Potential role of macular pigment in preserving rod-dominated dark adaptation in the older eye

Laura Patryas

MANCHESTER 1824
The University of Manchester

Supported by:

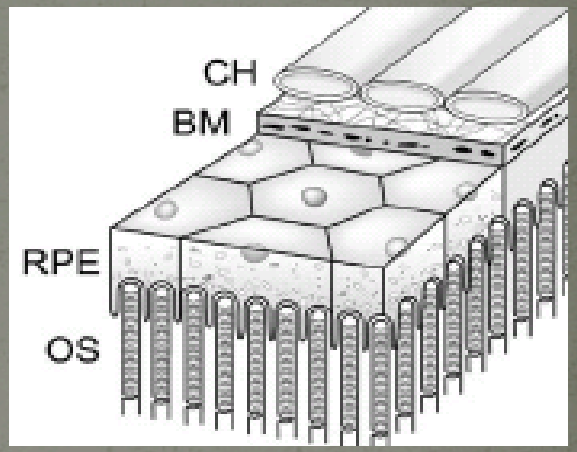
BBSRC bioscience for the future

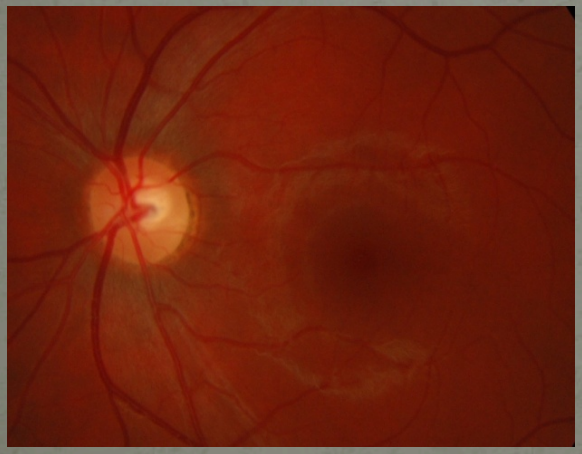
VITABIOTICS WHERE NATURE MEETS SCIENCE

British Congress of Optometry and Vision Science 2011

Introduction

Dark adaptation becomes slower with age. The cause for this is unknown but may be related to ageing of the RPE/Bruch's membrane complex.





Macular pigment (**MP**) is a powerful antioxidant and may protect the retina from photochemical damage.

MP is composed of composed of lutein and zeaxanthin.

Introduction

Recent evidence suggests that:

1. Higher MP levels preserve scotopic sensitivity in older adults (Hammond et al., 1998)

2. Higher MP levels improve rod recovery in age-related macular degeneration (**AMD**) (Berendschot et al., 2011)

Objectives

(i) To characterise the rate of scotopic sensitivity decline with age using CRT-based dark adaptometry

(ii) To see whether the rate of rod recovery is correlated with macular pigment optical density (**MPOD**)

Methods

Subjects

33 subjects, divided into 2 groups:

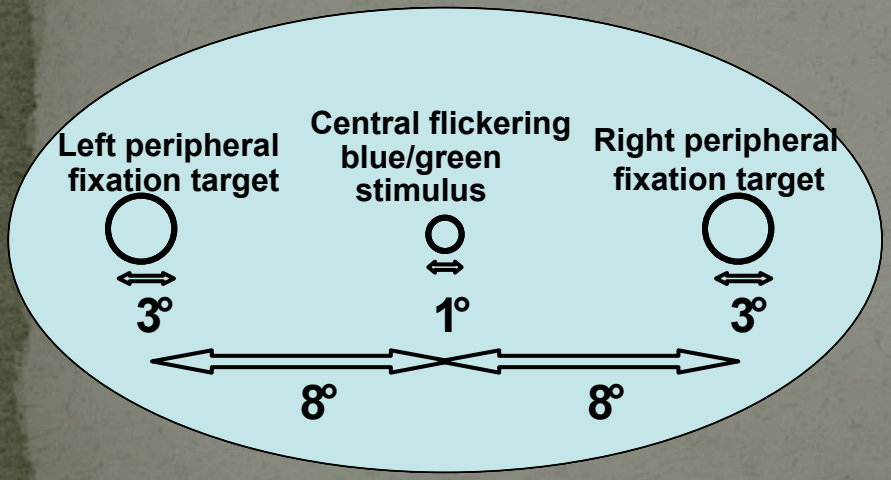
Older group
(≥ 45 years old, n=16,
mean age 57.44 ±7.98)

