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The Relationship between Macular Pigment and Visual Performance

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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]

PURPOSE

In this poster, we present baseline data from the Collaborative Optical Macular Pigment ASsessment Study (COMPASS), which represents a cross sectional evaluation of the relationship between MP optical density (MPOD) and visual performance and comfort across a broad and refined range of functional tests. We also present preliminary data from the COMPASS longitudinal lutein supplementation investigation.

SUBJECTS and METHODS

At baseline, we recruited 142 young healthy subjects (mean ± SD age = 28.85 ± 6.37 years). A typical study visit lasted approximately four hours. Those aspects of visual performance assessed, and their sequence, is presented in Table 1.

MPOD measurement

MPOD measurements were obtained by customised heterochromatic flicker photometry (cHFP, using the Macular Densitometer^{TM}) 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.

Table 1.

DESCRIPTION	TIME (minutes)
Information leaflet and informed consent	10
Collection of blood for serum carotenoid analysis	10
Lifestyle and vision case history questionnaires	20
Refraction, visual acuity, and ocular dominance	25
Colour vision	20
Glare sensitivity	10
Visual function questionnaire	10
Contrast sensitivity	25
BREAK	~30
Macular pigment optical density spatial profile	30
Dietary questionnaire	30
Short wavelength automated perimetry	15
Photostress recovery	15
Fundus and iris photography	10
Total time:	260

Table 2.

Retinal eccentricity*	Mean MPOD
0.25°	0.48 (±0.19)
0.5°	0.39 (±0.17)
1°	0.21 (±0.12)
1.75°	0.09 (±0.09)
3°	0.09 (±0.07)
Average	0.25 (±0.12)

Glare sensitivity

Mesopic (3 cd/m^2) contrast sensitivity was also tested under medium (42 Lux) and high (84 Lux) glare conditions using a sine grating functional acuity contrast test.

Photostress Recovery Time (PRT)

PRT was evaluated using a previously described macular automated photostress test[2] using a Humphrey 745 visual field analyzer.

Statistical analysis

Pearson correlation coefficients were calculated to investigate bivariate relationships and partial correlation coefficients when controlling for confounding variables. We used the 5% level of significance throughout our analysis. Repeated measures analysis was conducted for longitudinal data.

RESULTS

Reliability testing of methods

Following pre-test training, repeat testing on 10 subjects at three separate study visits (over a 10 day period) was conducted. The intraclass correlations (ICC) obtained for all methods were high (Mean ± S.D = 0.705 ± 0.158).

The mean (±SD) **MPOD**, at all degrees of retinal eccentricity measured at baseline are summarized in Table 2. There was a statistically significant positive relationship between BCVA and MPOD at all retinal eccentricities measured (r = 0.237 to 0.308, p < 0.01) [e.g. Figure 1].

There was a statistically significant positive relationship between **mesopic and photopic contrast sensitivities (at 7.5 and 11.8 cpd)and central MPOD** (r = 0.167 to 0.220, p < 0.05) [e.g. Figure 2]

Figure 1.

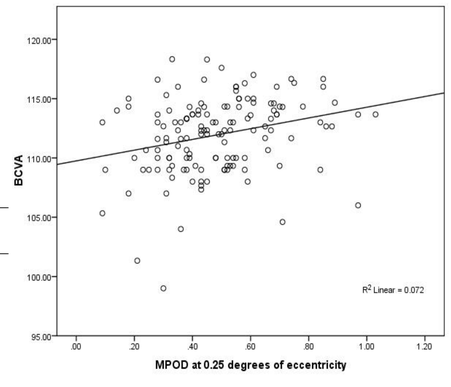
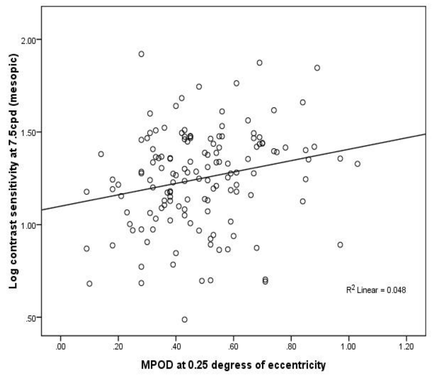


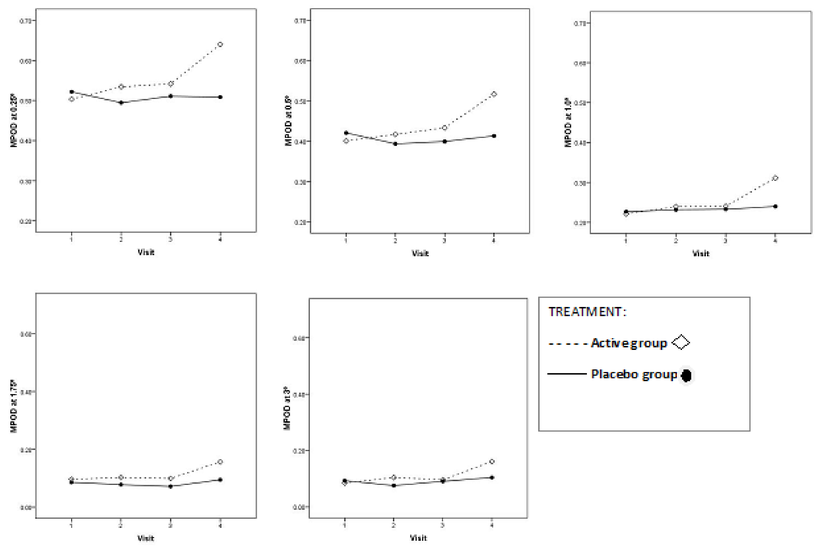
Figure 2.



COMPASS longitudinal (preliminary) findings: MPOD

We conducted repeated measures analysis of MPOD, for all retinal eccentricities measured (i.e. at 0.25º, 0.5º, 1.0 º, 1.75 º, and 3º), over the 12-month study period, using a general linear model approach, with treatment as a between-subjects factor. As seen in Figure 3, there was a statistically significant time/treatment interaction effect ($p < 0.05$) for all retinal eccentricities measured, with the exception of MPOD measured at 1.75º, which only demonstrated a borderline statistically significant time/treatment interaction effect (e.g. $p = 0.063$ for Huynh-Feldt test). MPOD increased with time in the A group, but remained virtually static in the P group. Particularly, this effect was due to a change in MPOD (in the A group) at 12-months (confirmed using paired t-test analysis between all study visits, $P < 0.05$ for all eccentricities, at 12-months).

Figure 3.



CONCLUSION

Photostress recovery and glare sensitivity were unrelated to MPOD cross – sectionally. However, measures of central visual function, including BCVA and contrast sensitivity, were positively associated with MPOD. These effects of MP on visual performance are likely to apply equally and possibly more significantly in an older population, where, for example, the incidence of driving accidents and falls directly relate to visual performance. The COMPASS longitudinal, placebo-controlled and randomized, supplementation trial will ascertain whether augmentation of MPOD can influence visual performance in such a young, healthy subject group.

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