

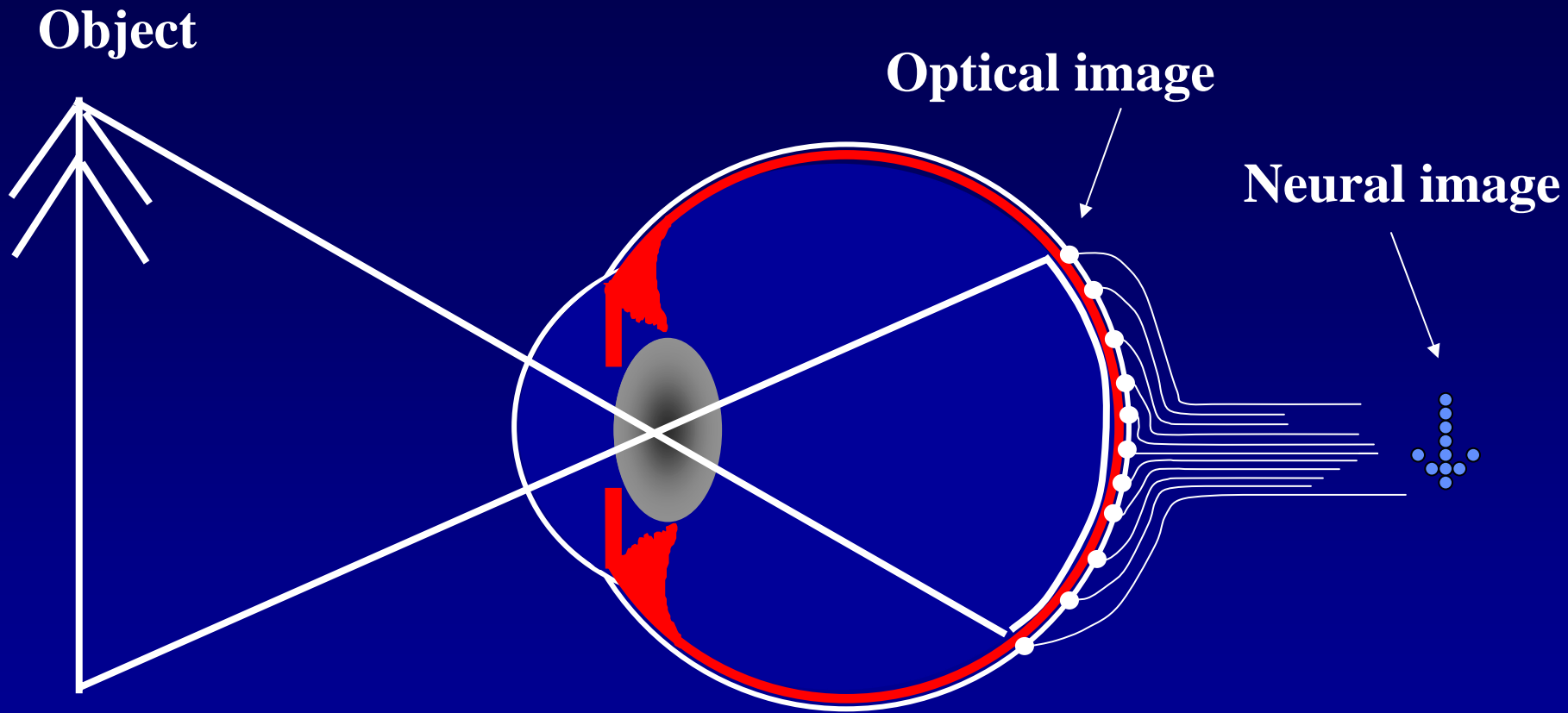
Separating neural and optical losses of vision with age



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Vision Science
University of Ulster at Coleraine

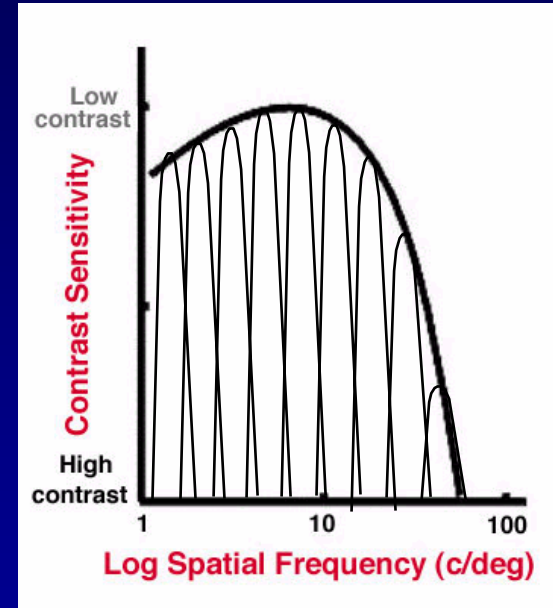
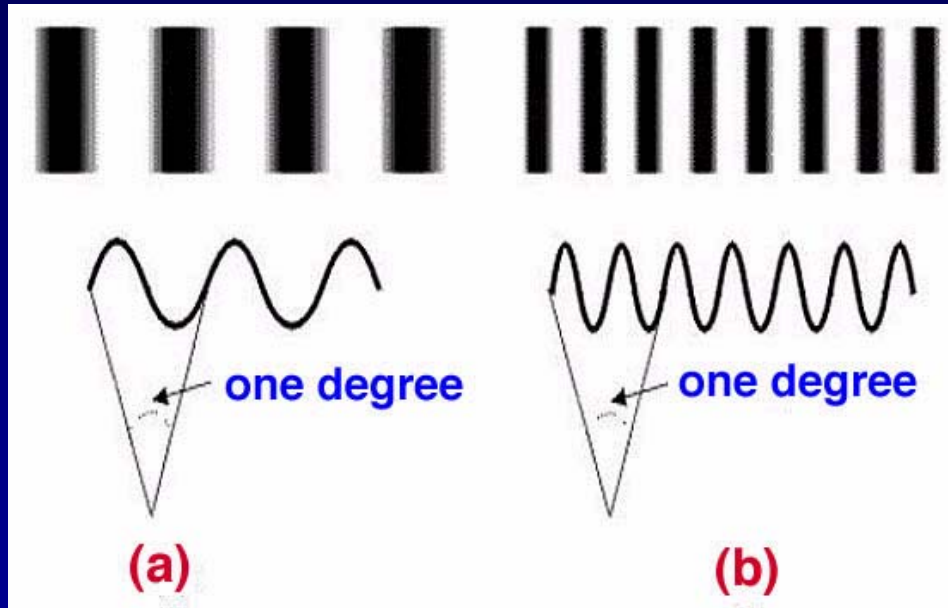


Stages of Visual Processing



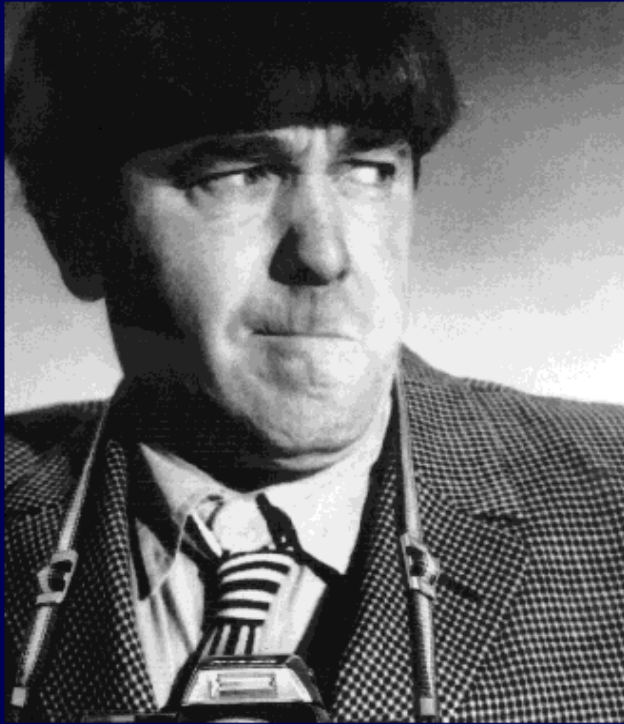
Spherical aberration, Oblique astigmatism,
Distortion, Coma, Diffraction, Chromatic aberration*

Building blocks of vision: the sinusoid

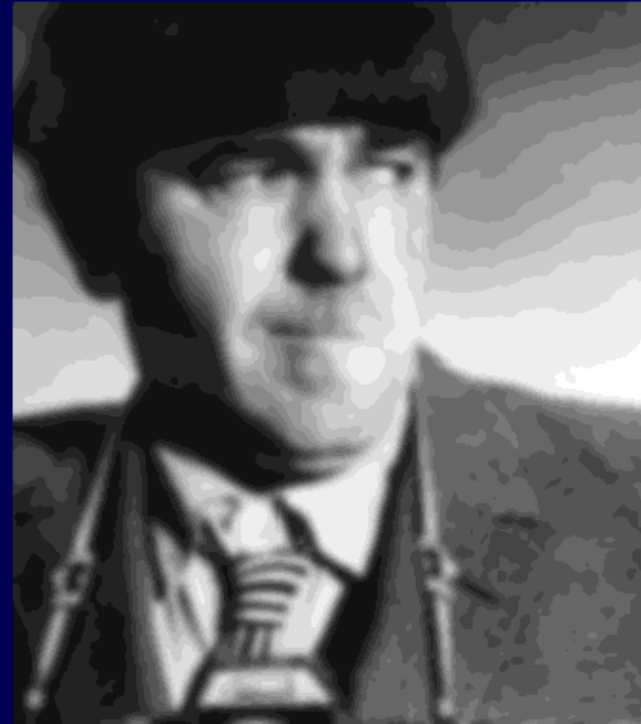


Filtering Limit to Visual Resolution

Original

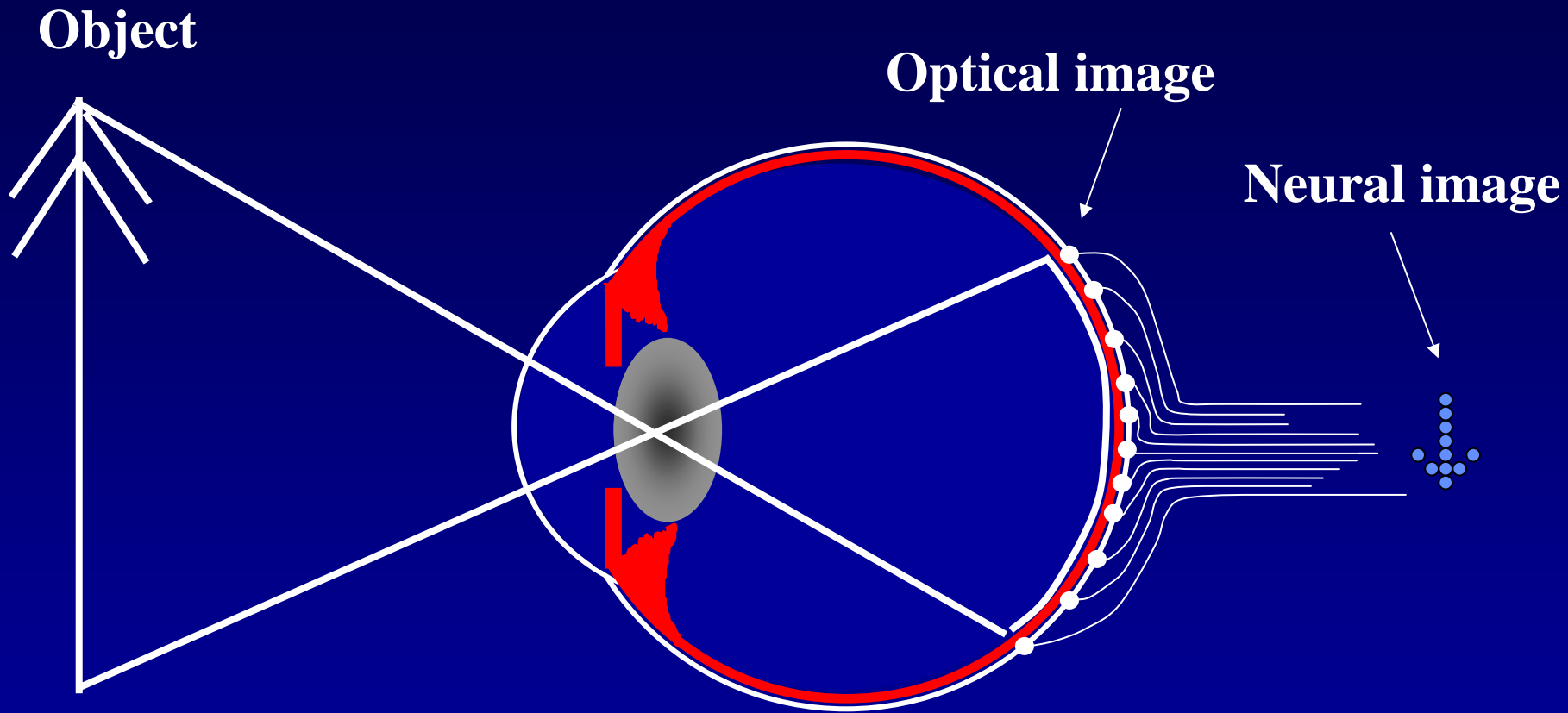


Low-pass Filtered



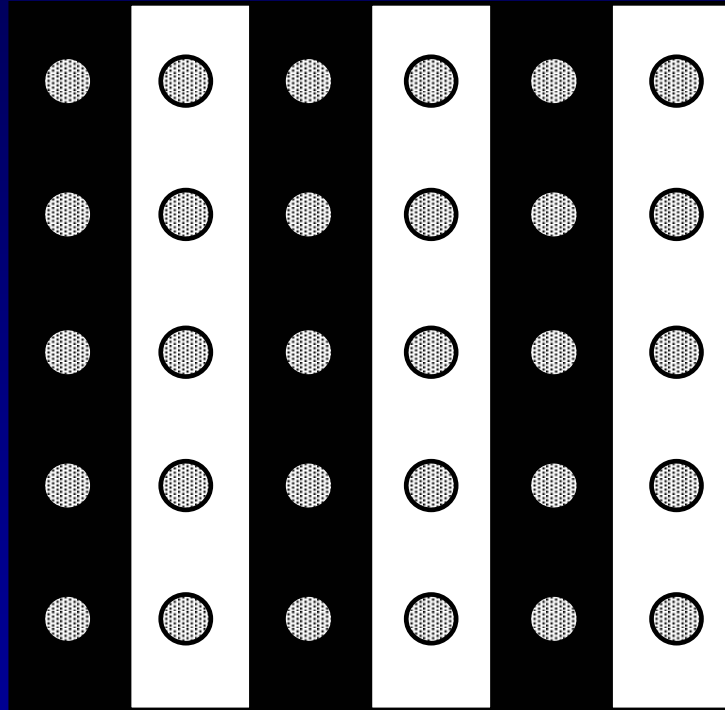
Foveal resolution is limited by the optics of the eye in that spatial frequencies higher than the resolution limit of the retina do not pass through.