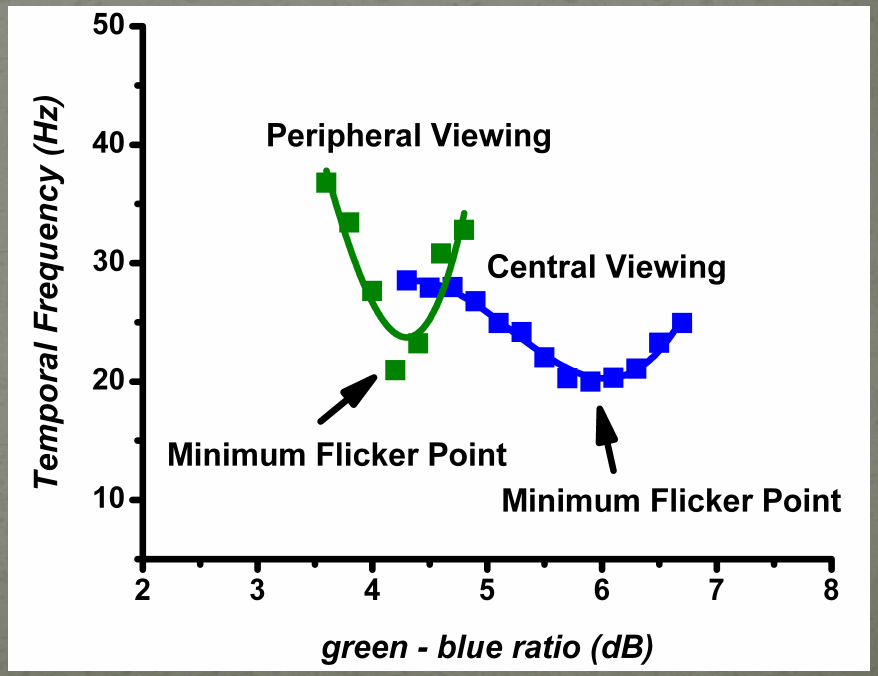
Younger group
(<45 years old, n=17,
mean age 25.12 ±6.08)

Methods

Macular pigment optical density

MPOD was measured psychophysically using MPS 9000 based on heterochromatic flicker photometry.

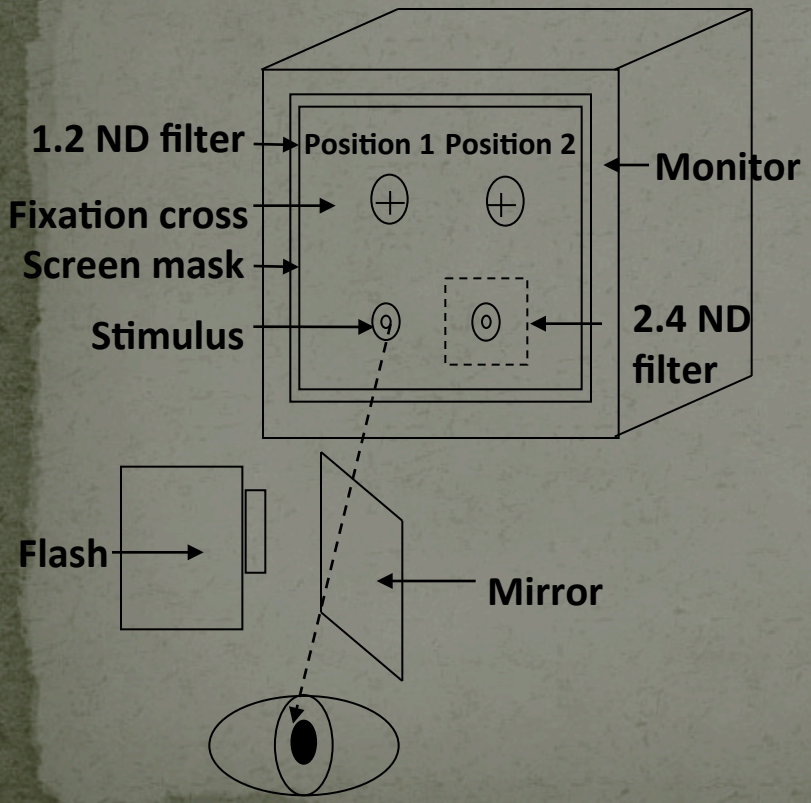




Methods

Dark adaptation

Dark adaptation was measured using a CRT monitor.

