

Assessment of visual performance in relation to macular pigment density in human vision

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Abstract

Purpose: Macular pigment (MP) is found in diurnal primate species when vision spans a large range of ambient illumination and is mediated by cone and rod photoreceptors. Rods exhibit large spatial summation generating more sluggish responses. Rod and cone signals combine in the mesopic range and this can contribute to reduced contrast acuity and poor spatial/temporal resolution. Since absorption of blue light by the MP can reduce the strength of rod signals, its presence in the centre of the retina may extend high acuity, cone-mediated vision at low light levels. This hypothesis was tested in a supplementation trial with lutein (LUT) and zeaxanthin (ZEA), the constituents of MP, by evaluating contrast acuity in the high mesopic range using a new Contrast Acuity Assessment (CAA) test (Aviat.Space.Environ.Med.74:551–559,2003).

Methods: CAA thresholds were measured under mesopic conditions, first to establish a baseline and then 6 months after daily supplementation with 20mg LUT or ZEA (n=8), 10mg LUT + 10mg ZEA (n=10) or placebo (n=4). In order to minimize the spread in thresholds only subjects with higher order rms wavefront aberration $\leq 0.86 \mu\text{m}$ were included. The retinal illuminance was one troland and the mean pupil diameter was $6.97 \pm 0.90 \text{ mm}$. Background retinal illuminance was kept constant and independent of pupil size fluctuations using a real-time, closed-loop-system for pupil size measurement and control of screen luminance.

Results: The data reveal a robust trend toward lower CAA thresholds in the groups supplemented. The difference to placebo was statistically significant ($p=0.0011$) in the group treated with LUT.

Conclusions: The results suggest that supplementation with LUT or ZEA can lower contrast acuity thresholds in the mesopic range and this may benefit driving at night and other spatial discrimination tasks when the ambient illumination is low. The results are consistent with the proposed hypothesis, but further experiments are needed with larger sample sizes to explore the whole of the mesopic range.