Stages of Visual Processing



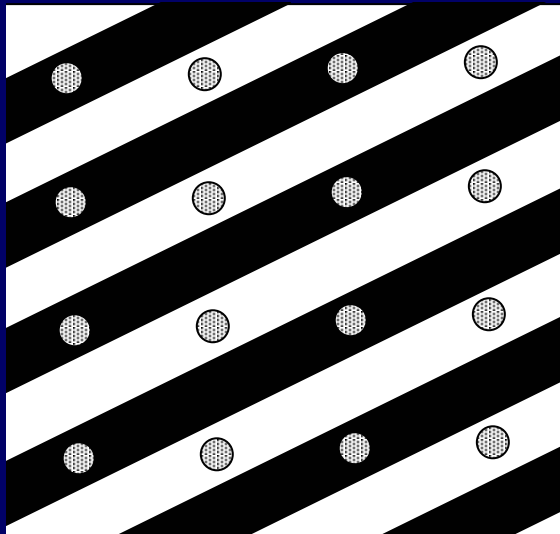
Spherical aberration, Oblique astigmatism,
Distortion, Coma, Diffraction, Chromatic aberration*

(Shannon's Sampling Theorem)

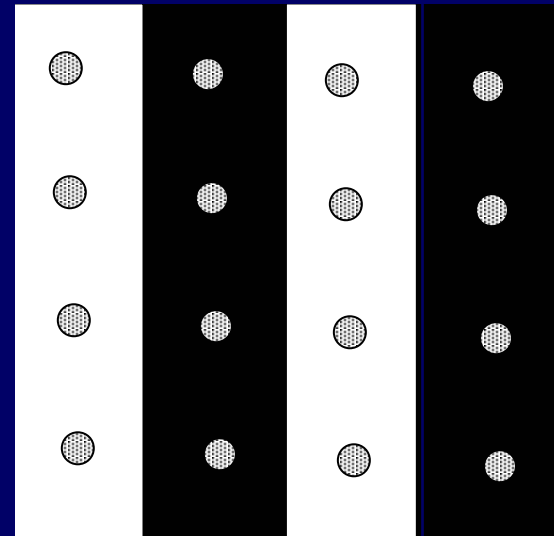


MAR = spacing = $1/\sqrt{\text{density}}$

Aliasing due to under-sampling



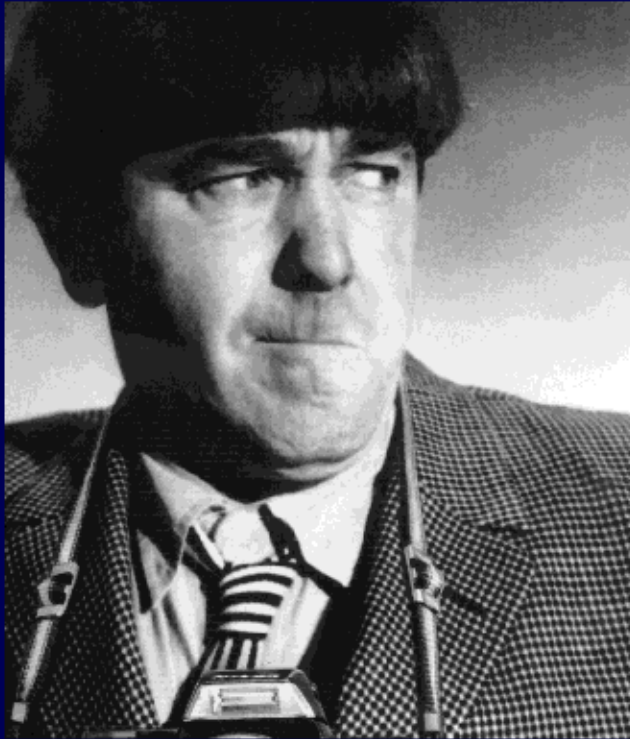
A



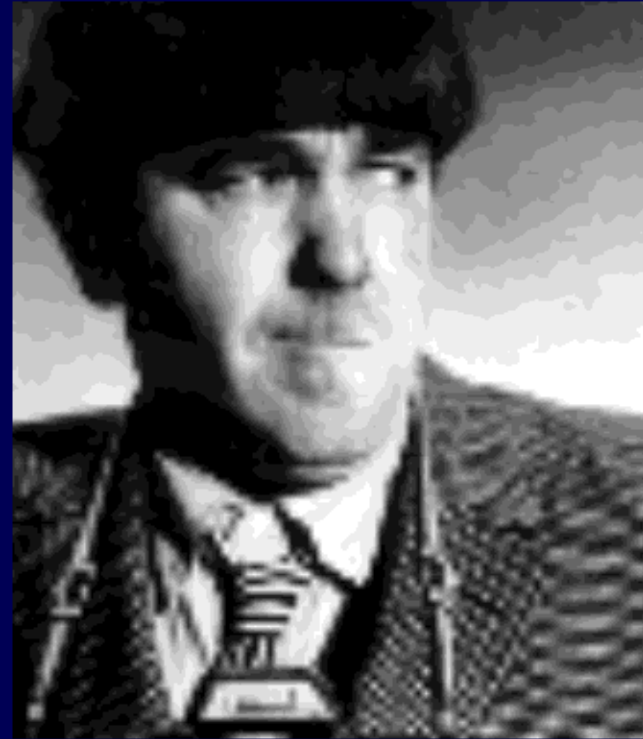
B

Sampling Limit to Visual Resolution

Original



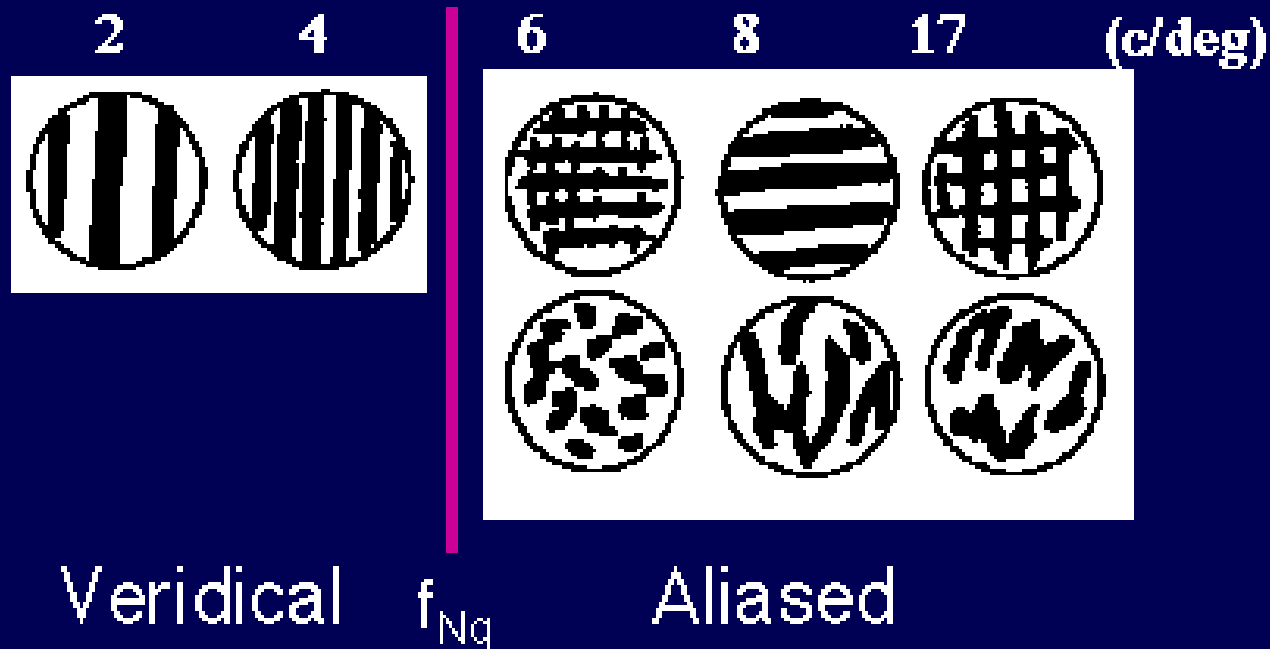
Undersampled



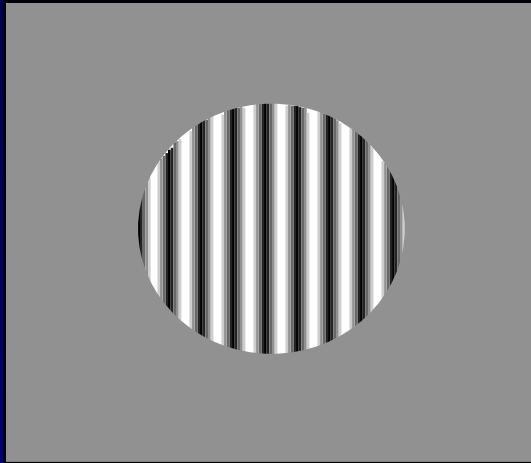
Peripheral resolution is limited by the retinal sampling density, in particular the ganglion cells.
specifically $MAR = \text{spacing} = 1/\text{rt.density}$

Perceptual Aliasing in Peripheral Vision

Appearance of vertically oriented gratings located 30° eccentric in the peripheral field.