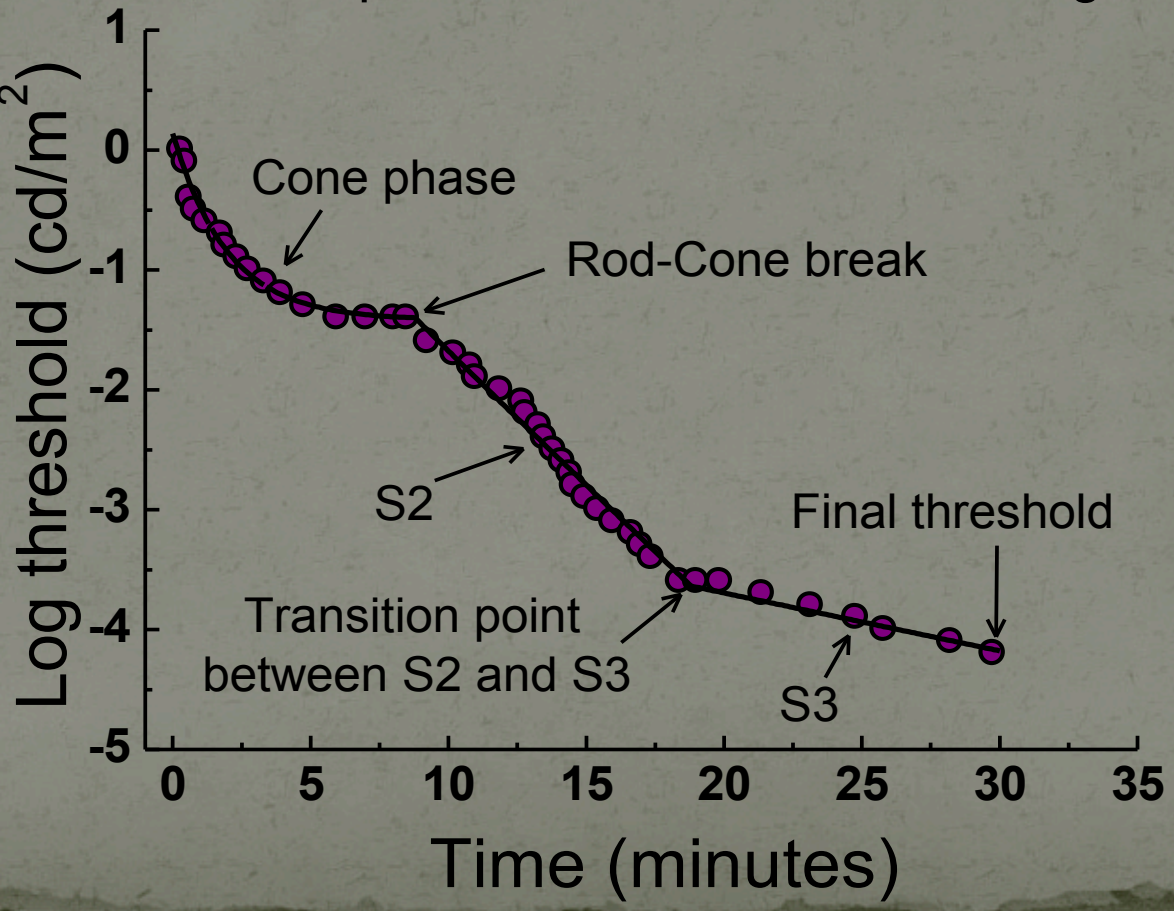


- The CRT's luminance range was extended using ND filters
- Test area was bleached using an electronic flash
- Thresholds were measured for 30 mins using MOA
- Viewing was monocular with a natural pupil and the unstimulated eye wore a patch

Analysis

MPOD and dark adaptation were measured twice therefore data points are the means of two sessions.

Dark adaptation curves were plotted as $\log_{10}$ threshold (cd/m²) vs time (mins) and fitted with an exponential-bilinear model using Matlab.

