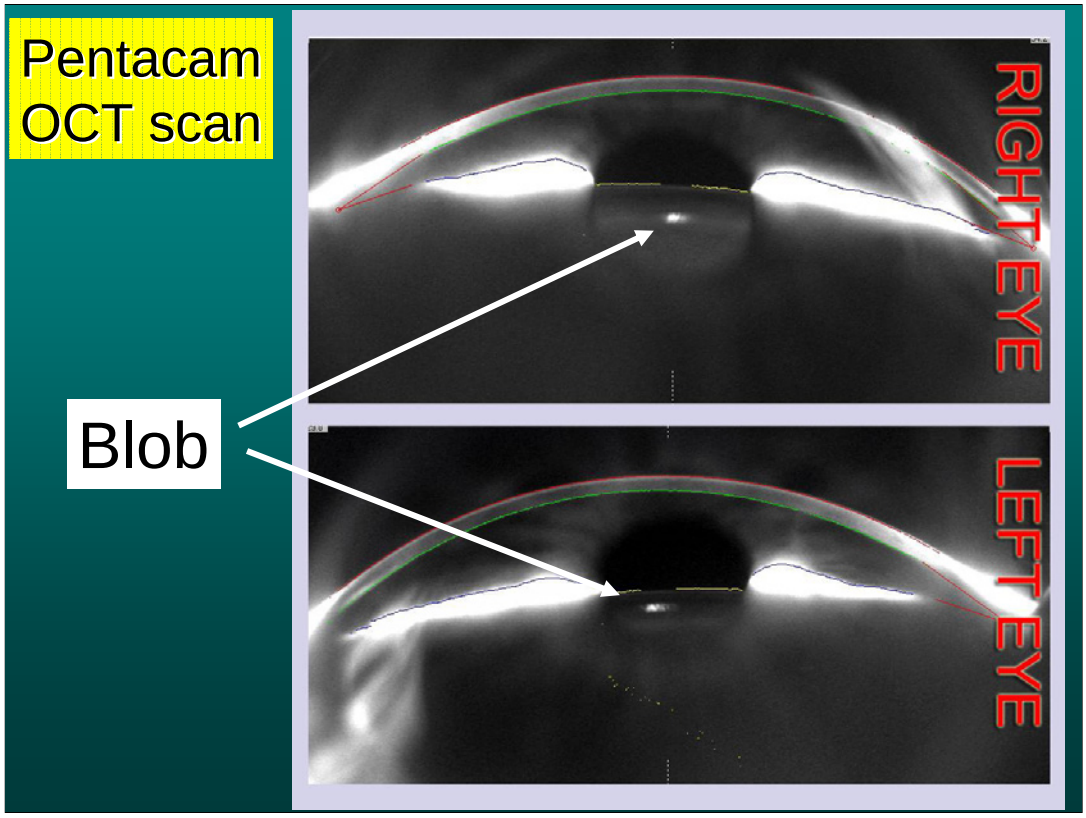
Mini Cataract

Does
One
Blob
Matter ?

I guessed I had a mini cataract which was distorting my vision – in the same way that a blob on the windshield can disturb a driver's vision.

A blob at the side of the windshield can pass unnoticed but a blob on the centre line can have an effect quite out of proportion to the size of the blob.

