

## Impact case study (REF3)

<b>Institution:</b> University of Bristol		
<b>Unit of Assessment:</b> 5) Biological Sciences		
<b>Title of case study:</b> New macular pigment screening technology helps individuals at risk of age-related macular degeneration worldwide		
<b>Period when the underpinning research was undertaken:</b> 2012 - 2019		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Nicholas Roberts Shelby Temple	Professor of Sensory Ecology Senior Research Associate	2009 - present 01/2011 - 04/2017
<b>Period when the claimed impact occurred:</b> 2014 - 2020		
<b>Is this case study continued from a case study submitted in 2014?</b> No		

### 1. Summary of the impact

Age-related macular degeneration is a leading cause of blindness, affecting more than 600,000 people in the UK and 200 million globally. Low macular pigment density is a risk factor for the disease, but screening has been hampered by technological limitations. University of Bristol research showed that our ability to see the polarization of light could be used for rapid and non-invasive assessment of macular pigment density. In 2016, spin-out company Azul Optics Ltd was formed to develop the product, MP-eye, and has attracted over [text removed for publication] of investment. MP-eye has sold [text removed for publication] across the UK, mainland Europe and Scandinavia, Canada, Australia and the Philippines. MP-eye improves personalisation of consultations with optometrists and changes individuals' behaviour to protect their long-term eye health. Opticians have reported increased sales of sunglasses, supplements and blue filtering lenses.

### 2. Underpinning research

Polarization is a property of light, like colour and brightness, which can provide distinct and useful information about a visual scene. Many animals use the polarization of light to improve visual contrast and to inform behaviours including navigation and communication. Prof Nicholas Roberts and Dr Shelby Temple, with funding from the BBSRC [i, ii], developed a new, real time display-screen technology for visualizing different polarization images which was used to test how well different species of both invertebrates and vertebrates (cephalopods, fish and crustaceans) [1, 2] could see the polarization of light.

Roberts and Temple realised that the same technology could be extended to test how sensitive humans are at seeing the polarization of light [2]. The test was based on "Haidinger's brushes" – an entopic visual phenomenon that relies on the absorption of light by macular pigments in the eye. They hypothesized that the threshold of being able to see Haidinger's brushes (HB) as the percent of light that was polarized was decreased would relate to the density of macular pigments in the eye.

Macular pigments (MPs) absorb short-wavelength (380–500nm) visible light and thereby provide protection to the most vulnerable and arguably important region of the retina, the fovea at the centre of the macula. In addition to blue light protection, the macular pigments are antioxidants

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and neutralize free radicals that are a causative agent for age-related macular degeneration (AMD). Higher levels of MPs reduce later life risks of developing AMD.

While working on publication [2], Temple made the connection that this technology could be used as a tool to assess an individual's risk factor for AMD. Follow-up research funded through a BBSRC Research Grant [ii], an associated Impact Acceleration Award [iii], and an Innovate UK Innovation to Commercialisation of University Research (ICURe) Aid for Start-Ups Grant [iv], uncovered the full details of the relationship between the macular pigment density and our ability to see the polarization of light, proving this was a feasible approach [3, 4].

The core technology was patented [5], and a company (Azul Optics Ltd) was set up and incorporated in August 2016. Independent investment and grant funding were obtained, and over three years the company has developed a product called the MP-eye. The approach is elegantly simple. Individuals are asked to identify the direction of rotation of HB when presented with a circular stimulus illuminated with an even intensity of polarized white light in which the electric field vector rotates either clockwise or anti-clockwise. By reducing the degree of polarization of the stimulus light, a threshold for perceiving HB (degree of polarization threshold) is determined. Unlike previous methods of assessing macular pigment density, the speed and ease of measurement of degree of polarization threshold makes it well suited for large-scale screening of macular pigmentation. In 2017, Dr Temple was awarded the BBSRC Innovator of the Year award for his success in translating his research into a transforming commercial entity.