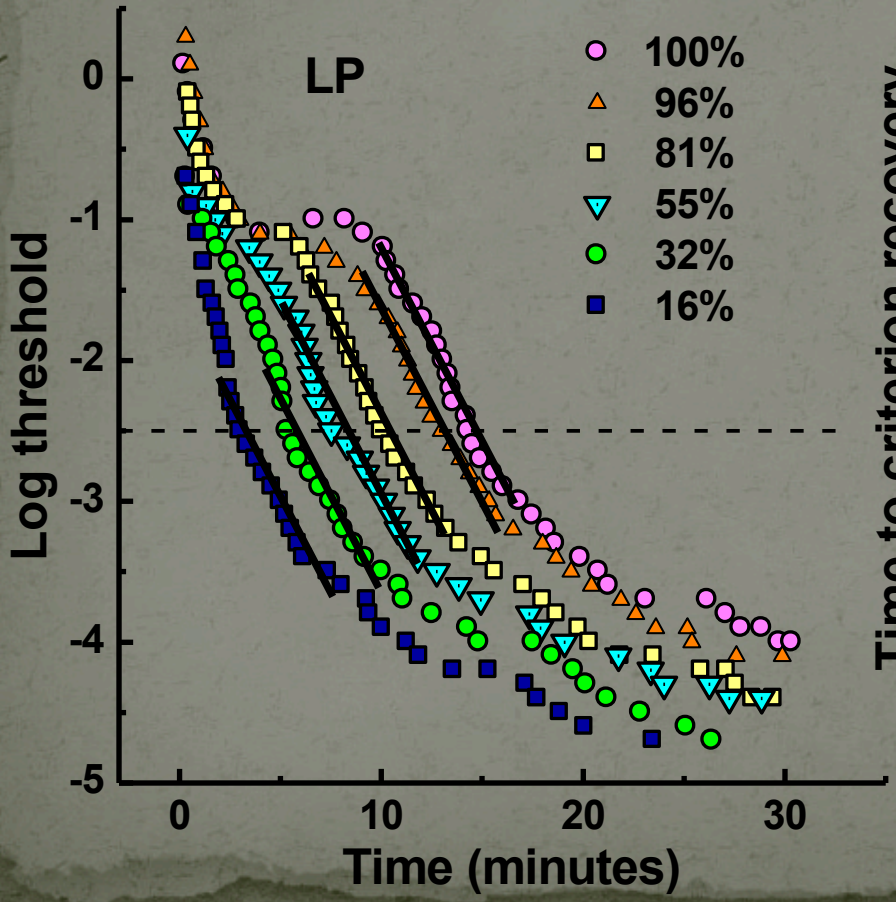


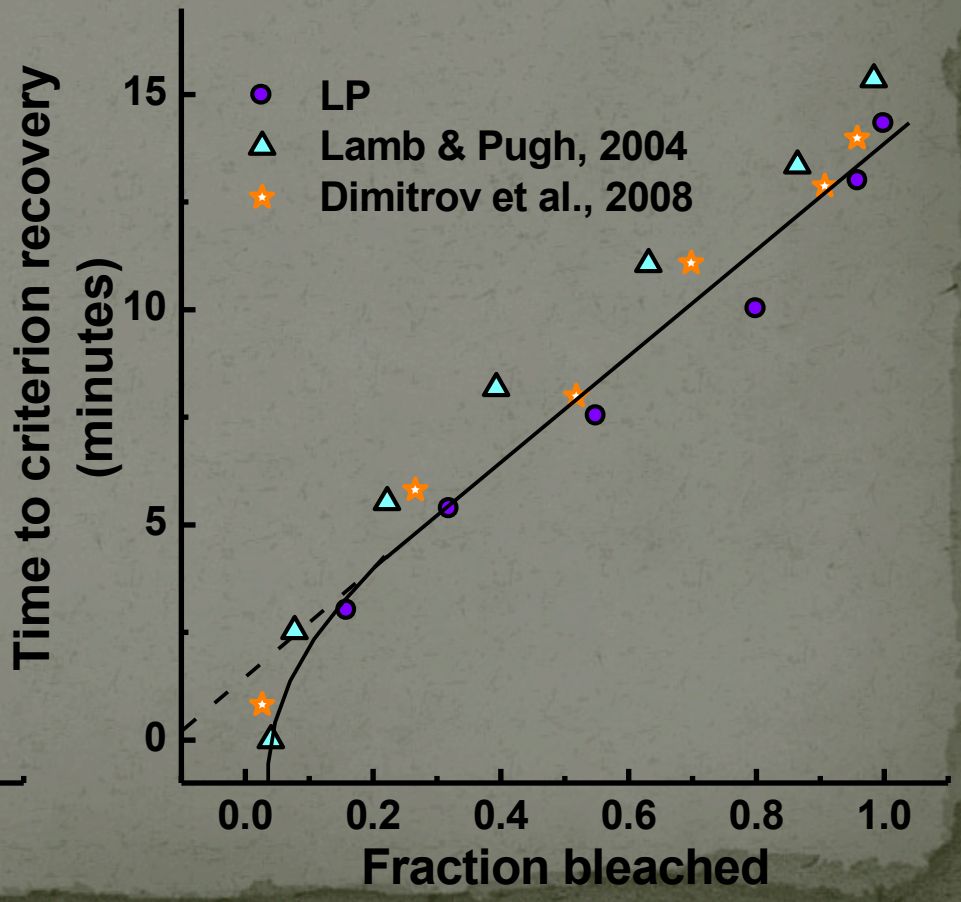
Results

Dark adaptation

The S2 region showed a linear relationship with the size of bleach for fractions above 20%.

Our data (LP) were in good agreement with previous studies.

