A comparison of psychophysical and optical methods for determining the spatial profile of Macular Pigment

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INTRODUCTION

A straightforward comparison of absolute values of the Macular Pigment Optical Density (MPOD) obtained with optical and psychophysical methods is difficult. Because of its spatial peakedness, the size of the retinal field probed has a major effect. In the objective technique of spectral fundus reflectance, the MPOD is the average over the retinal field sampled, whereas in the psychophysical heterochromatic flickerphotometry minimizing flicker might be achieved at or near the edge of the test field.

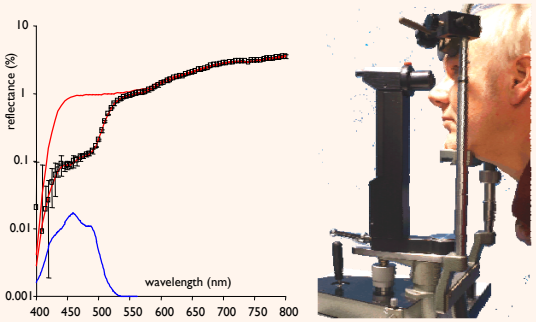
PURPOSE

To investigate the origin of the discrepancies between optical and psychophysical methods of measuring MPOD by comparing MPOD at different eccentricities.

METHODS

Spatial MPOD profiles were compared in 19 healthy individuals (13 women, 6 men) aged 26 ± 8 years, using spectral fundus reflectance and heterochromatic flickerphotometry.

spectral fundus reflectance



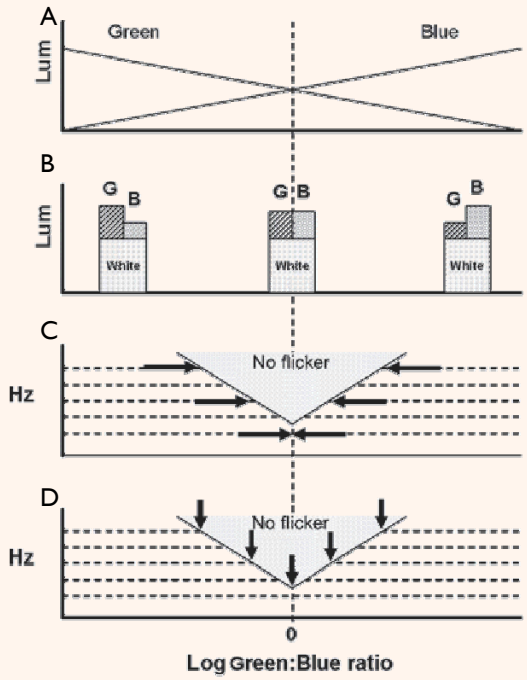
Reflectance as a function of wavelength. The red curves show model fits, with and without macular pigment. The blue curve represent the absorption profile of the macular pigment.

MPOD reflectometry estimates were obtained at 0, 1, 2, 4, 6 and 8 degrees eccentricity with the Macular Pigment Reflectometer[1], that also allowed separate determination of lutein and zeaxanthin. Measurements were performed without pupil dilation

heterochromatic flickerphotometry

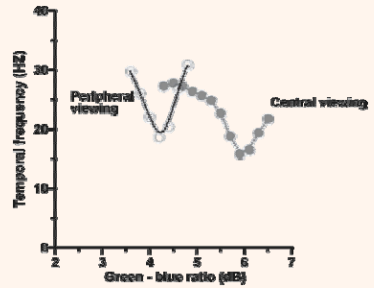
The Macular Pigment Screener[2] (called QuantifEYE in the USA) was used to assess MPOD psychophysically at 0, 0.5, 1, 2, 3, 4, 6 and 8 degrees eccentricity.

In contrast with the more conventional approach of adjusting a luminance ratio until flicker is eliminated, it employs a new technique for obtaining the minimum flicker point whereby observers press a button when they detect flicker.



