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Macular Pigment and its Contribution to Spatial Vision

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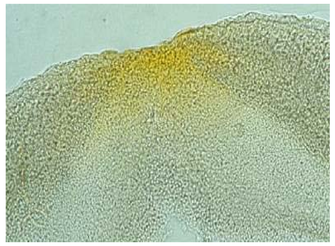
INTRODUCTION

Macular pigment (MP), which is composed of three dietary carotenoids, lutein (L), zeaxanthin (Z) and *meso*-zeaxanthin (MZ), is predominantly located at the site of maximum visual acuity in the human retina. MP absorbs short wavelength light prior to photoreceptor stimulation. Filtering such defocused short wavelength (blue) light could enhance visual performance by reducing the effects of chromatic aberration and light scatter.[1] This hypothesis, in relation to MP, remains unproven and poorly investigated to date.

Figure 1.



Central, pre-receptoral retinal location of MP. Adapted from Trieschmann et al., 2008[2]

PURPOSE

The **C**ollaborative **O**ptical **M**acular **P**igment **AS**sessment **S**tudy (COMPASS) is a double blind, placebo controlled and randomized clinical trial, designed to investigate whether MP optical density (MPOD) influences spatial vision and visual comfort by means of selective short wavelength light absorption prior to photoreceptor light capture.

SUBJECTS and METHODS

We recruited 142 young healthy subjects (mean ± SD age = 28.85 ± 6.37 years). The spatial profile of MPOD was assessed by customized heterochromatic flicker photometry (cHFP), which has been shown to be a reliable and repeatable method of quantifying MPOD.[3] Visual performance was assessed using visual acuity, mesopic and photopic contrast sensitivity, glare sensitivity and photostress recovery time measures. Each subject also completed a visual performance questionnaire, generating a performance index of the subject's perception of their functional vision in terms of colour, acuity, glare, light/dark adaptation and daily visual tasks.

MPOD measurement

MPOD measurements were obtained by cHFP (using the Macular Densitometer™) at five loci (0.25º, 0.50º, 1º, 1.75º and 3º of retinal eccentricity), with a reference point at 7º, to generate a complete spatial profile of MP.

Best corrected visual acuity (BCVA)

BCVA was assessed using a computer-generated LogMAR, high contrast chart, employing a SLOAN ETDRS letterset. A visual acuity rating (VAR) was computed to quantify precise acuity limits.

Contrast sensitivity function (CSF)

Mesopic (3 cd/m^2) and photopic (100cd/m^2) CSF curves were plotted using spatial frequencies of 1 cycle per degree (cpd), 4.1 cpd, 7.5 cpd, 11.8 cpd and 20.7 cpd. Gabor stimuli were displayed on a CRT monitor and sensitivities were determined using a linear staircase procedure.

Glare sensitivity

Mesopic (3 cd/m^2) and photopic (85 cd/m^2) contrast sensitivity was also tested under glare conditions using a sine grating functional acuity contrast test, and a radial glare source. CSF curves were plotted using spatial frequencies of 1.5 cpd, 3 cpd, 6 cpd, 12 cpd and 18 cpd. Glare effects on the CSF were determined for medium (35 Lux) and high (128 Lux) glare intensities.

Photostress Recovery Time (PRT)

PRT was evaluated using a previously described macular automated photostress test[4] using a Humphrey 745 visual field analyzer.

RESULTS

These results represent the baseline findings from COMPASS. Mean ± SD MPOD obtained at peak (0.25º eccentricity) was 0.48 ± 0.19. There was a statistically significant positive relationship between BCVA and MPOD at all retinal eccentricities (r = 0.236 to 0.354, p < 0.01) [Figures 2 and Figure 3 illustrate the relationship at 0.25º and 0.50º respectively].

Figure 2.

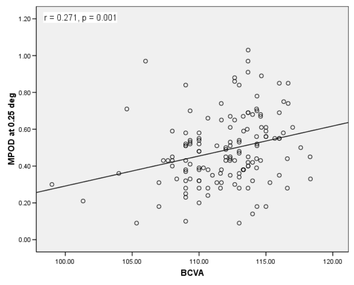
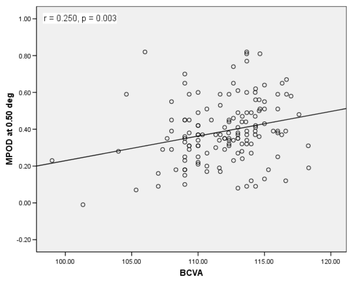


Figure 3.



There was a statistically significant positive relationship between mesopic and photopic contrast sensitivities and MPOD, but confined to the central 0.50° of retinal eccentricity (mesopic contrast sensitivity @ 7.5 cpd, 11.8 cpd and MPOD at 0.25º, 0.50º: r = 0.171 to 0.210, p < 0.05; photopic contrast sensitivity @ 1.0 cpd, 7.5 cpd, 11.8 cpd and MPOD at 0.25º, 0.50º: r = 0.174 to 0.197, p < 0.05; [Figures 4 and 5 illustrate the relationship between MPOD at 0.25º and both mesopic and photopic contrast sensitivity at 7.5cpd respectively].

Figure 4.

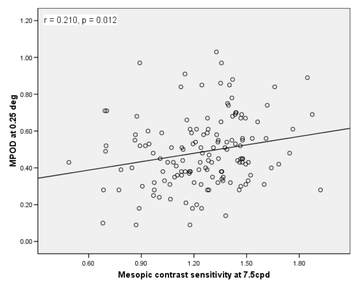
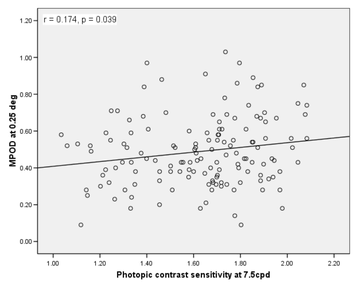


Figure 5.



There was an inverse relationship between mesopic contrast sensitivity under glare conditions for all spatial frequencies and MPOD at all degrees of retinal eccentricity, but was not statistically significant (p > 0.05).

There was no statistically significant relationship observed between MPOD and any of the functional aspects of subjective visual function questionnaire (r = -0.188 to 0.148, p > 0.05). There was also no statistically significant relationship observed between MPOD and PRT. (r = 0.002 to 0.102, p > 0.05).

CONCLUSION

Given its short wavelength absorption characteristics and central, prereceptorial location [see Figure 1], MP exhibits ideal properties to optimize visual performance. Visual performance, as assessed by visual acuity and contrast sensitivity measures, does appear to be influenced by MPOD. Photostress recovery and visual performance under glare conditions however show no significant relationship with MPOD.

The lack of consistency among the results possibly reflects the inherent difficulty associated with efforts to clarify the role of MP with respect to visual performance using a cross sectional methodology. A placebo controlled, randomized MP supplementation clinical trial, has the capacity to more adequately address the critical research question.

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