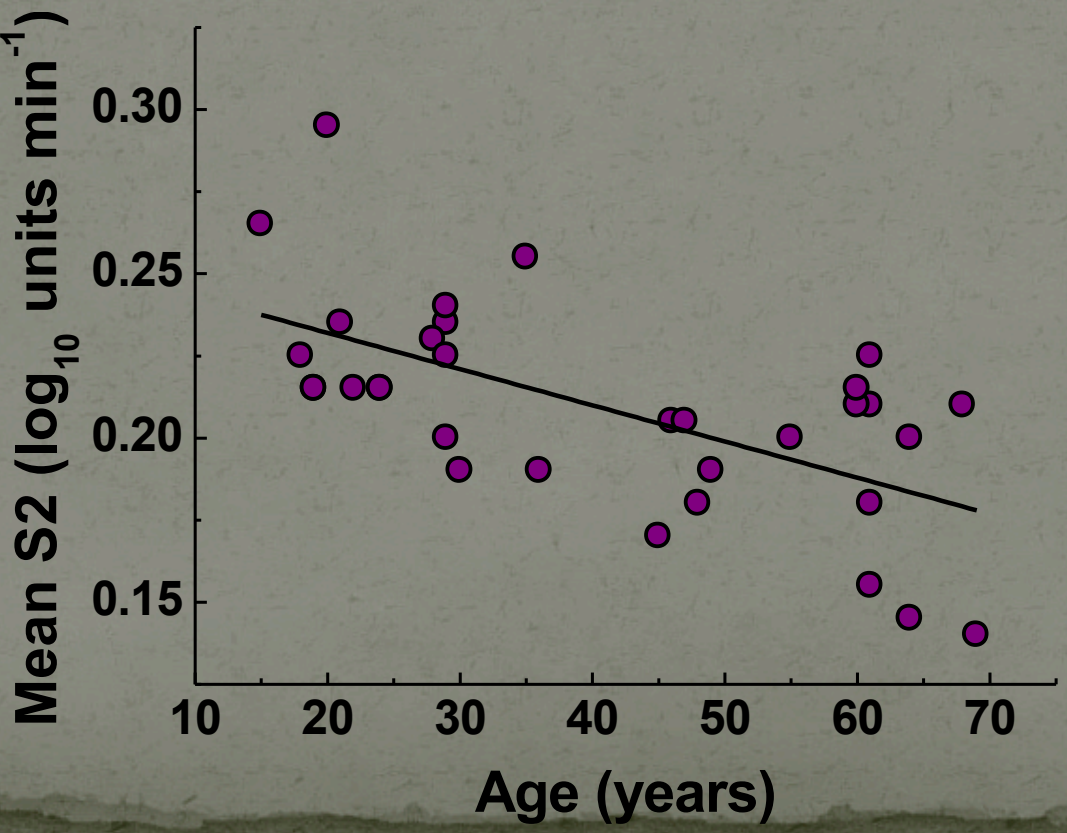


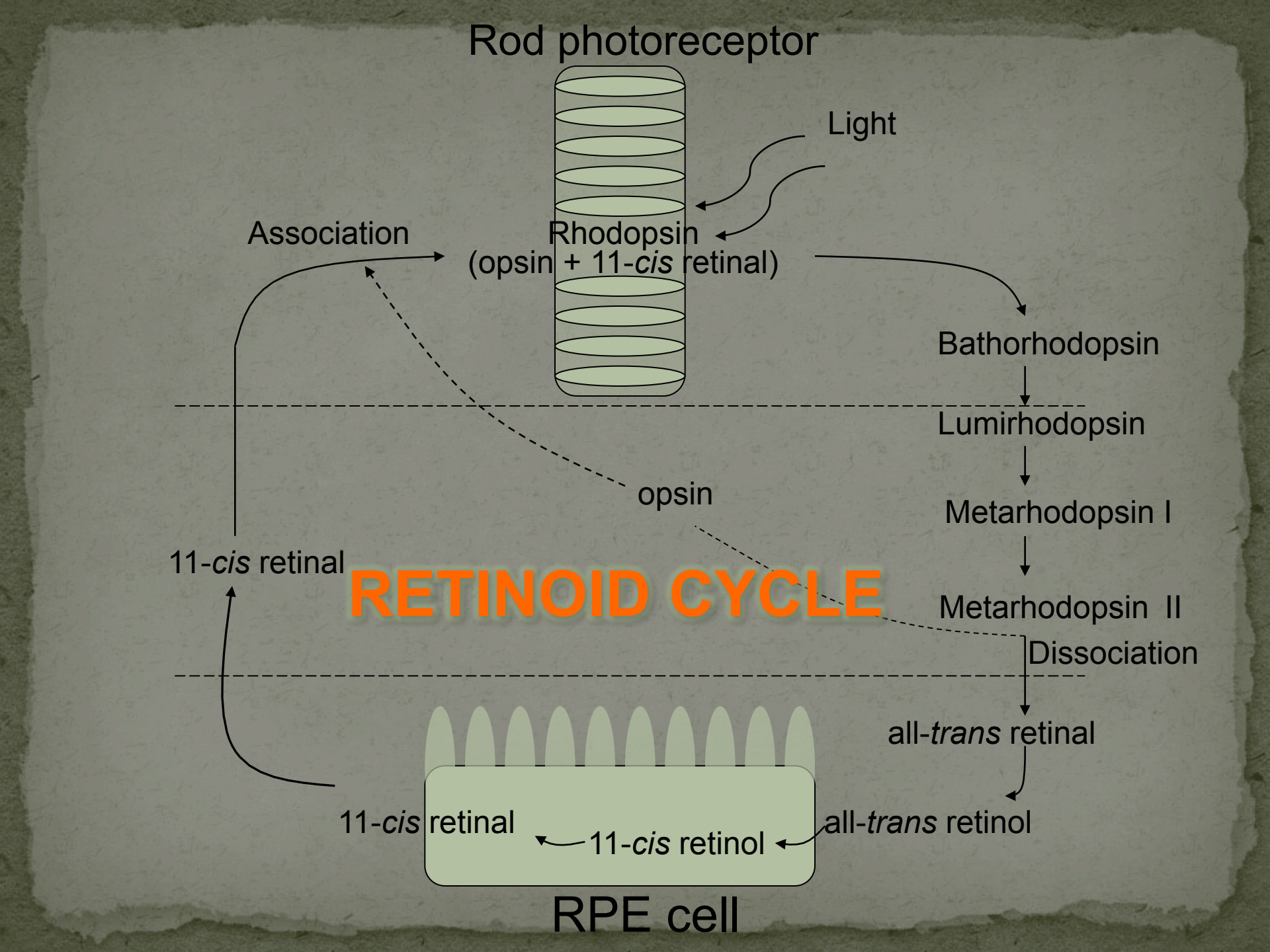


Results

Dark adaptation

Mean rate of S2 for the younger group was 0.23 ±0.03 $\log_{10}$ units min^{-1} (time constant [tc] =1.9 minutes). The older group was significantly slower than the younger group (r = 0.62, F[1,32] = 18.77, p < 0.0002) with an average S2 of 0.19 ±0.03 $\log_{10}$ units min^{-1} (tc = 2.3 minutes). The rate of S2 recovery decreased 0.01 log units/min per decade.