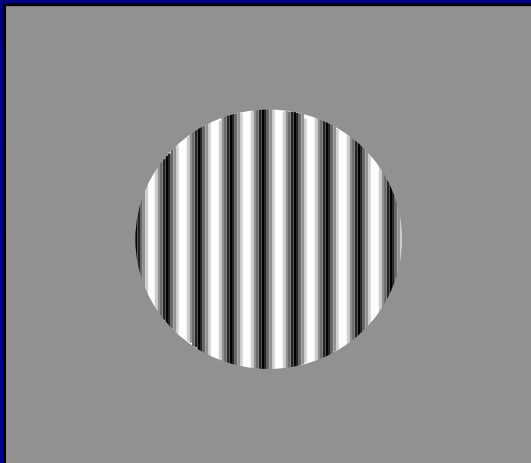
Detection



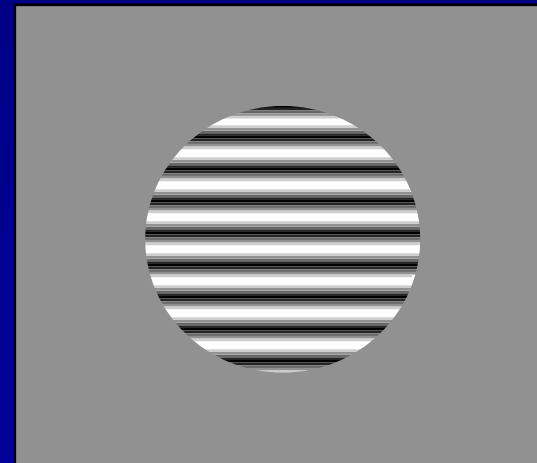
VS

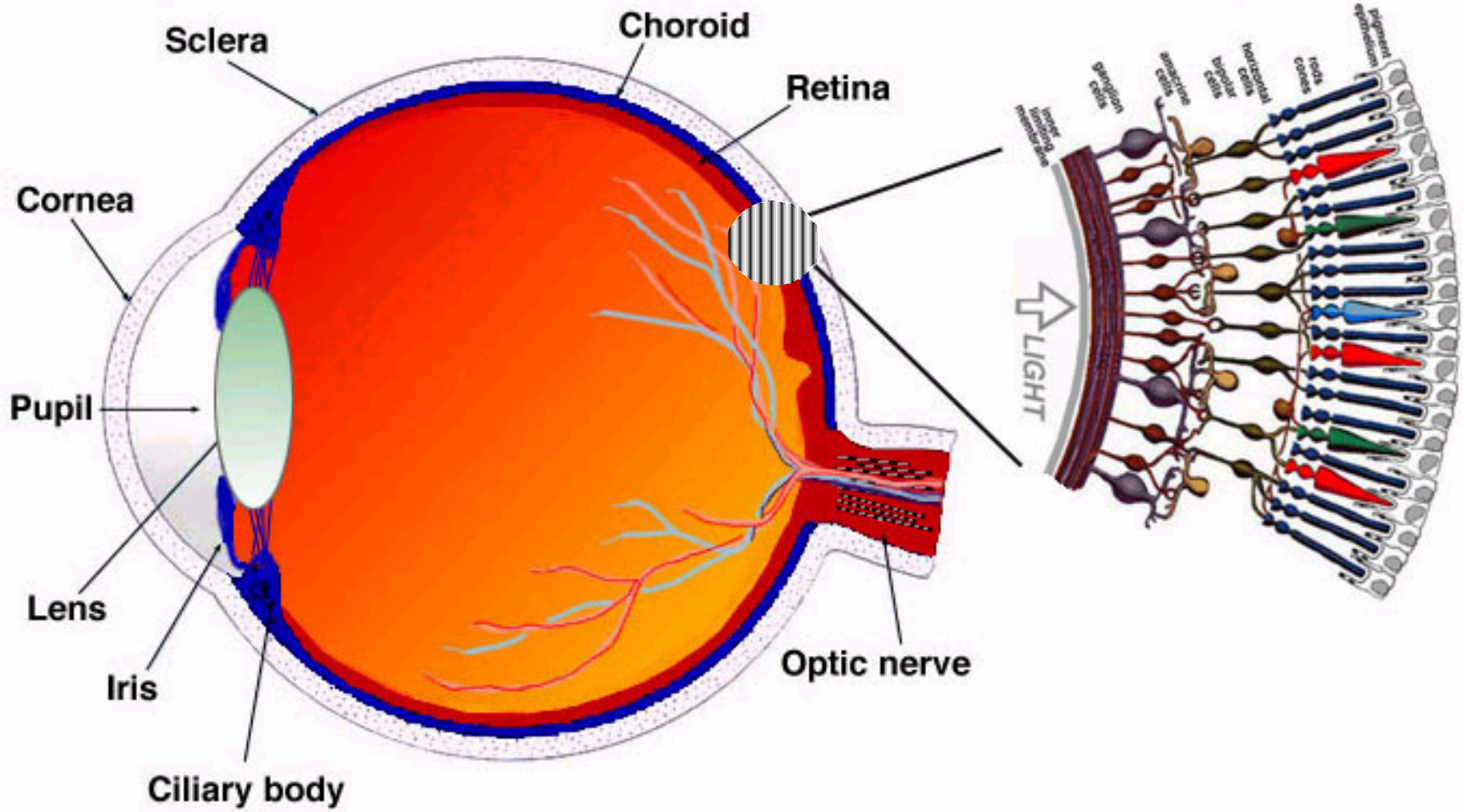


Resolution

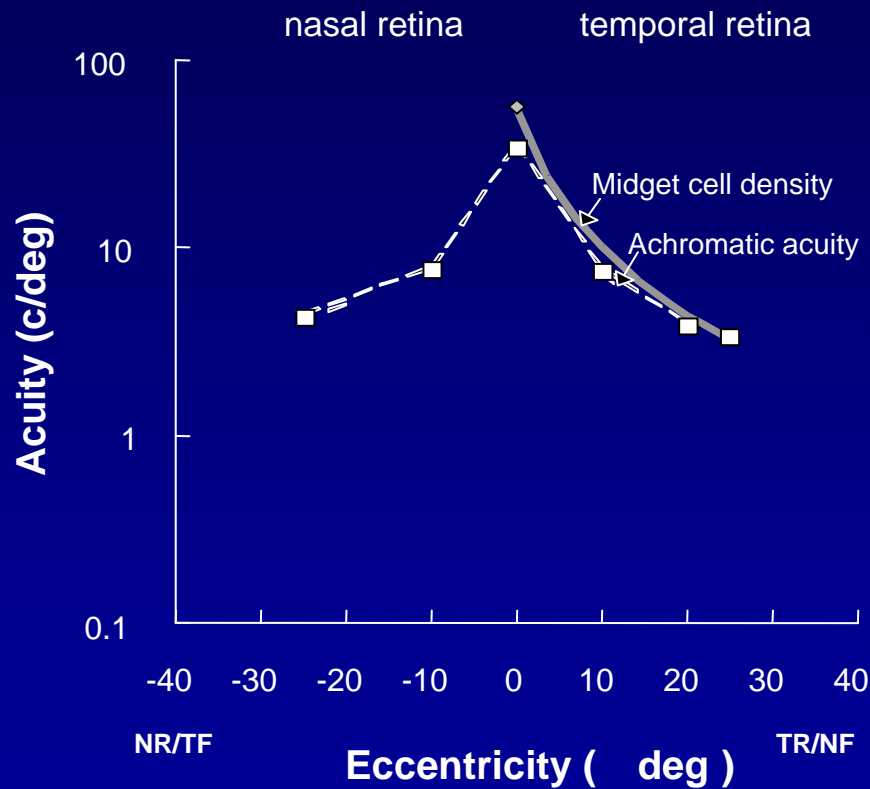


VS

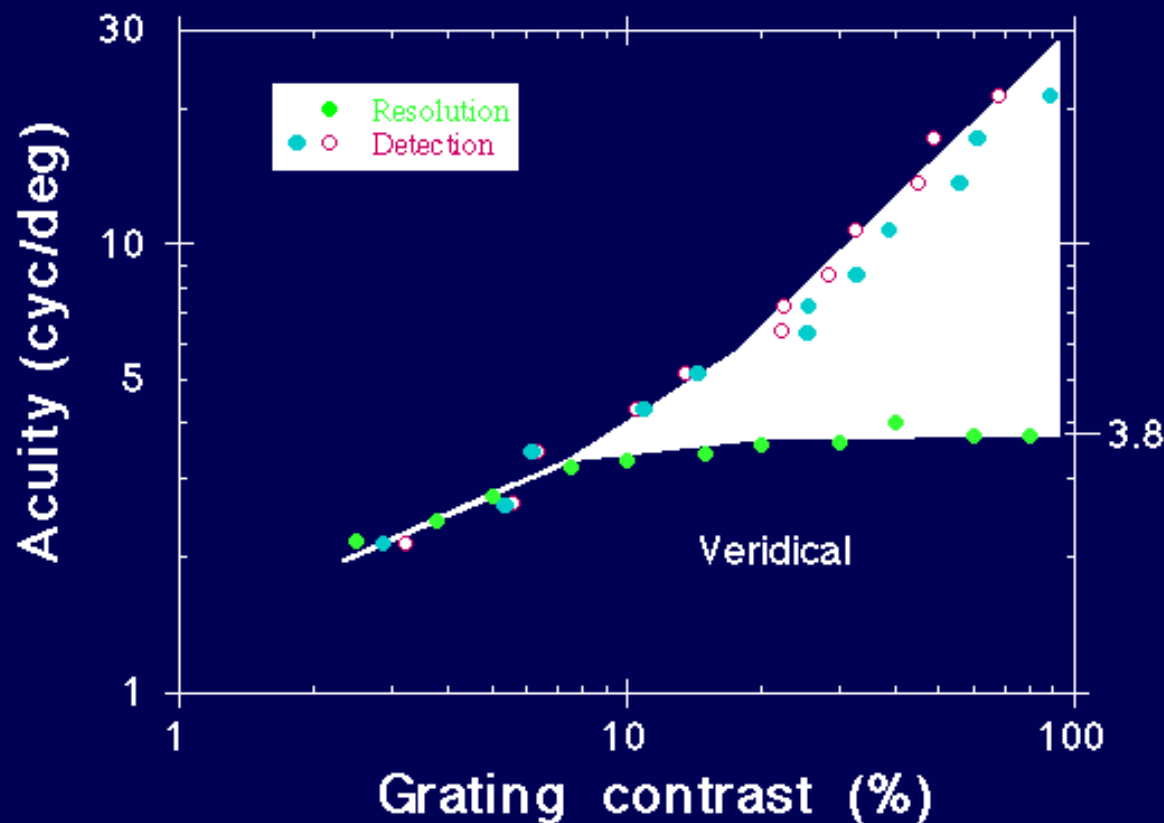




Peripheral achromatic Resolution Acuity

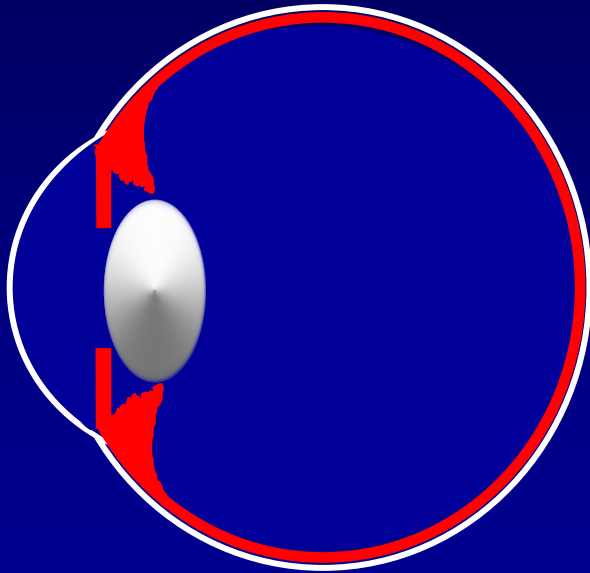


Resolution saturates but detection doesn't

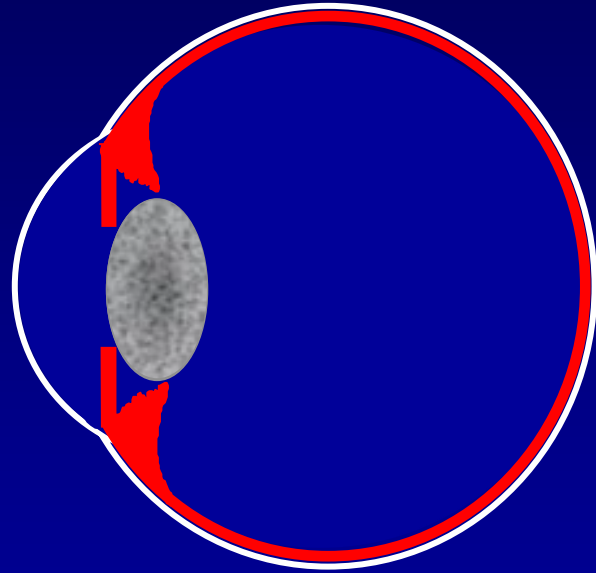


Age related lens opacity

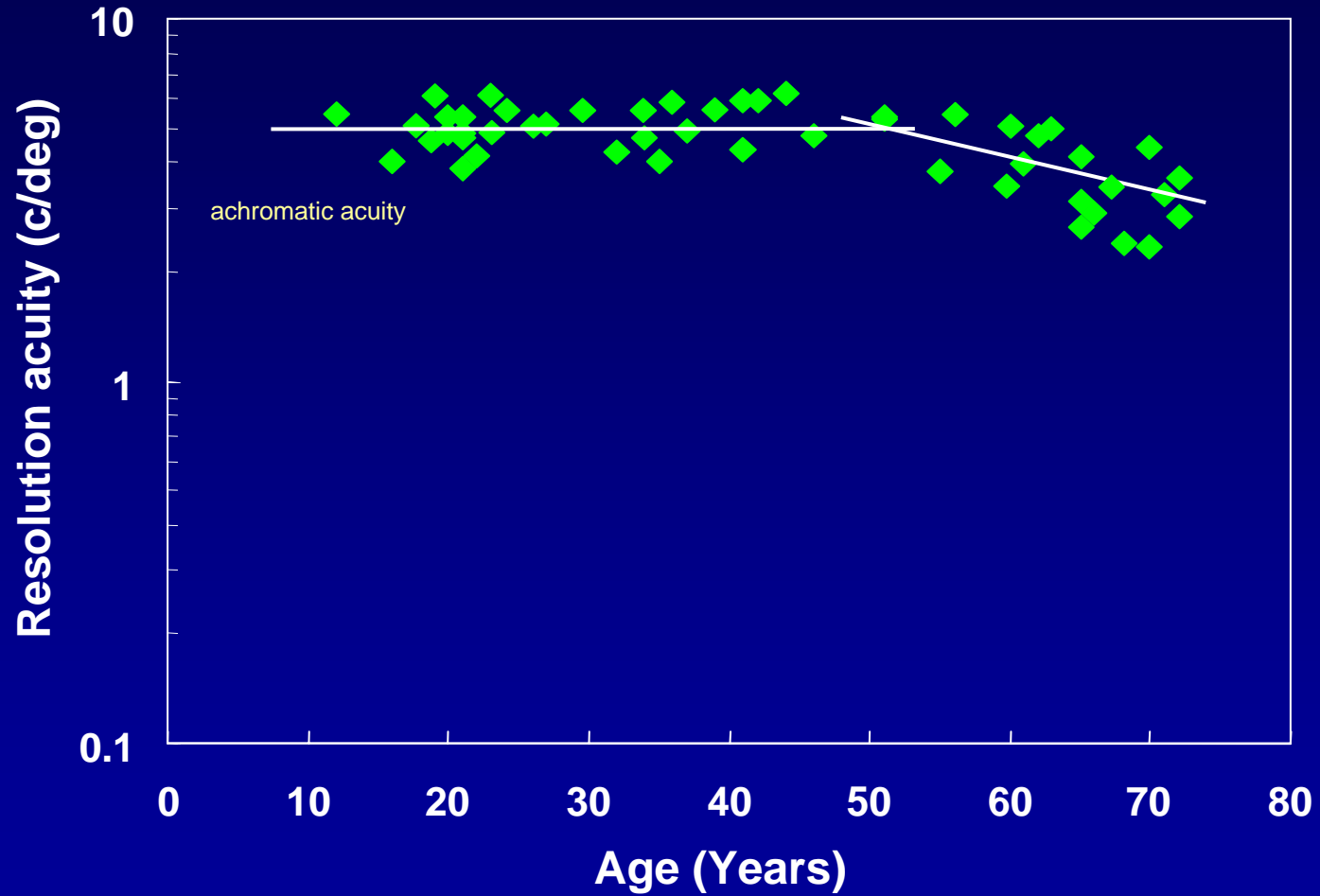