### 3. References to the research

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- 1) **Temple SE**, McGregor JE, Miles C, Graham L, Miller J, Buck J, Scott-Samuel NE, & **Roberts NW**. (2015). Perceiving polarization with the naked eye: characterization of human polarization sensitivity. *Proceedings of the Royal Society B*, 282(1811), 20150338. DOI: [10.1098/rspb.2015.0338](https://doi.org/10.1098/rspb.2015.0338)
  - 2) Misson GP, **Temple SE** & Anderson SJ. (2018). Computational simulation of Haidinger's brushes. *Journal of the Optical Society of America*, 35(6), 946-952. DOI: [10.1364/JOSAA.35.000946](https://doi.org/10.1364/JOSAA.35.000946)
  - 3) **Temple SE**, Roberts NW & Misson GP. (2019). Haidinger's brushes elicited at varying degrees of polarization rapidly and easily assesses total macular pigmentation. *Journal of the Optical Society of America*, 36(4), B123-B131. DOI: [10.1364/JOSAA.36.00B123](https://doi.org/10.1364/JOSAA.36.00B123)
  - 4) Misson GP, **Temple SE** & Anderson SJ. (2019). Computational simulation of human perception of spatially dependent patterns modulated by degree and angle of linear polarization. *Journal of the Optical Society of America*, 36(4), B65-B70. DOI: [10.1364/JOSAA.36.000B65](https://doi.org/10.1364/JOSAA.36.000B65)
  - 5) University of Bristol. (2017). *Measuring sensitivity to polarized light*, WO 2017/1344331 A1
  - 6) Azul Optics Limited. (2019). *Testing a subject's vision*, WO 2019/207288 A1
- Grant Funding:
- i) **Roberts N**. [Extreme Vision: Ultimate Designs in Animal Optics](#), BBSRC Fellowship, 2009 - 2014, GBP738,402
  - ii) **Roberts N**. [Seeing the world in a different light – discovering how vertebrates see polarized light](#), BBSRC Research Grant, 2011 – 2013, GBP325,121
  - iii) **Temple S**. BBSRC Impact Acceleration Award, 2015 – 2016, GBP10,350
  - iv) **Temple S**. [Azul Optics](#). Innovate UK Innovation to Commercialisation of University Research (ICURe) Aid for Start-Ups Grant, 2016 – 2018, GBP500,000

#### 4. Details of the impact

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Age-related macular degeneration (AMD) affects more than 600,000 people in the UK alone and is estimated to cost the UK healthcare system GBP1.6 billion annually. This number will rise over the coming years as we all continue to live longer and diets worsen for many. Globally the number affected by AMD is predicted to increase to 288 million by 2040.

##### **Commercialization of a new diagnosis technology**

Following the application to patent the core technology [5], Azul Optics Ltd was set up in August 2016 and, over a three-year period, a novel diagnostic to assess the amount of macular pigment present in the eye was developed. The device, the MP-eye, is designed for optometrists and enables them to identify people who are at a current increased risk of AMD. Consequently, customers can be empowered to take preventative actions such as wearing protective eyewear and hats, quitting smoking, improved diet and / or supplements and increased fitness, all of which can reduce the risks of sight loss later in life. MP-eye was registered with the MHRA as a class 1 medical device in October 2018 [Ai].

To date, Azul Optics has attracted total investment of [text removed for publication] [Ai]. The MP-eye was shortlisted for the 'good' award (best use of technology for doing good) in the South West 'SPARKies' awards (2018) and was a finalist for the 'Product of the Year' at the Association of Optometrists (AOP) awards (2020).

In 2018, Azul Optics signed an exclusive UK distribution agreement with BIB Ophthalmic Instruments that increased MP-eye product reach across the UK [B]. Subsequent to this, Azul Optics has started working with distributors across [text removed for publication] [Ai].

##### **Improved optometrist service provision**

Optometrists value the additional service and highlight how *'the technology has really added an extra dimension to our service'* [C]. Feedback from a number of UK practices confirms the added value to both individual customer consultations:

- *'a more personalised and individualised consultation to our patients, meaning we can give them advice on what treatments would be best for them. It's also a really quick test, around a minute long, which benefits both us and the patient'* [C].
- *'Unlike an OCT image or fundus photograph that require me to interpret the output for them, my patients engage with the MP-eye test and so find it easy to understand their score'* [E].
- *'I had a conversation [with a younger patient] about eye disease and preventative care that I would typically have had with someone over 55'* [E].
- *'The MP-eye is a great piece of new technology that has become a focal point for conversations with our patients about what they can do to maintain good eye health through life'* [E].
- *'The fact that there is a device specifically designed to measure this seems to add weight to the conversations we always used to have anyway. It's certainly easier for our patients to understand a number on a 1 – 10 scale than the potentially abstract explanation & advice we would have given them in the past, and so responses to macular pigment screening have been overwhelmingly positive'. [Hi].*

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and the practice:

- *'the practice has significantly improved sales of supplements, blue blocking lenses & sunglasses, leading to a quick return on investment for the MP-Eye' [D].*

Of 432 customers at one practice, 151 (35%) scored low on the MP-eye and, of these, 43 chose to select lenses with increased protection against light damage (e.g., sunglasses, photochromics and blue filtering lenses). The effect of this on revenue for the practice is in the order of GBP1,500 per month. This increase in sales not only improves protection and benefits the eye health of customers, but also increases positive cash flow for optometrists who are able to sell protective products to customers [Aii].