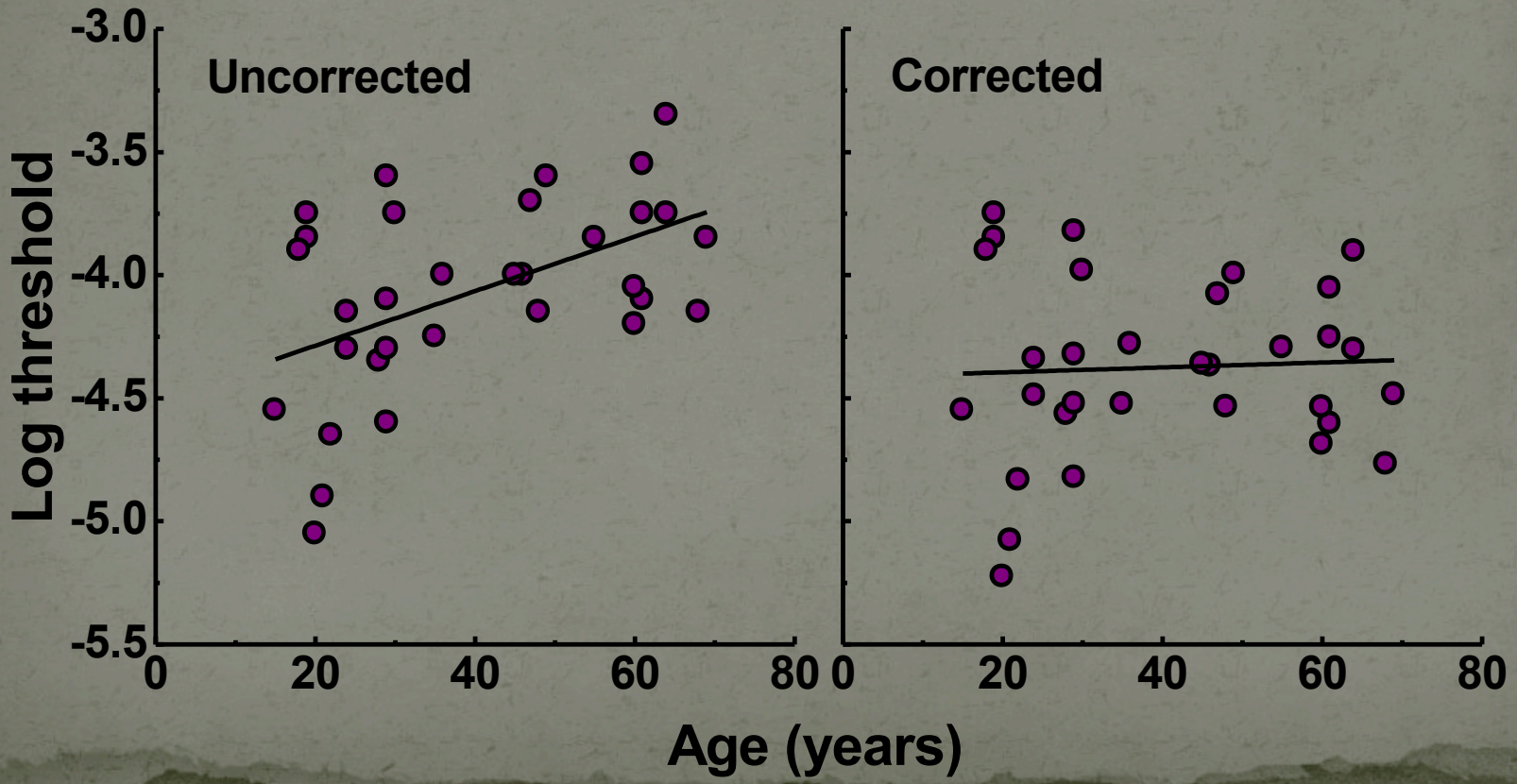



Rod photoreceptor
Light
Association
Rhodopsin
(opsin + 11-*cis* retinal)
Bathorhodopsin
Lumirhodopsin
Metarhodopsin I
Metarhodopsin II
Dissociation
opsin
11-*cis* retinal
RETINOID CYCLE
all-*trans* retinal
11-*cis* retinal
11-*cis* retinol
all-*trans* retinol
RPE cell