Young



Old



Resolution vs. age



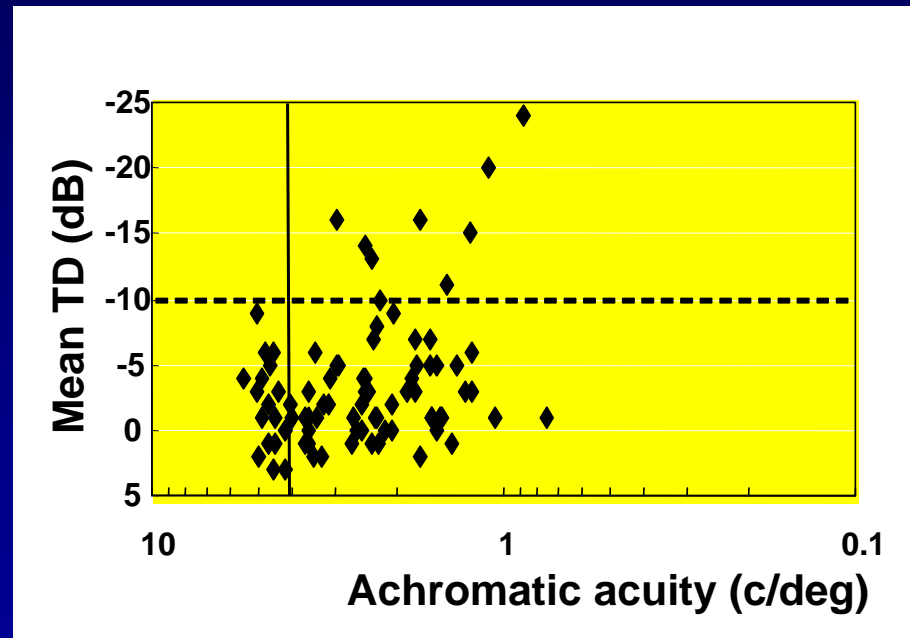
Glaucoma



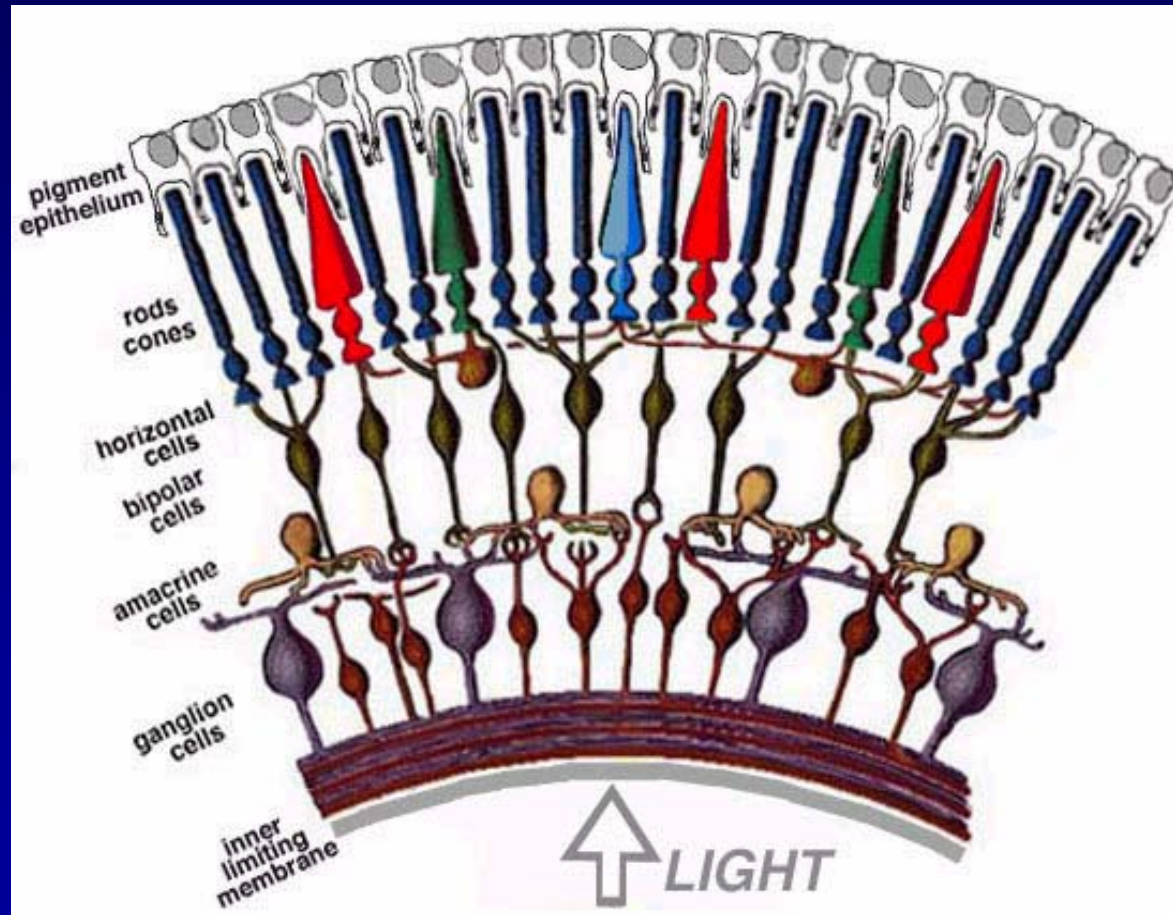
Resolution vs. Conventional perimetry in glaucoma

*HFA vs. resolution
acuity for each field
quadrant*

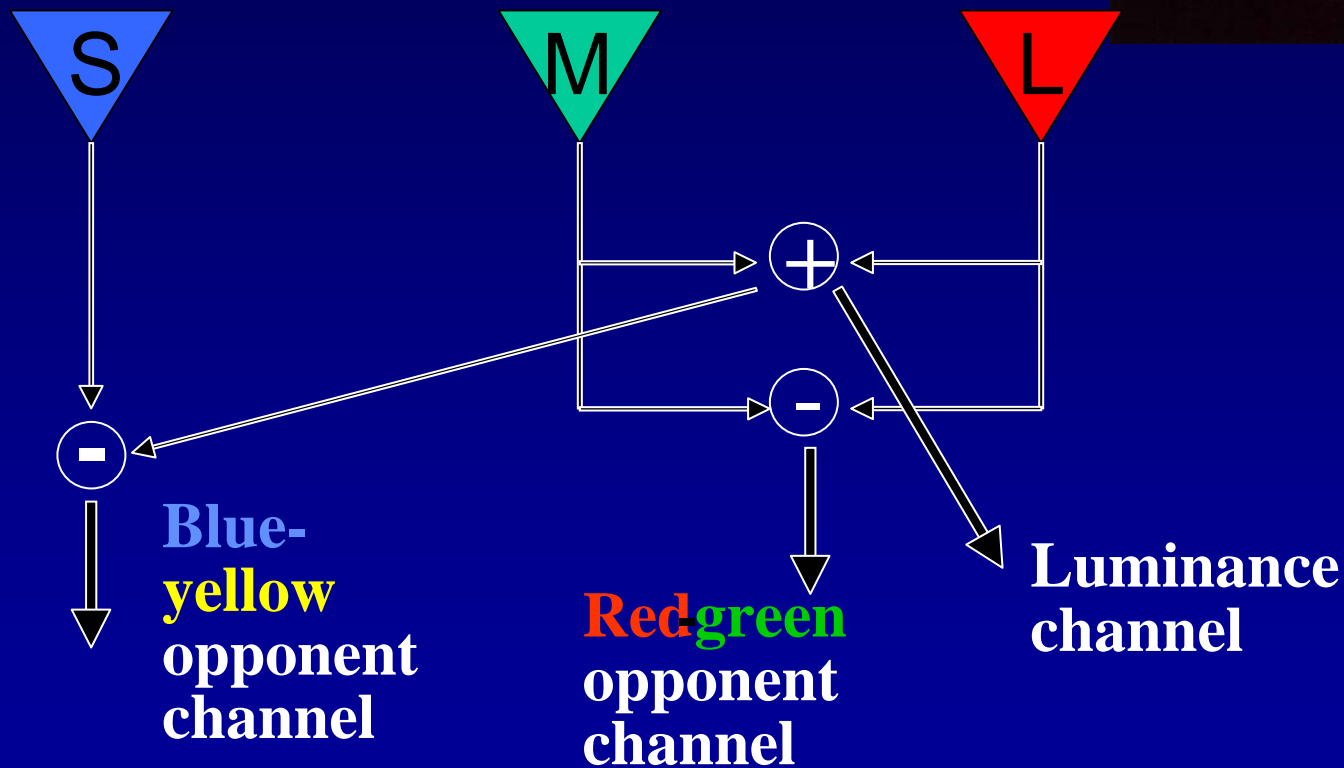
*(note locations deemed
normal by HFA but
displaying significantly
reduced resolution)*



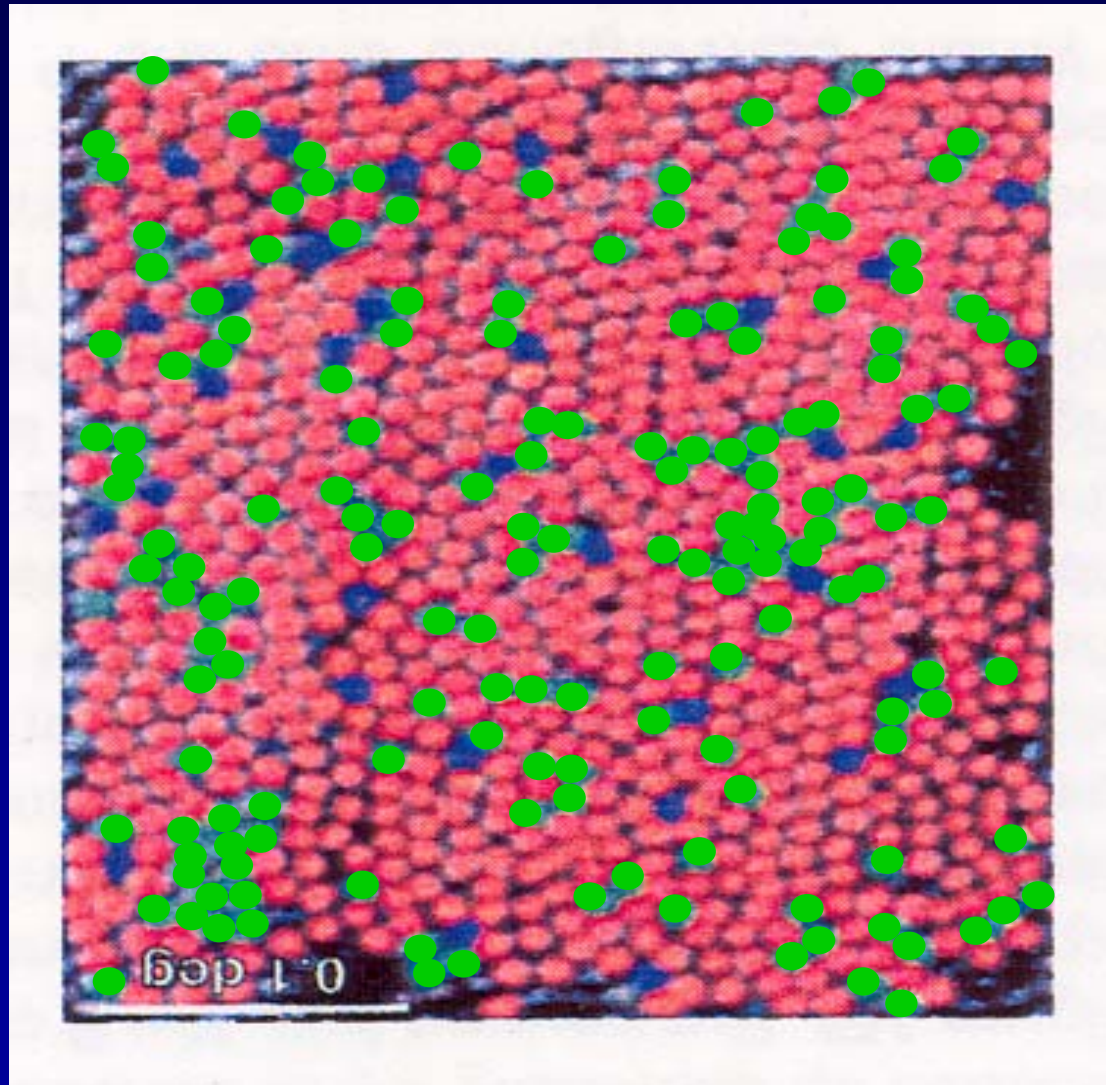
Parallel pathways and “reduced redundancy”



