azulOptics

What you need to know about

How the MP-eye assesses macular pigments

The MP-eye uses a persons' ability to see the shadow created on their retina by their own macular pigments in polarized light (known as Haidinger's brushes) to determine the amount of macular pigment present. This new approach is fast enough to fit into a regular eye test, and easy enough that everyone can have their macular pigments assessed.
The MP-eye assesses how much macular pigment is in the eye. Macular pigments only come from your diet and low levels have been linked to increased risk of blindness.

What does the MP-eye do?

Macular pigment assessment
Macular pigments in the eye protect the retina from short- wavelength, high-energy visible (violet-blue, 380 – 500 nm) light and the damaging effects of oxidization by free radicals (reactive oxygen species). They do this by absorbing as much as 80-90% of the harmful blue light, and acting as antioxidants (for review, see [1]). The higher the density of macular pigments, the greater the protection for the retina. The MP-eye assesses the amount of macular pigment present, thereby providing a measure of the eye's natural defences against blue light and free radicals.

Macular pigments are antioxidants that help protect photoreceptors from free radicals and reduce the amount of violet-blue light that reaches the retina.

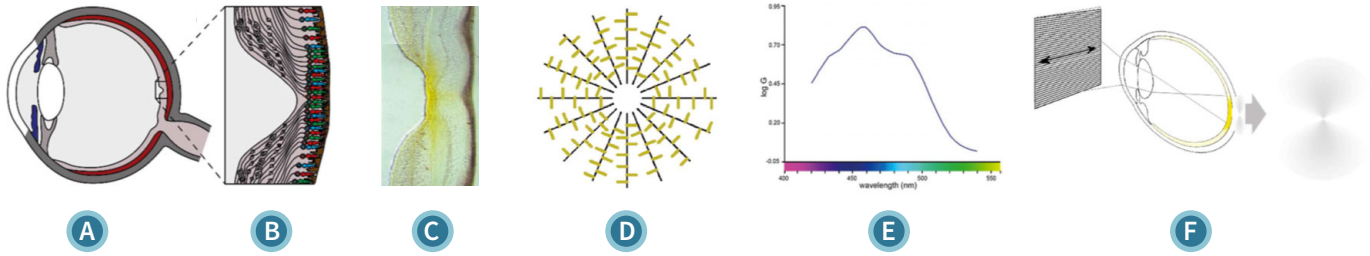


Figure 1. Schematic representation of the eye (a) and macula (b), with a cross section of a macula (c) showing macular pigments (MPs) in yellow (from Snodderly). The macular pigments (yellow lines in d) are bound to photoreceptor axons (black lines) that emmenate out of the centre of the fovea like spokes on a wheel (d). MPs absorb blue wavelengths (e) preferentially when polarized light is aligned with the long axis of the molecules, thus creating a shadow of a faded bowtie (Haidinger's brushes) on the retina (f).

How the MP-eye works

A psychophysical threshold test

The MP-eye produces a visual effect in the eye that becomes increasingly difficult to see. The test works by measuring the patient's threshold for seeing this effect, like how a Snellen or LogMAR chart is used to estimate visual acuity. For the MP-eye, the greater the amount of macular pigment the easier the effect is to see. And as the MP-eye makes the task harder, the more steps a patient with high macular pigments will be able to see therefore scoring a lower threshold, which is better. The patient is actively involved in the process as they must observe the effect and report if they can see it, or not, just like a visual fields test.

Haidinger's brushes

The MP-eye uses a visual effect known as Haidinger's brushes (Fig. 1), which is caused by the way macular pigments absorb polarized light. Macular pigments are long thin molecules that preferentially absorb violet-blue light (Fig. 1e) when the plane of polarization of the light is aligned with the long axis of the macular pigment molecule [2].

The macular pigments are attached in a perpendicular orientation to the photoreceptor axons [3] of the Henle nerve fibre layer, which emanate out of the centre of the fovea like the spokes of a wheel [4]. This alignment creates a pattern of concentric circles of macular pigment (Fig 1d).