### Change in consumer behaviour to improve eye health and ageing outcomes

Feedback from a practice in Northampton, reports nearly 2,000 people in about 1 year had been tested with their MP-eye system. Based on the availability of MP-eye [text removed for publication], nearly 20,000 people have been screened in the UK. Global figures, [text removed for publication], would put this number at over 50,000, of whom 30% who would have scored low, have consequently been given advice about how they can make lifestyle changes to decrease their risk of developing AMD. CEO of Distributor BIB Ophthalmic Instruments commented on the positive feedback from eye care professionals who report that *'the MP-eye has encouraged patients to take action on what they can do to protect their long-term eye health'* [Bi].

Data collected by Azul Optics [text removed for publication], to understand customer behaviour, has shown that the score an individual receives from the MP-eye assessment is associated with purchases of protective products. 78% of people that scored very low (1, blue test) bought protective products. This decreased to 43% of people that scored low (1 to 3, white test) and 17% of people that scored med (4 to 6), while 0% of people that scored high (7-10) bought protective products [Hii].

Macular pigments can only be obtained from our diet. To maintain healthy macular pigment levels, people must eat a diet high in lutein and zeaxanthin, which can be obtained from foods such as kale, spinach, red and yellow peppers, corn and various other dark and brightly coloured fruits and vegetables. Many people do not eat enough of these foods and/or spend too much time in sunlight or using up their macular pigments through poor lifestyle choices such as smoking and unhealthy food items.

- *'it has encouraged better buying decisions from some of our patients with respect to macular supplements, blue-protective lenses, Transitions & sunspecs' [Hi].*
- *'a female patient, aged 60 who has some drusen in her periphery, scored very low initially. I provided recommendations, including supplements, and 6 months later during the next check-up, the same patient measured had substantially increased. This is a great outcome for the patient' [E].*
- *'I [tested] a mother and her son....last year and she said, oh I'm sure he'll be brilliant because he's always quicker than me... We weren't busy so I said well let him have a go, and he scored really badly and she was quite shocked. Then opening the discussion we talked about his diet and she said he will not eat any fruit and vegetables. So since then she's been in and she said he'll let her make him kale and blueberry smoothy now. He's having it for breakfast because he wants to beat her.' [F].*

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Data collected by Azul Optics from their customers shows a 70% increase in sunglasses sales, a 100% increase in supplement sales and 200% increase in customers choosing blue filtering lenses creating a return in investment in 6-7 months [E].

A practice in Northamptonshire teamed up with their local association for the blind during National Eye Health Week to offer free drop in assessments using the MP-eye, aimed at people who don't get their eyes examined regularly. The Marketing and Fundraising Manager for the charity explained that *'By taking these readings now we can hopefully spot the signs of potential problems at an early stage and recommend ways of improving eye health.'* [I].

### Improved practitioner and public understanding of blue light risks

Many people are aware of the risks of UV light but often fail to realise that blue light is another wavelength in the light spectrum that can be dangerous for eye health. Dr Temple has given talks and interviews for both practitioners (e.g., Association of Optometrists (AOP)) and the public on the subject of blue light [G]. A recent webinar for Thea, a global pharmaceutical company, attracted 800 participants from their customer base and approximately 250 participants viewed a further webinar hosted by Azul Optics themselves [Giii]. Dr Temple has since been asked to provide scientific content on the blue light, reactive oxygen species and macular pigment topic to [text removed for publication] [A]. Feedback from an optometrist working with [text removed for publication] highlighted the benefit for his practice; *'it has improved my team's understanding of – and confidence in discussing – the blue light hazard'* [Hi].

## 5. Sources to corroborate the impact

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- A) i) Azul Optics (2021). Corroborating statement – Co-founder, Director  
ii) Azul Optics (2020). Email correspondence - Co-founder, Director
- B) i) Optometry Today (2018). [Azul Optics signs distribution agreement with BiB](#)  
ii) BiB Ophthalmic Instruments (2018). Brochure: [MP eye – Reduce your patient's risk of Age-related Macular Degeneration \(AMD\)](#)
- C) Malvern Gazette (2019). [New eye tech at Malvern opticians](#)
- D) Azul Optics (2020). Case Study: Azul Optics MP-Eye and Smith & Swepson Opticians
- E) Azul Optics (2020). UK Optometrist endorsements
- F) Azul Optics (2020). Interview with Founder & Optometrist at Park Vision, Nottingham
- G) i) Association of Optometrists (2018). [Clarifying the message on blue light](#)  
ii) Optometry Times (2020). [Dr Shelby Temple talks the Science of Blue Light in 2020 and podcast](#)  
iii) Thea (2020). [It's all bright in the macula!](#)  
iv) YouTube (2019). [Is blue light dangerous? Dr Shelby Temple](#)
- H) Azul Optics (2021). i) Questionnaire for reviewing the MP-eye trial and ii) email correspondence containing data
- I) Northamptonshire Association for the Blind (2019). [Early Detection Day will screen for dangers of sun-damaged eyes as part of National Eye Health Week](#)