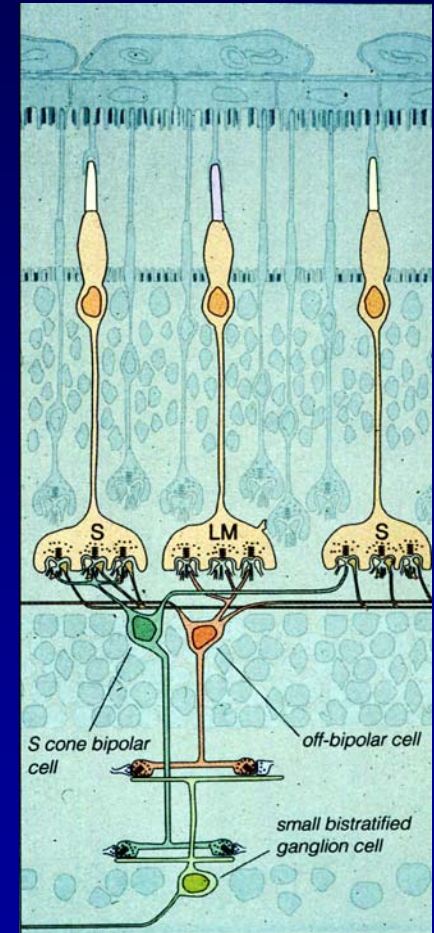
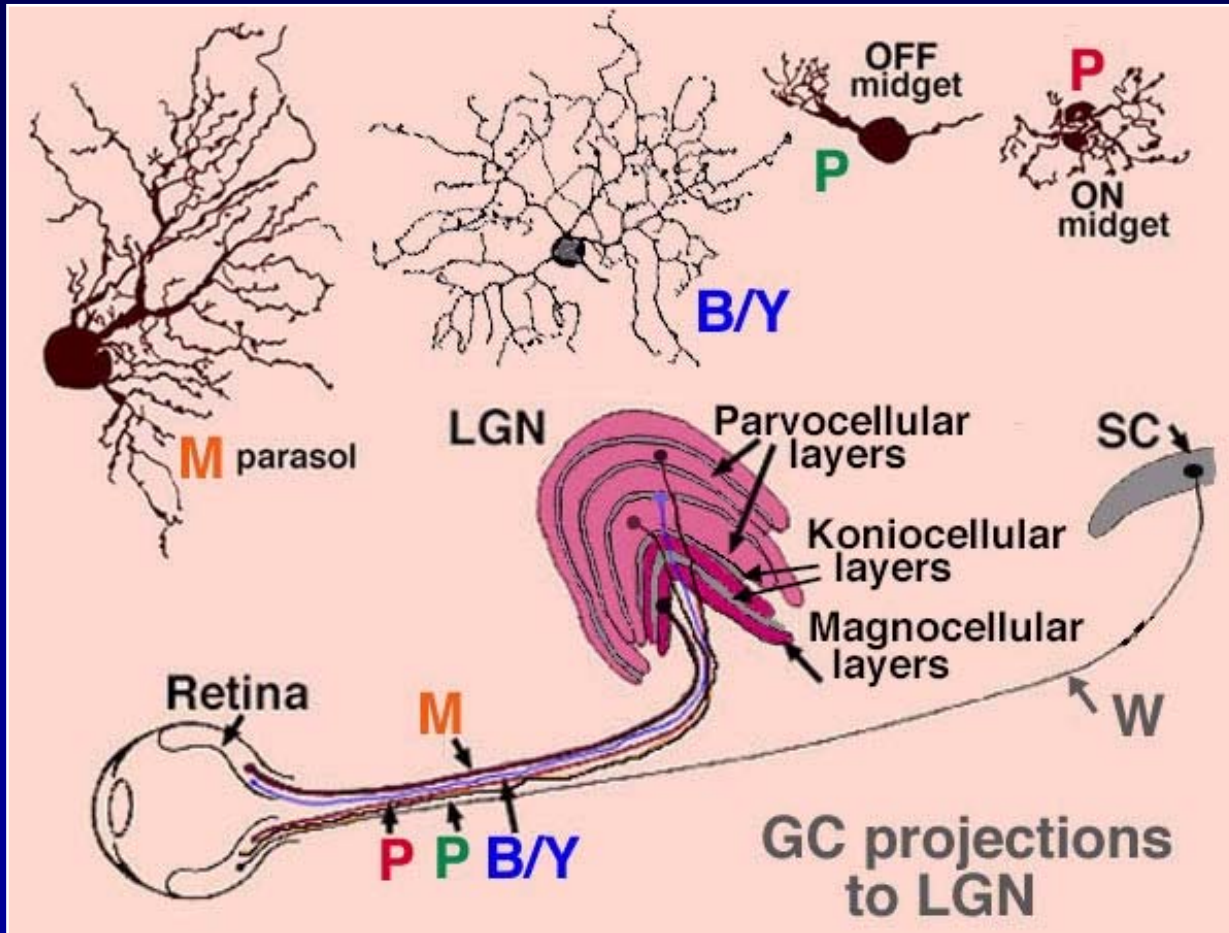
Opponent theory of colour vision

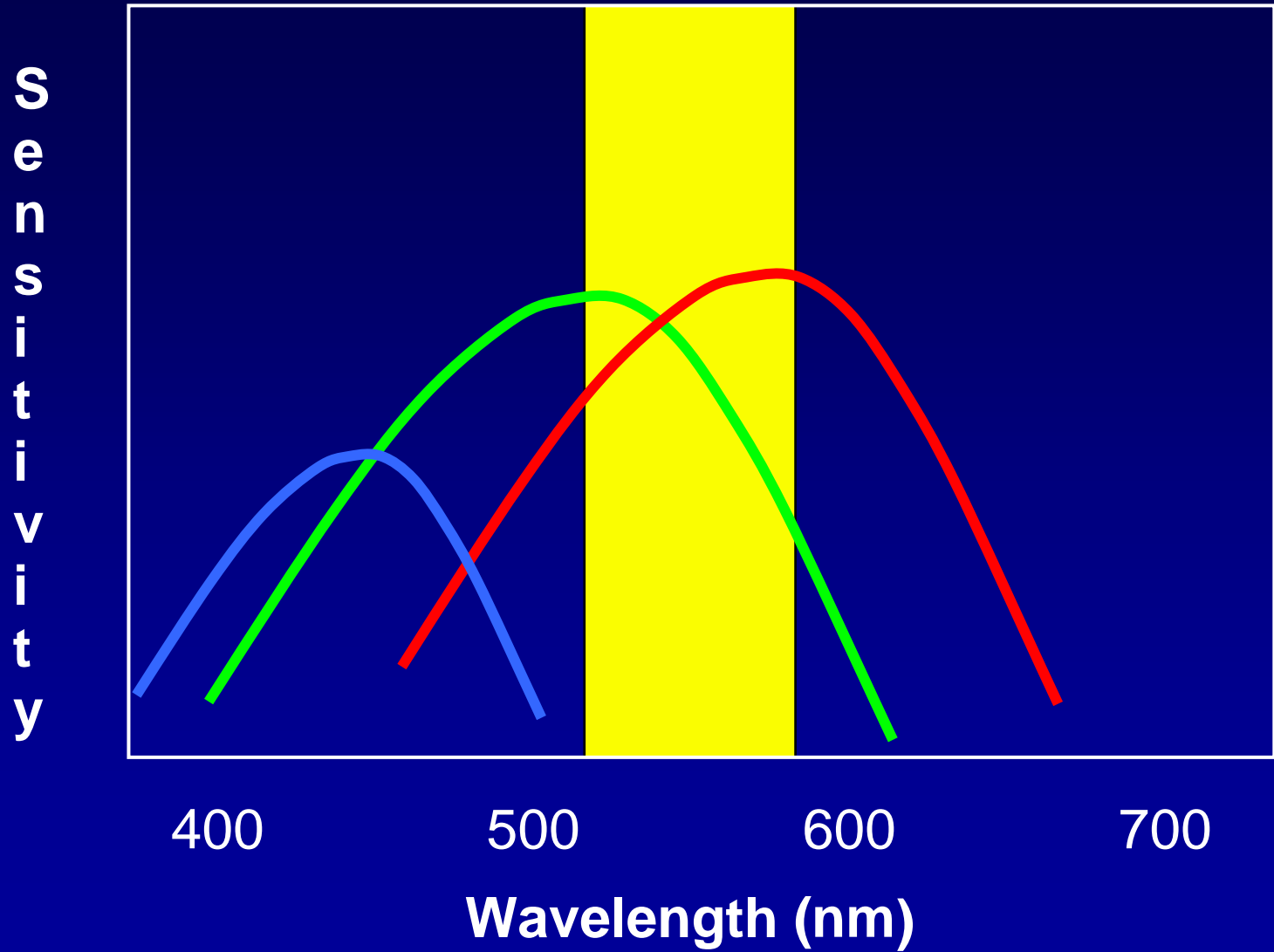


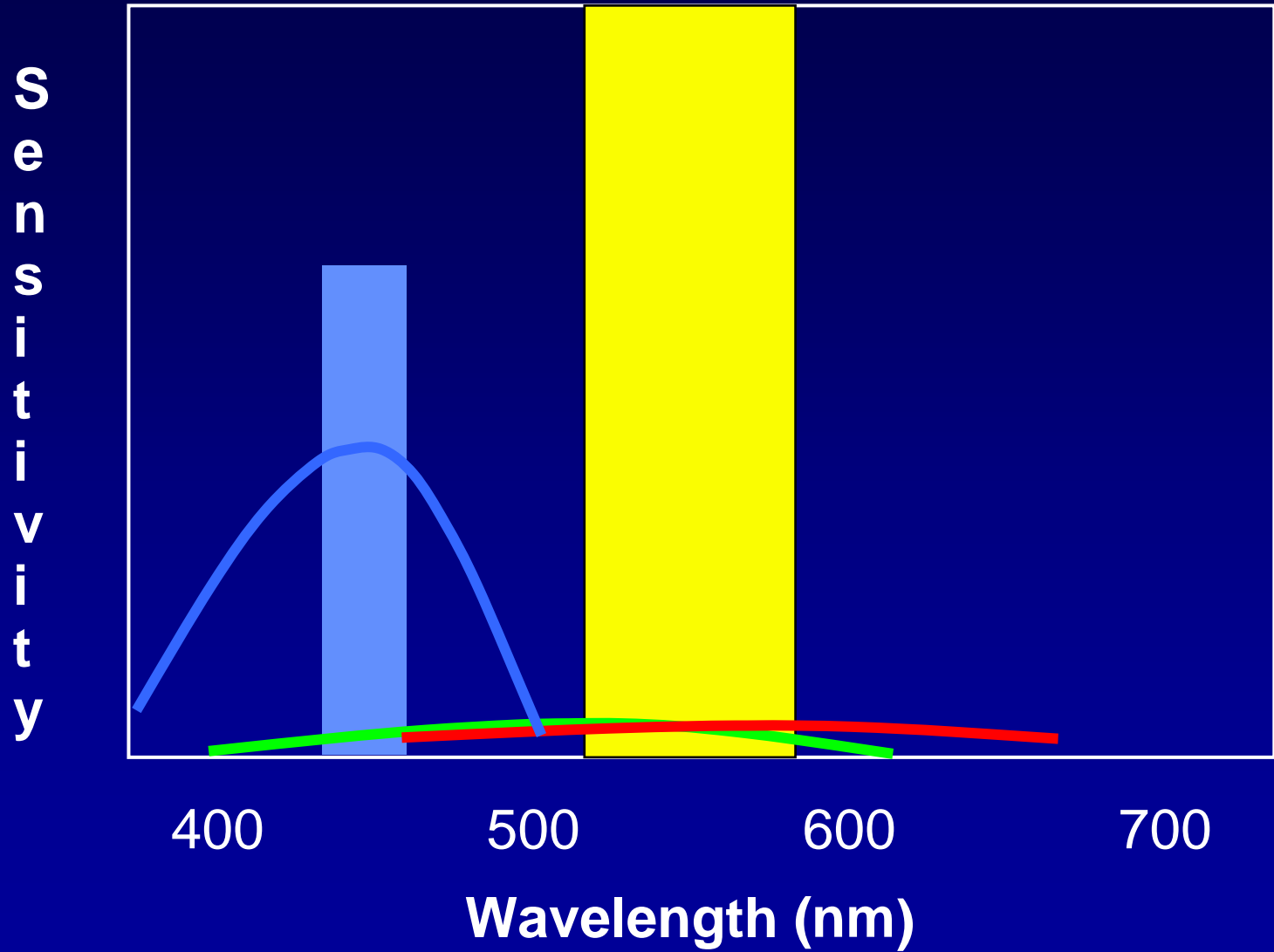
Trichromacy: but blue cones are sparse!