When linearly polarized white light is observed by the retina, the absorption of the violet-blue light by the macular pigments creates a yellow shadow on the retina, where the macular pigments are aligned with the angle of the incoming polarized light. The pattern of this subtle yellow shadow has been described as a bow-tie, hourglass, or propellar and is known as Haidinger's brushes, after Karl von Haidinger who first described the effect in 1846 [5].

How well a person can perceive Haidinger's brushes is a function of the density of their macular pigments, which is the underlying principle used by the MP-eye [6-8].

What is polarised light?

Light has both particle and wave properties. As a wave it has a wavelength, which defines its colour and a wave vibration plane, which defines its polarization. Sunlight has waves vibrating in multiple planes (unpolarized). Light is polarised when the waves are vibrating in a single plane.

Light reflected from shiny horizontal surfaces like water are horizontally polarized. Polarizing sunglasses only let vertical waves in so the surface reflections (horizontal waves) are removed.

Optimising the effect

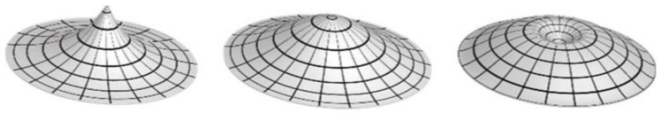
The Haidinger's brushes effect is subtle, so the MP-eye uses a special lighting environment to optimise conditions for seeing the effect. Haidinger's brushes would normally disappear within 2–5 seconds as the brain quickly adapts to static images (Troxler effect), so the MP-eye uses a rotating polarizer to maintain the effect indefinitely.
The patient will see Haidinger's brushes rotating clockwise or anti-clockwise depending on the rotation direction of the polariser and they are asked to report the direction of rotation that they observe.

Reaching threshold

The MP-eye uses patented filters that decrease the amount of light that is polarized (degree of polarization), making the Haidinger's brushes effect increasingly difficult to see [6, 7].

Threshold indicates macular pigment volume

Due to the different patterns of macular pigment density that people have (peaked, central dip etc.) [9-11] it is more useful to measure the total volume of macular pigment than just a single eccentricity.



peaked hill-shaped central dip

Clinical research has shown that a person's ability to perceive Haidinger's brushes using the MP-eye is related to total volume of macular pigments in the macula [7]. People who see Haidinger's brushes at a low degree of polarization have higher levels of macular pigmentation. The MP-eye decreases the degree of polarization in 10 steps and therefore provides a score out of 10.

Why use the MP-eye?

Know the score

For the first time, the MP-eye enables eyecare professionals to assess their patients' total macular pigmentation (macular pigment volume) as part of a regular eye exam. Every individuals' macular pigment levels are unique to them and this not only determines how much natural protection they have against long-term light damage, it affects aspects of their vision such as contrast sensitivity and glare (for more information on this, see our information sheet on macular pigments).

> Knowing a patient's score means eyecare professionals can better tailor their advice and services to that individual to support them in maintaining their long-term eye health.

Empower patients to take action

Patients with low natural defences can be advised to take actions that will help protect their eyes.

Who to test with the MP-eye

✓ Anyone with normal vision can be tested with the MP-eye and they only need to be able to indicate the direction of rotation (clockwise or anti-clockwise) verbally or with some other form of communication, such as hand movements.

✗ Patients with the following conditions may not be able to see Haidinger's brushes:

- colour blindness
- excessive damage of papillomacular bundle
- acuity less than 6/60
- corneal opacities that reduce visual acuity below 6/30
- vitreous opacities due to uveitis with VA less than 6/22
- widespread damage to the macula
- macular lesions
- diabetic retinopathy
- traumatic edema of the macula
- macular deterioration due to keratitis and uveitis
- amblyopia
- eccentric fixation
- absence of macular pigment

Literature cited

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