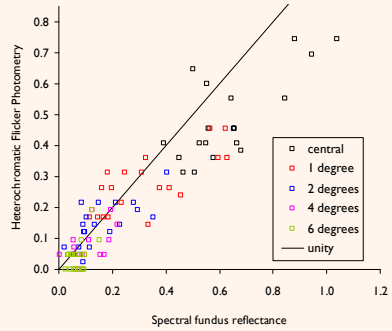
Schematic presentation of the heterochromatic flickerphotometry (HFP) procedure

- *A. The luminance of the blue and green light emitting diodes are yoked so that there is no change in mean luminance across the range of green-blue ratios*
- *B. Luminance profiles at different green-blue ratios, illustrating the white pedestal*
- *C. Conventional HFP where subjects adjust green-blue ratio for minimal flicker using a constant flicker rate*
- *D. Method used in current study where flicker rate is gradually reduced and subject presses a button when they detect flicker*



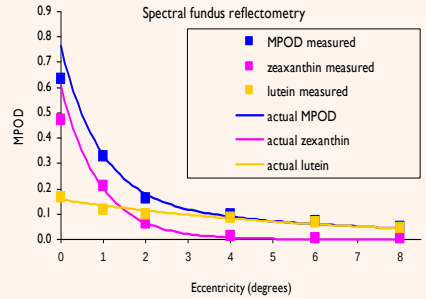
Typical measurement of the Macula Pigment Screener. The difference between the minima gives an estimate of the MPOD.

RESULTS



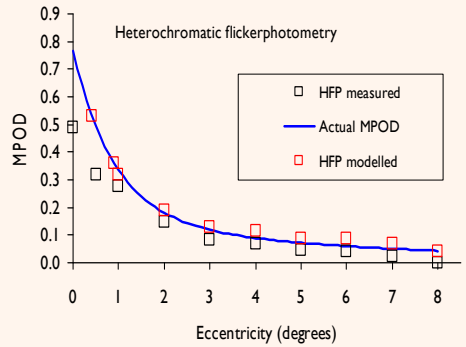
MPOD obtained with the psychophysical heterochromatic flickerphotometry versus MPOD obtained with the optical spectral fundus reflectance.

We assumed an exponential decay for both the lutein and zeaxanthin distribution and determined these spatial distributions from our spectral fundus reflectance data, that measure the average over a 1 degree field. The sum of these two is the actual MPOD profile.



Mean MPOD of the 19 subjects as a function of eccentricity obtained with spectral fundus reflectance.

For all eccentricities greater than 1 degree there was very good agreement between the actual MPOD values and the MPOD estimates obtained by the MPS, that employed a 1degree test field ($r = 0.94$, $p < 0.001$). Note that we added the MPOD estimate from the MPR data at 8 degrees eccentricity to all MPS estimates, since in the latter the value at 8 degrees is taken as the reference point. For the 0 and 0.5 degree measurements the agreement was poor.



Mean MPOD of the 19 subjects as a function of eccentricity obtained heterochromatic flickerphotometry.

In order to account for the difference between the two techniques at 0 and 0.5 degrees we assumed that on average, observers set flicker thresholds using a point at about 0.4 degrees of the flickering target when the 1 degree target was presented at 0 degrees, and at about 0.9 degrees when the 1 degree target was presented at 0.5 degrees from the centre. After these corrections there was a high correlation between the values obtained with the two techniques ($r = 0.87$, $p < 0.001$).

CONCLUSION

The psychophysical measurement of MPOD can be corrected by assuming that flicker thresholds are based on observers fixating close to the edge of the flickering target at 0 and 0.5 degrees eccentricity. At other eccentricities, flicker thresholds are not based on this so called edge strategy and resulting MPOD measurements are virtually indistinguishable from those obtained with the optical technique.

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References
[1] van de Kraats et al, *J Biomed Opt.* 2006;**11**:064031-064037
[2] van der Veen et al., *Ophthalmic Physiol Opt.* 2009;**29**:127-137