Ganglion cell classes





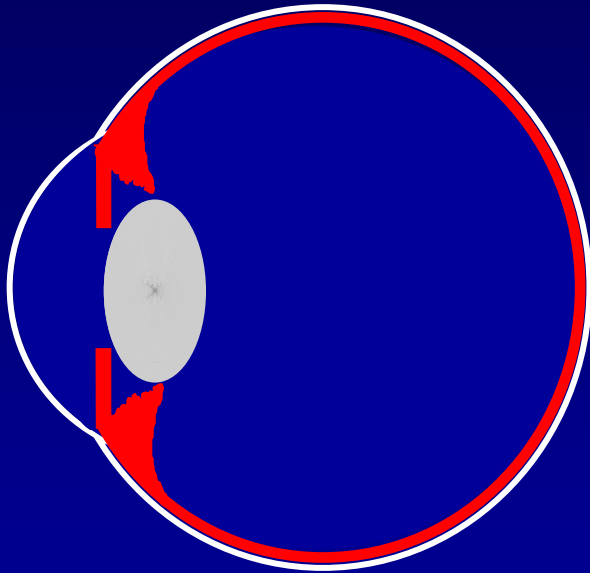


SWAP

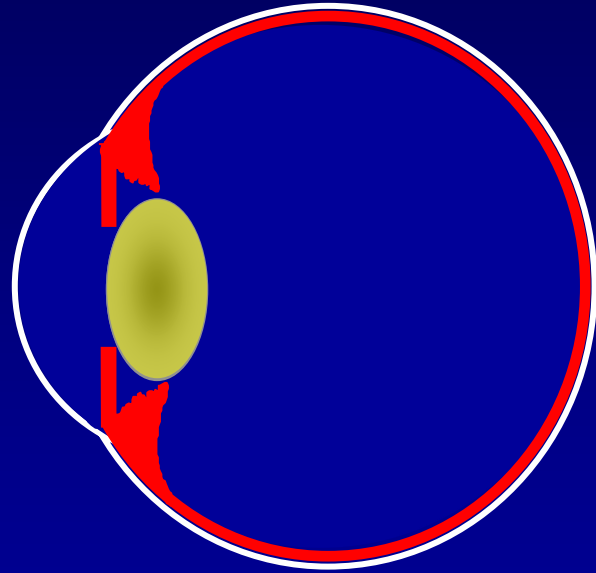


Problems with SWAP

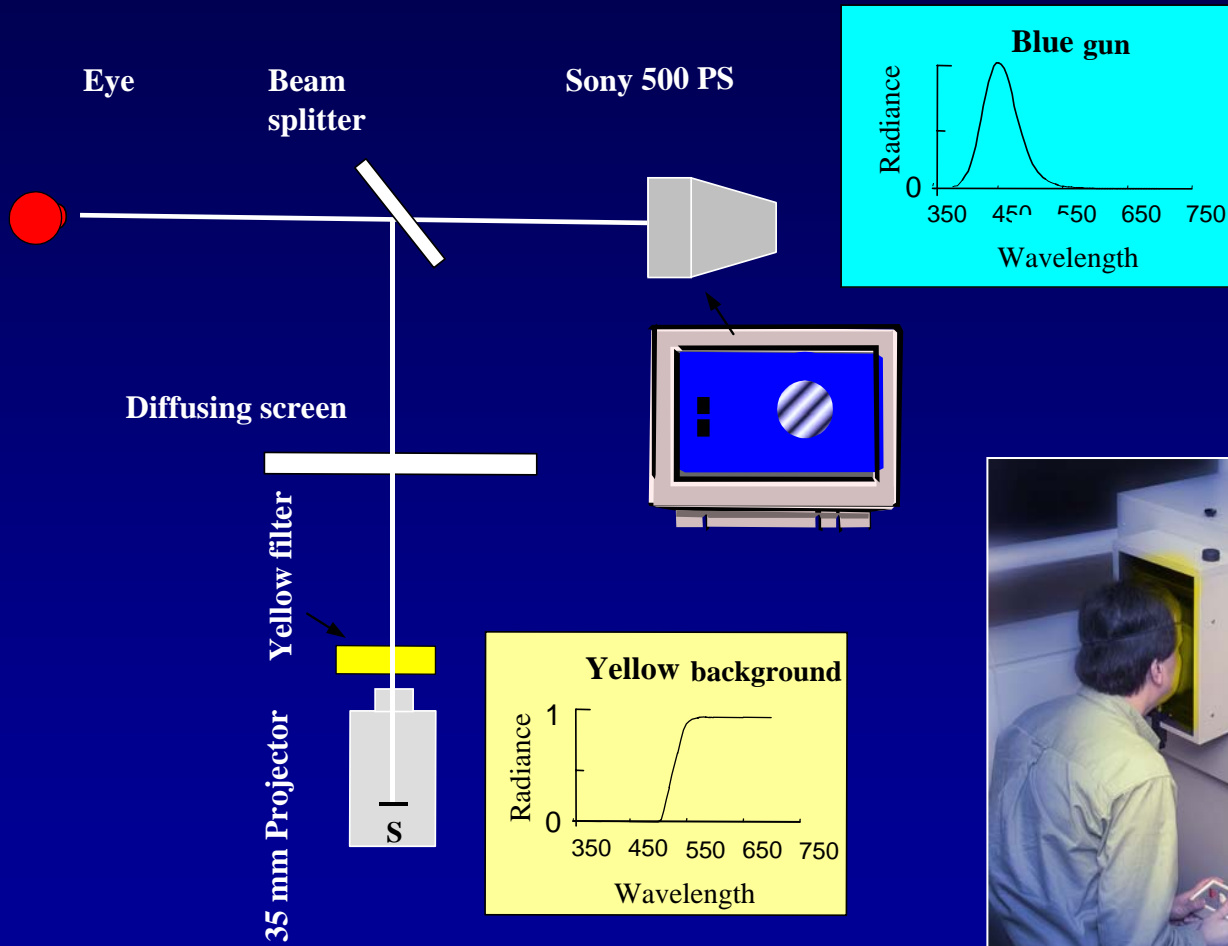
Young



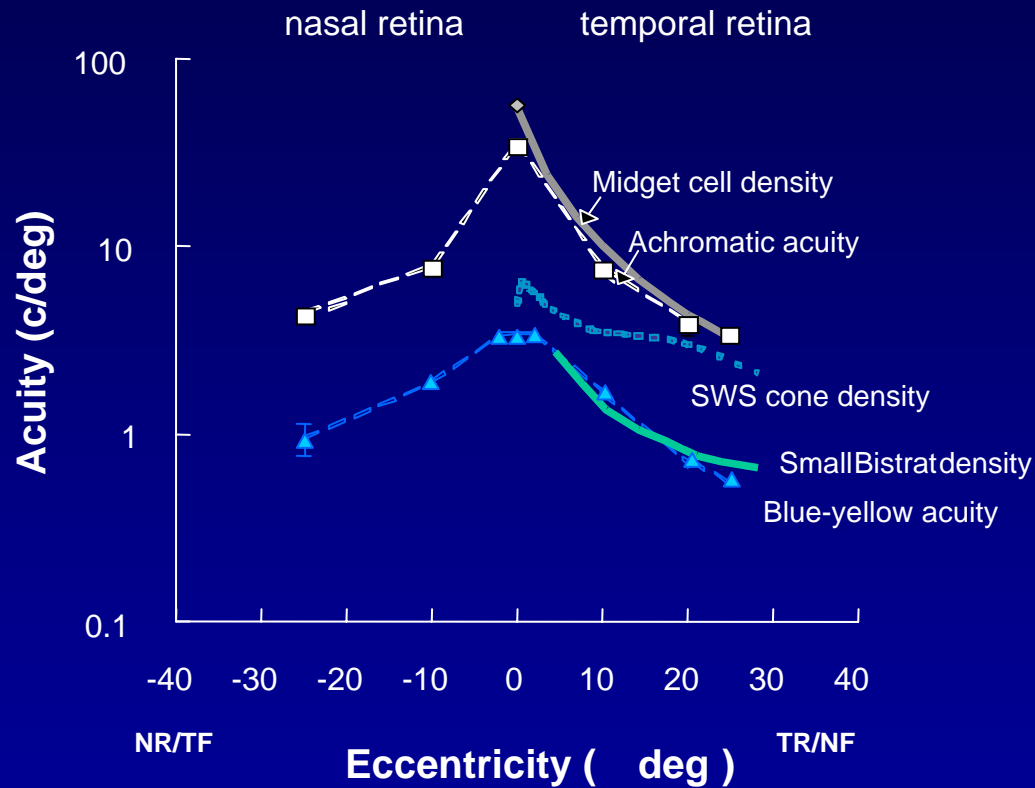
Old



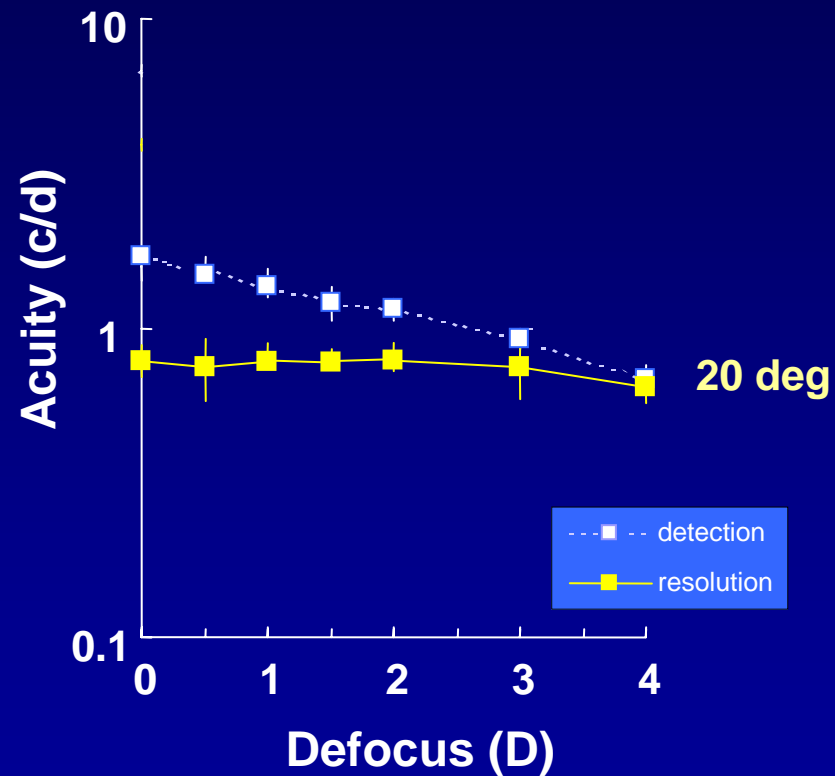
Short Wavelength Acuity Perimeter



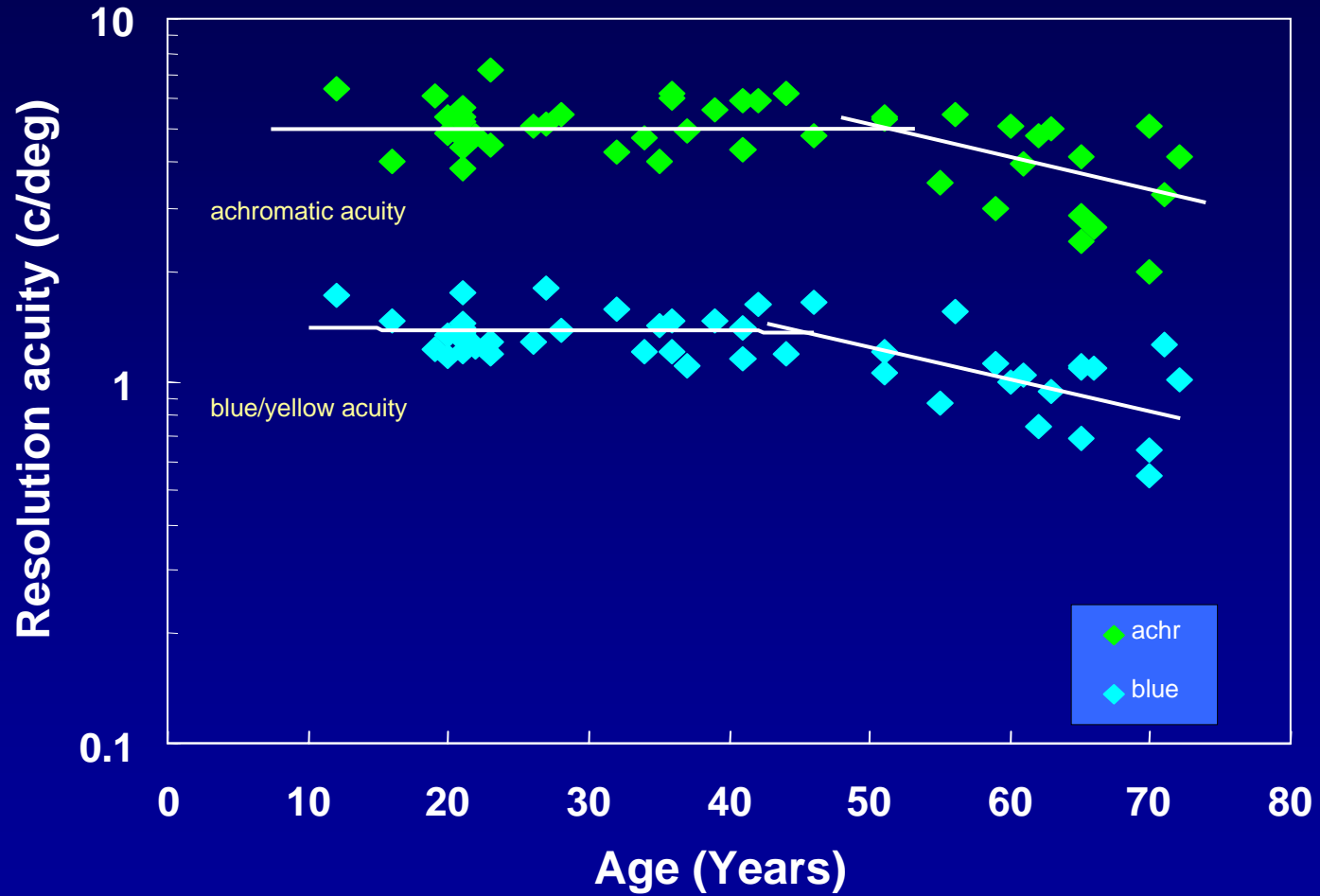
Peripheral SWS Resolution Acuity



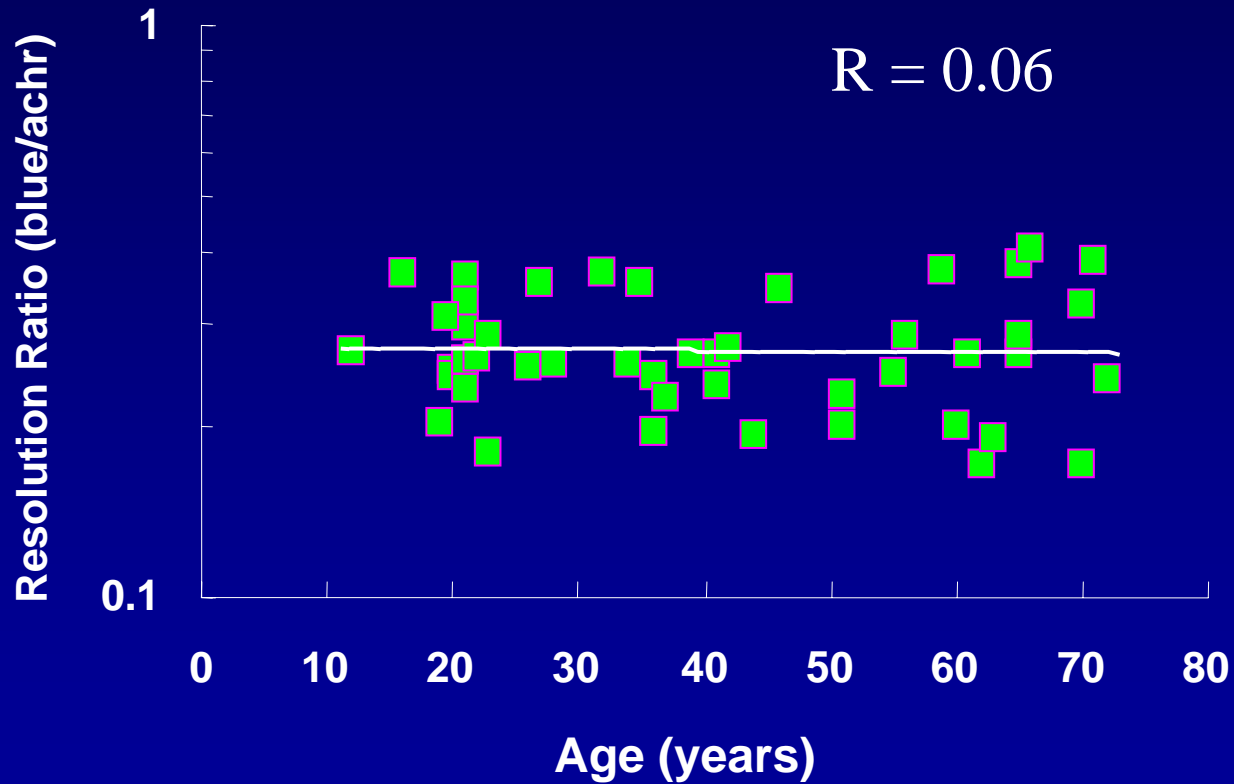
Acuity vs. defocus



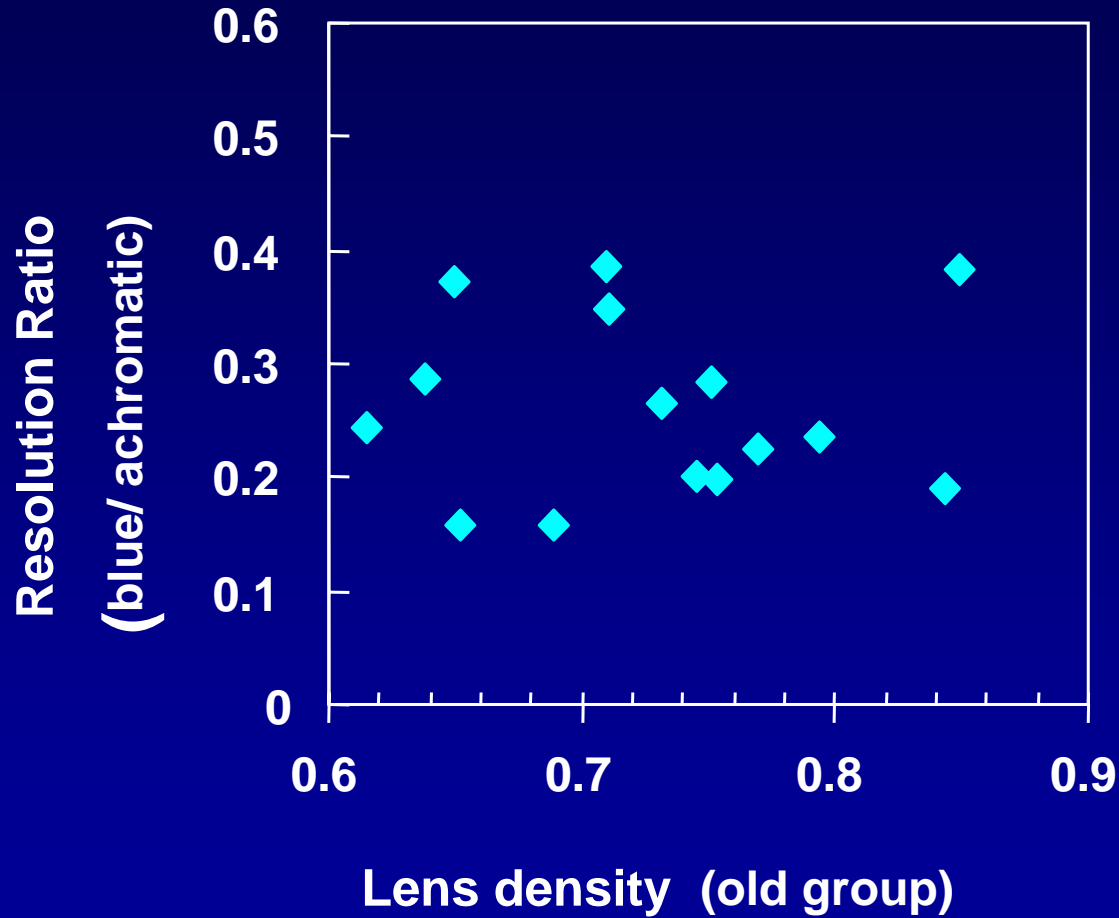