Results

Dark adaptation

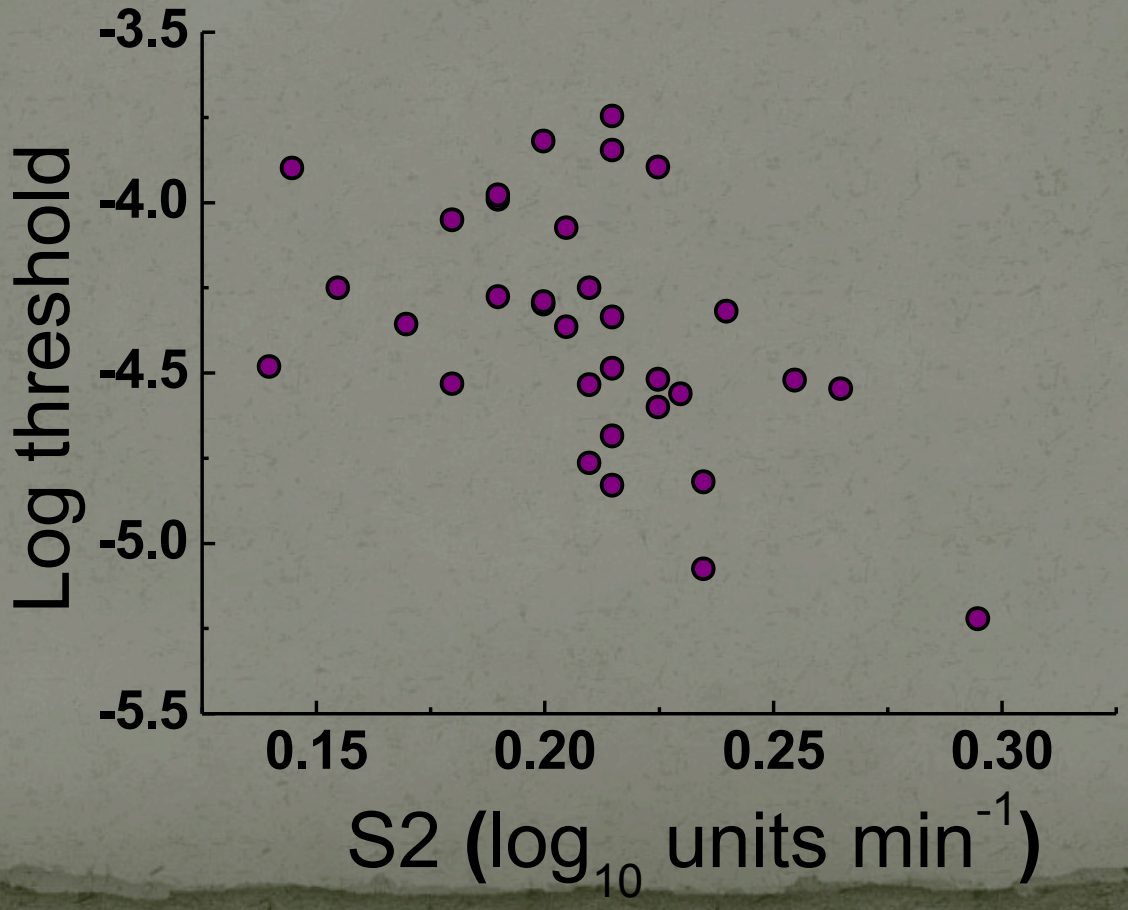
Before pre-retinal correction the mean threshold was significantly higher (0.4 log units) in the older group (p <0.004) and declined at a rate of 0.1 log units per decade. After correction, the older group sustained an average threshold elevation of 0.1 log units (p = 0.63).



Results

Dark adaptation

We also found significantly lower dark adapted thresholds (improved sensitivity) with faster S2 recovery for the whole group (r = 0.49, F[1,32] = 9.57, p < 0.005).

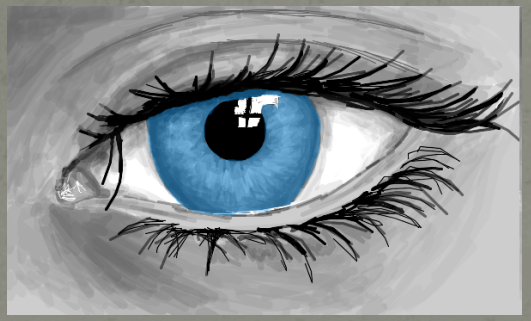


Results

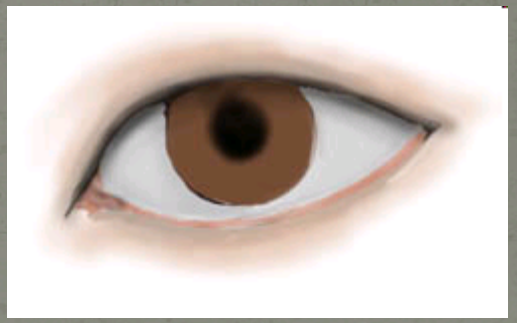
Macular pigment

The average MPOD for our group was 0.37 ±0.21. There were no significant correlations between gender or age and MPOD.

Subjects with light iris pigmentation had significantly lower MPOD than those with dark iris pigmentation (p = 0.03).