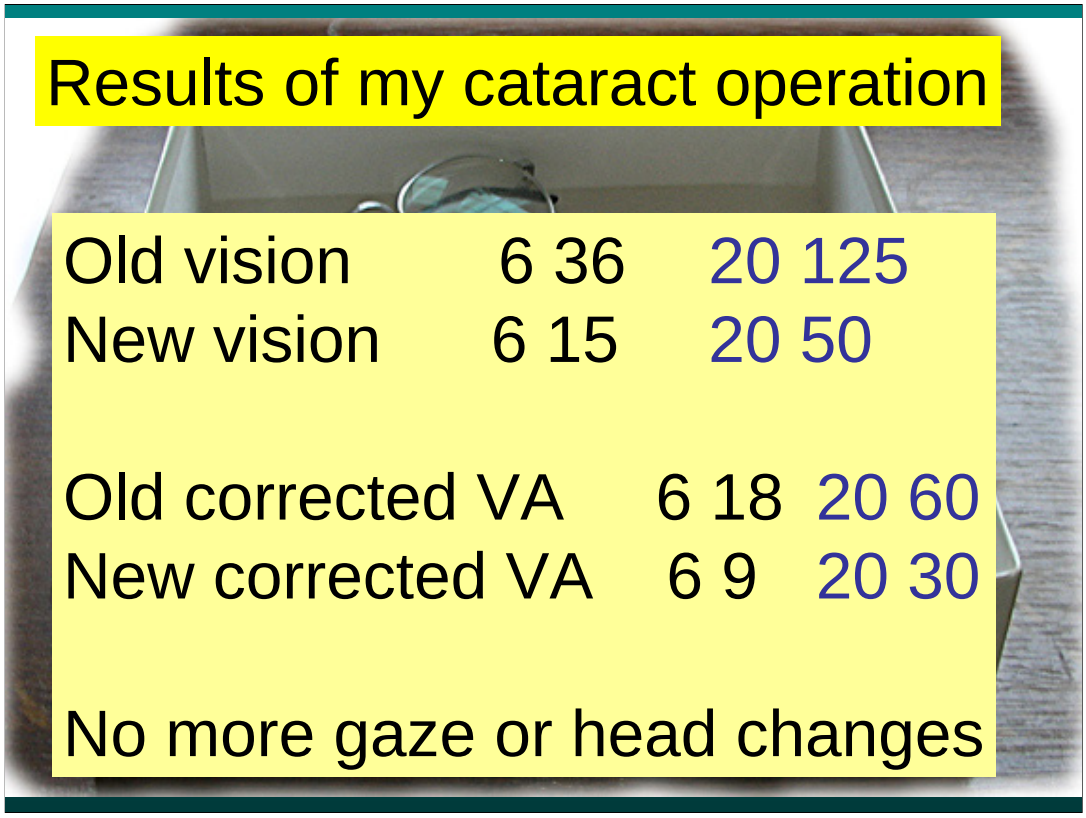
Did I have a central blob ?



In April 2009 I visited an Optics fair and was able to try a new Pentacam OCT scanner.

Not only did the scan show the asymmetry in the front surface of my eye – it also showed a blob in my crystalline lens. Perhaps the scanned blob was an unwanted artefact of the machine – but, for me, it was sufficient proof that my eyes had mini cataracts that were distorting my vision – the raindrops on the window effect.

In late August/ early September 2009 I elected to have cataract surgery on both eyes – spaced 10 days apart.

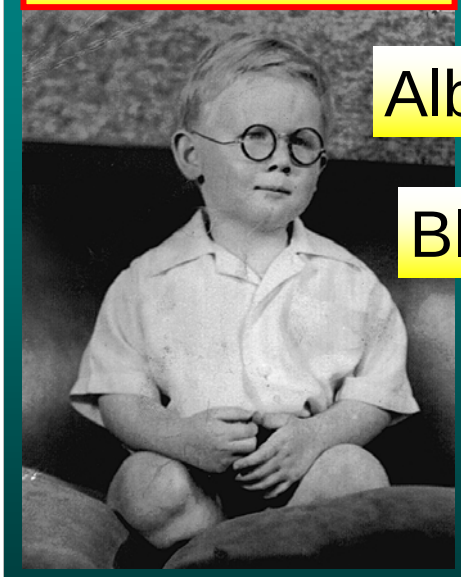


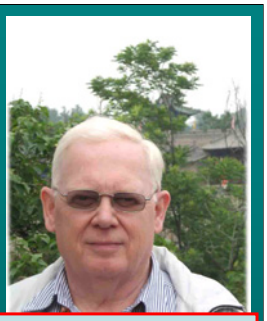
I asked the surgeon to aim for a two thirds correction of my astigmatism and he was able to achieve this goal. My astigmatism was reduced from 7 Dioptres to 2.5 Dioptres.

The principal gain from the surgery was that the raindrop effect was eliminated. No longer were there significant changes in my script as I moved my head up and down or from side to side.

The downside is that I now need to wear varifocal lenses in my glasses.

Full Circle





Albino ? Yes

Blind by 5 ? No Way !

And now for that Beer !

drbrianevans@aol.com