Results: Resolution vs. age



Results: Resolution Ratio vs. age



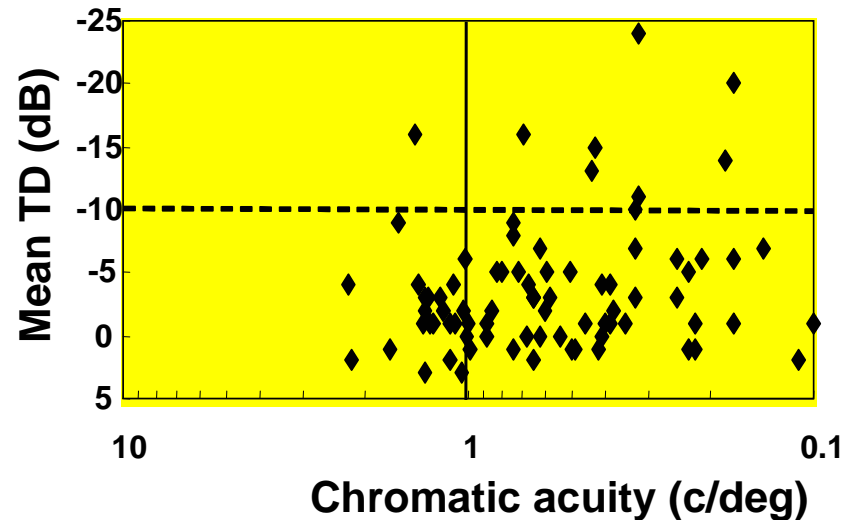
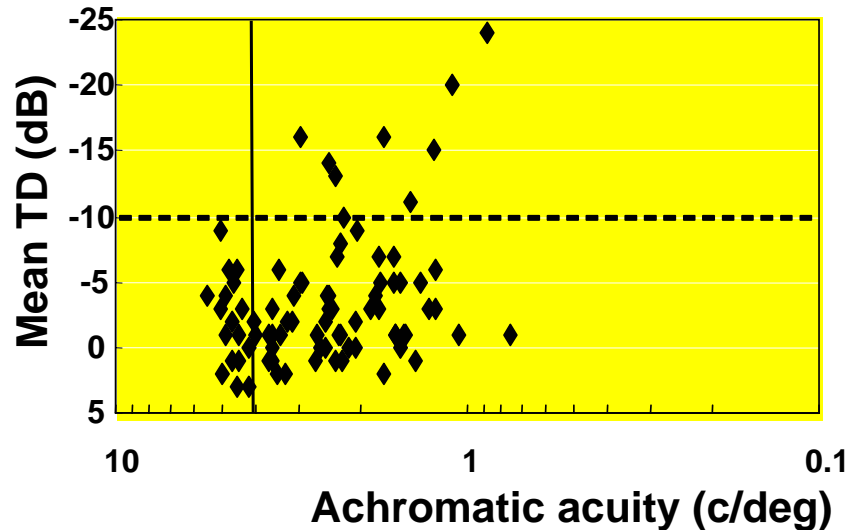
Results: Resolution Ratio vs. Lens density



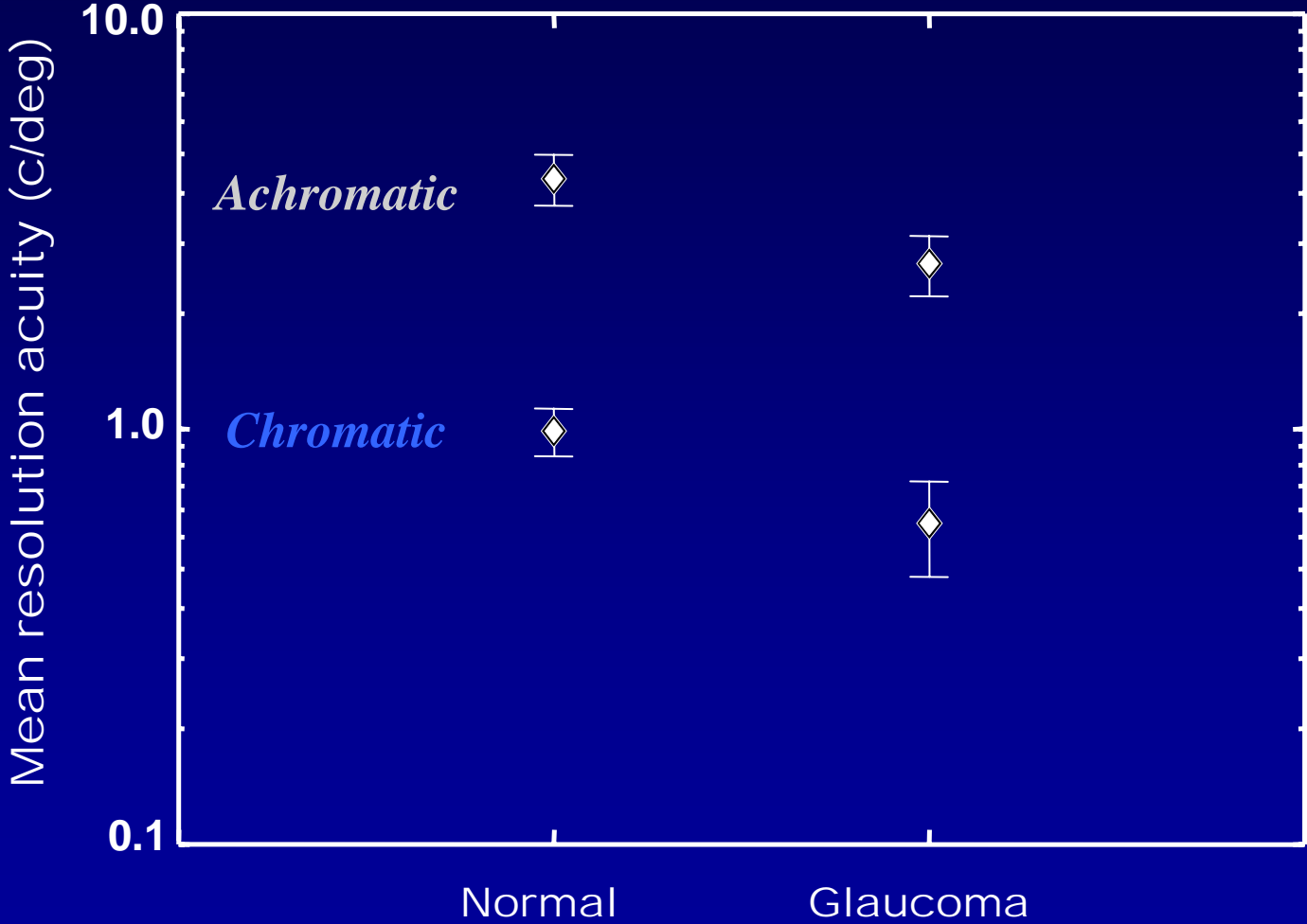
Resolution vs. Conventional perimetry in glaucoma

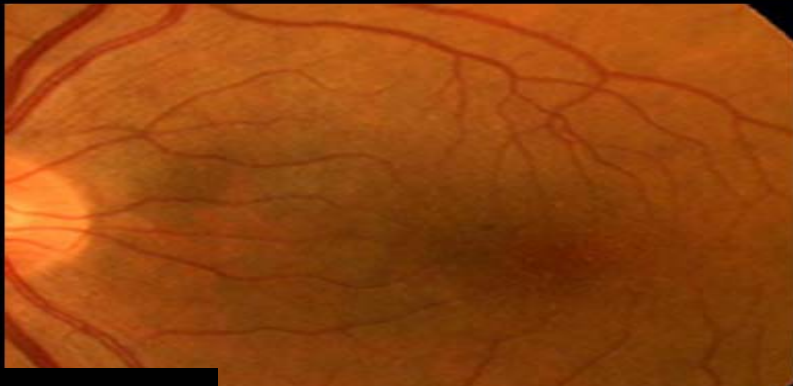
*HFA vs. resolution
acuity for each field
quadrant for achromatic
and chromatic stimuli*

*(note locations deemed
normal by HFA but
displaying significantly
reduced resolution)*



SELECTIVE LOSS?