MPOD: 0.3 ±0.20

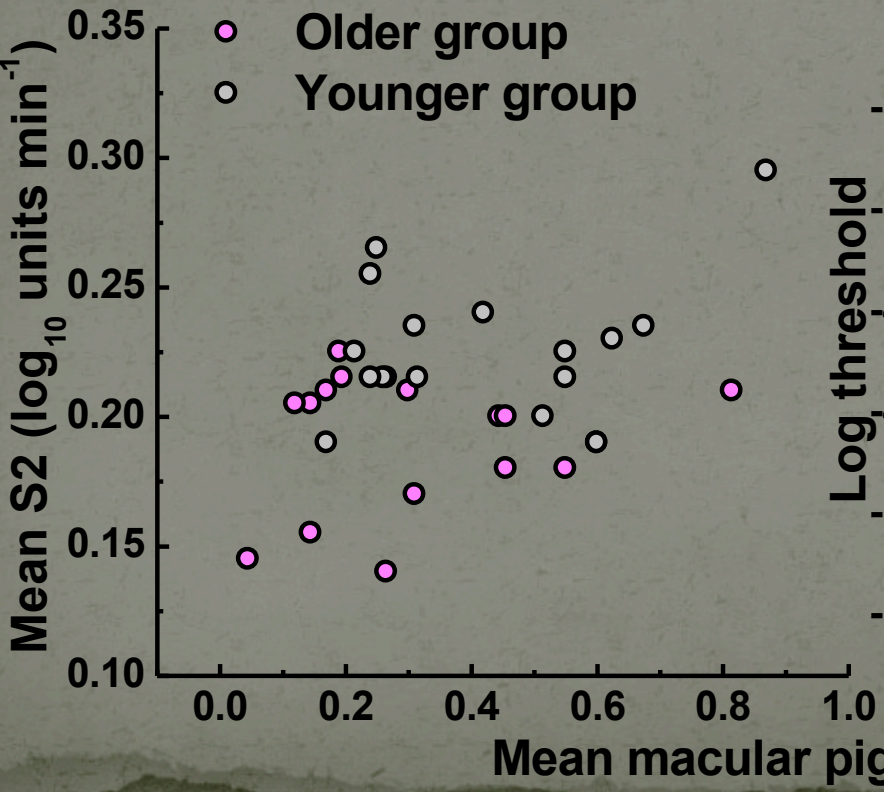


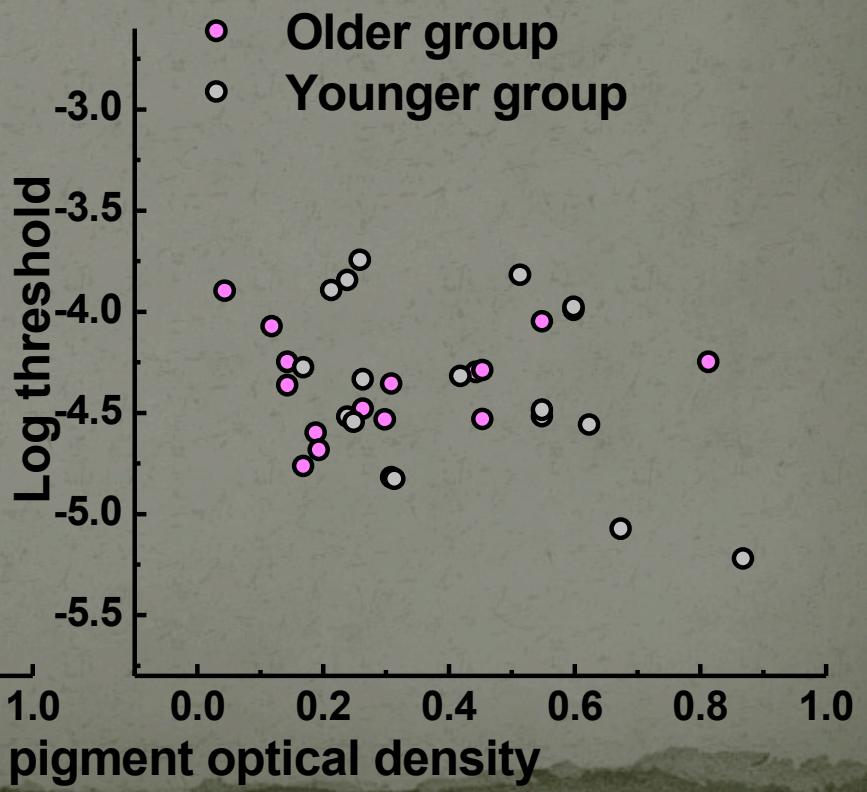
MPOD:0.5 ±0.19

Results

Dark adaptation & MPOD

We found a weak relation between MPOD and S2 (r = 0.32, F[1,32] = 3.5, p = 0.07) and MPOD and thresholds (r = 0.24, F[1,32] = 1.85, p = 0.18). The rate of S2 for the lower 10% of MPOD was significantly slower compared with the upper 10% (p = 0.037).



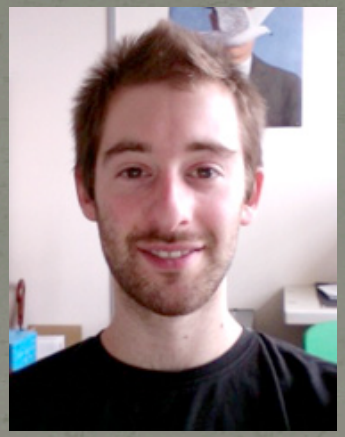


Conclusions

- Our CRT-based dark adaptometry method produced results that agree with previous studies using alternative techniques.
- Slowing down of S2 with increasing age found in this study is indicative of delayed rhodopsin regeneration which may be related to structural changes in the Bruch's membrane/RPE complex subsequent to oxidative stress.
- Macular pigment is a powerful antioxidant therefore augmentation of MPOD could have beneficial effects on scotopic vision in the elderly. Longitudinal, placebo-controlled intervention studies are needed to explore this possibility.

Thanks!

Ian Murray



Daniel Baker

Neil Parry

Dave Carden

Tariq Aslam