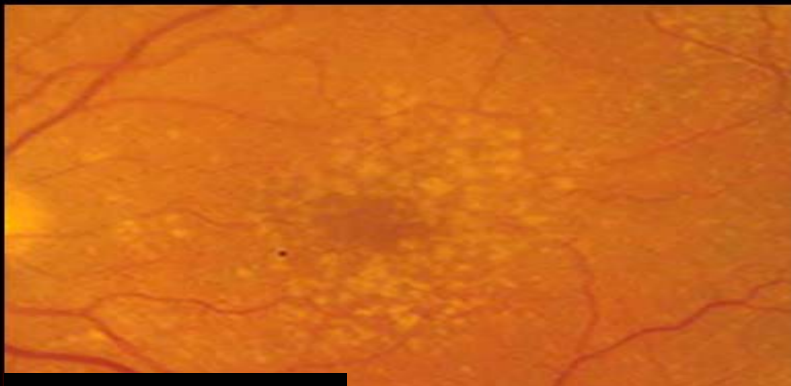




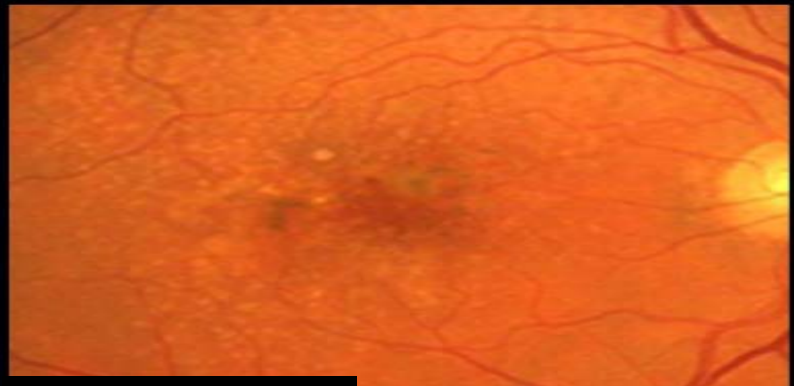
Normal



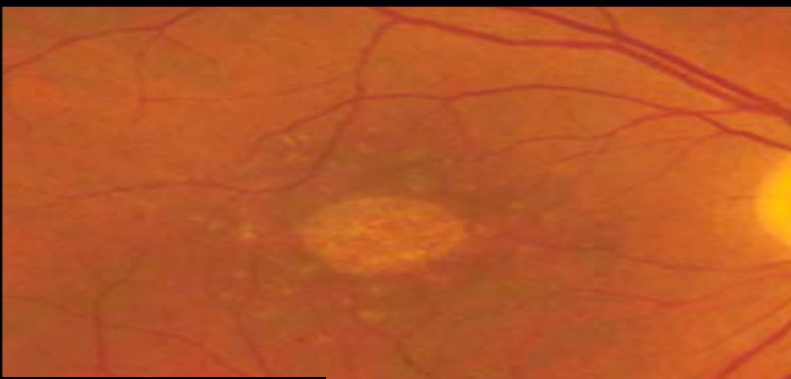
ARM, Grade 1



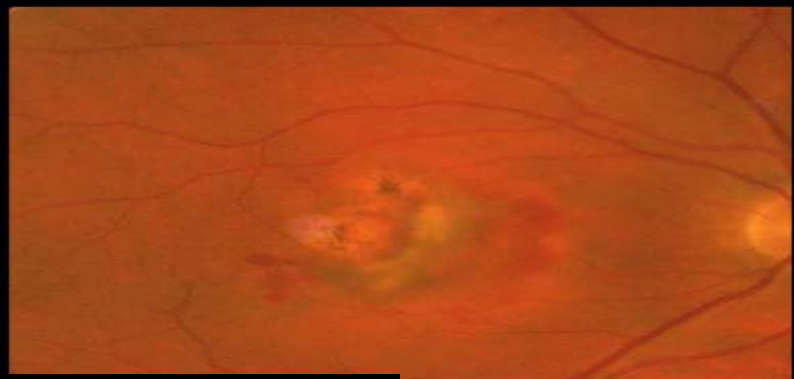
ARM, Grade 3



ARM, Grade 5

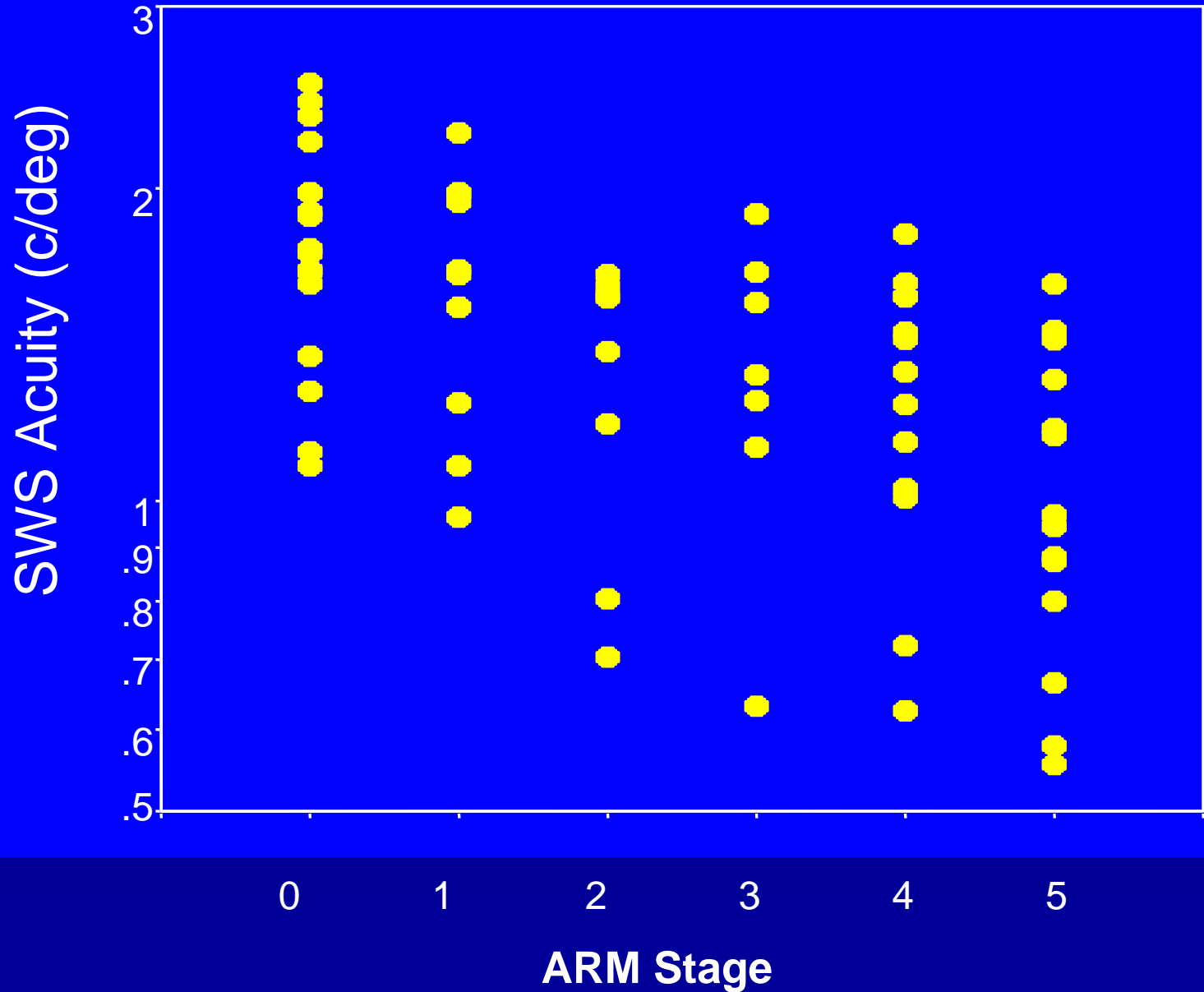


AMD, Atrophic

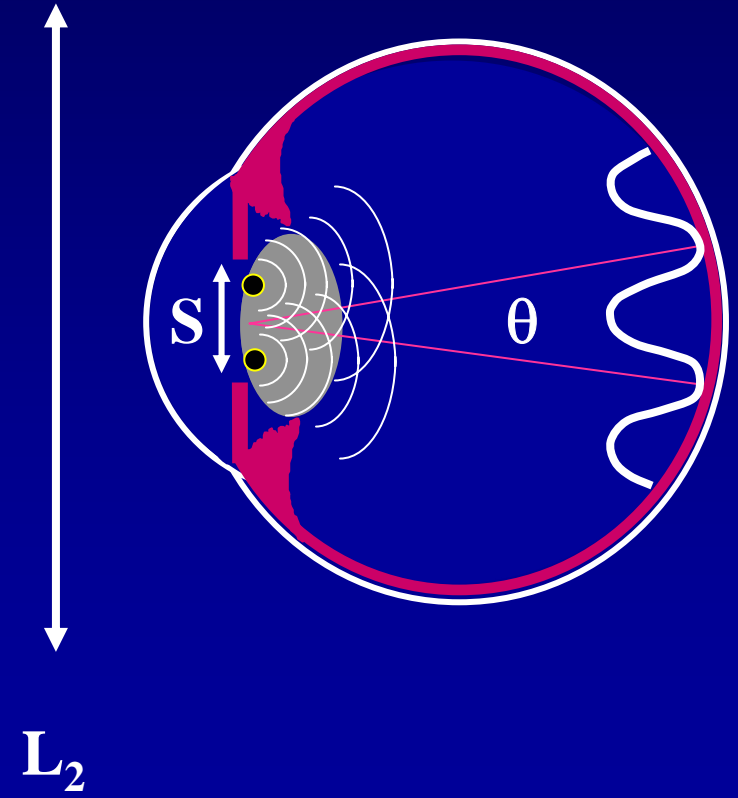
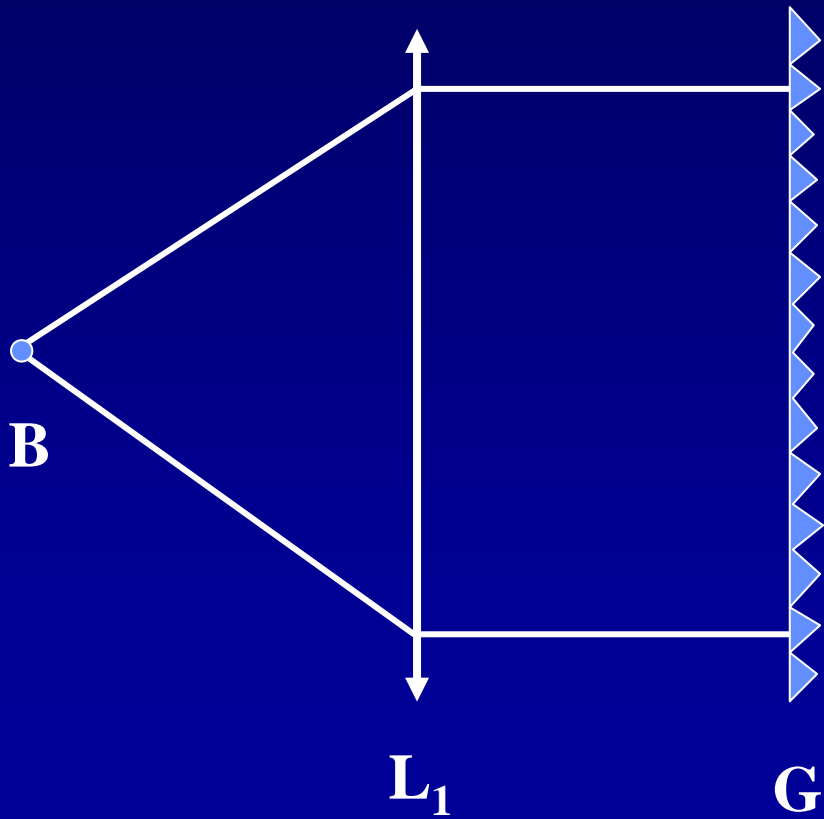


AMD, Exudative

1-way ANOVA [$F(5, 63) = 5.33, p < 0.001$]



Retinal Interferometry





Thanks!

Colm O'Brien

Usha Chakravarthy

Raymond Beirne

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Margarita Vidinova

Robert Rainey

Wellcome Trust

BBSRC (ERA)