What effect will introducing a Fluorescent yellow Hurling ball (or sliotar) have on visibility, according to 'normal' vision and colour vision defects?

The question as to whether or not the colour of the ball in sport enhances visibility is one under serious debate. Chris Beck, brand manager of Srixon found this an interesting topic, and looked in great detail at this fact. Srixon is a brand owned by SRI Sports Limited, a subsidiary of Sumitomo Rubber Industries Ltd., specializing in golf and tennis. Beck stated that the 'yellow' ball used in sports such as golf and tennis, is in fact made up of a green/yellow combination. He looked into the visibility of the 'green/yellow' golf ball and found that, in comparison to the ordinary white ball, 'it was twice as easy to see at 210 yards and three times easier to spot at 250 yards.' Beck's study was quite a generalized one and does not specify the effect of colouring on different colour vision abilities, thus it is worth venturing further into this matter.

Colour vision defects come in many forms, for example; protanopia, deuteranopia, tritanopia and monochromatism.

Protanopia, often referred to as 'red/green colour blindness', is a relatively common colour vision defect, affecting 1% of males, and 0.02% of females. They lack in the amount of long-wavelength sensitive retinal cones. This type of defect makes one perceive short wavelengths of light as a blue colour, until approximately 492nm (or just before the yellow end of the spectrum), where they then perceive grey. This perception of grey is known to be the 'neutral point'. Immediately beyond this point, and hence at longer wavelengths they perceive yellow, until reaching very long wavelengths when a saturated yellow colour is observed. Please look below at Figures (2) and (3), this will highlight perception of a typical protanope. (Goldsteine, 2010)

Deuteranopes, again accepted to be ‘reg/green colour blindness’, is less common affecting 1% of males, yet only 0.01% of females. They lack in the amount of medium-wavelength cones (green end of the spectrum). It differs from protanopia in that individuals struggle more greatly at the green end of the spectrum, whereas red proves more problematic for protanopes. The neutral point for deuteranopes is at a slightly longer wavelength than that of prontanopes, 498 nm. A deuteranope experiences very similar problems as protanopes; such that purple shades are indistinguishable from blue hues. (Backhaus, Kliegl and Werner, 1998) The visible spectrum of a deuteranope is illustrated below in Figures (4) and (5).

Tritanopia, or ‘blue/yellow colour blindness’ is far less common than the previous two conditions, affecting only 0.002% males and 0.001% females. (Goldsteine, 2010) Tritanopia affects one’s ability to discriminate colours ranging from short-mid wavelengths (and hence blue/yellow range of the spectrum). Thus, they observe short wavelengths with a blue tinge and longer wavelengths as red. Their neutral point occurs at approximately 570nm. Tritanopes are at a disadvantage in detecting yellow shades, and in particular will struggle discriminating between yellow and green. This is illustrated below in Figures (6) and (7). (Gegenfurtner and Sharpe, 2001)

Monochromatism is an extremely rare phenomenon, occurring only 1 in 1 million. It is the defect referred to as ‘total colour blindness’. It is due to at least two of the retinal cone pigments lacking, thus resulting in monochromates being unable to distinguish between colours at all, and hence giving the perception of a black/white world. (Grosvenor, 2007) This is illustrated below in Figure (8).

The ball in hurling, more commonly known as a 'sliotar', originated in 1886. It was brown in colour, very similar to that shown here. As expected, this ball deemed very difficult to see against the green grass on the pitch, therefore needed adaptation. Improvements were made, accredited to Johnny McAuliffe, which improved; visibility, wear and weight. In appearance, the newest version of the sliotar is illustrated here.

The sliotar must meet certain standards, according to the GAA before being used in professional competitions. The following regulations apply:

- The diameter is between 69 mm and 72 mm (not including the rib)
- The mass is between 110 g and 120 g
- The rib height is between 2 mm and 2.8 mm, and width between 3.6 mm and 5.4 mm
- The leather cover can be between 1.8 mm and 2.7 mm and is laminated with a coating of no more than 0.15 mm

When designing the ideal hurling ball, the above criteria must be met. The question of colouration; ie maintaining a white coating or adapting a yellow colour is still in question. Therefore it is worth debating this fact in accordance to relevant research.

A study was carried out by Sloan and Habel, testing how different colours were viewed by patients of different colour vision abilities. They concluded that, provided the correct luminance levels and chromaticity were achieved, necessary identifications were made across the whole spectrum regardless of colour vision anomaly.

(Sloan and Habel, 1955) In a study carried out in 1972, on different tennis balls, results found the best overall visibility was achieved when a fluorescent yellow colour was adapted. It in fact, proved to be measurably more visible than a white ball, even when viewed on the television. (Dennis, 1972)

In 1986, at Wimbledon, the first yellow ball was introduced, and proved superior to the original white balls in accordance to; players, spectators and television audience. (www.BBC.co.uk)

Similar conclusions were found in studies in; 1990, 2000 and 2007; such that a bright/fluorescent coloured ball is preferred and/or deemed easier to see. (Quigley, 1990; Komatsu et al, 2000; Nugent, 2007)

It is now worth discussing what each type of colour vision defect may experience with the introduction of this fluorescent yellow ball. For example, both protanopes and deuteranopes can still detect yellow, therefore strengthening the case for the introduction of a fluorescent yellow ball. As for a monochromate, who generally see the world in ‘black and white’, it may not make a difference. Although one could argue that the contrast between the fluorescent yellow ball and the grass may prove easier for such a person to discriminate than a white ball and the grass. The only type of colour vision defect that may be deterred by the introduction of a yellow ball may be a tritanope. As they have a disability in discriminating colours ranging from short-mid wavelengths, they may in fact struggle detecting this yellow ball, and are at a further disadvantage when trying to distinguish the yellow ball from the green grass.

Another factor to consider in the design is the colour of the stitching. Dennis' experiment, briefly mentioned earlier, also looked into the best colour/contrast for the stitching. He concluded that red stitching, in fact, offers maximum contrast, and hence enhanced visibility against a yellow ball. (Dennis, 1972) These findings were re-established by Shinohara, in 2009, whereby he found reddish colouring (in golf) improved visibility. (Shinohara, 2009)

Therefore, in conclusion, the answer to the question is yes, it would be beneficial to create a new sliotar in a fluorescent yellow colour. Visibility would be further advanced if red stitching was used. Finally, it would not greatly affect visibility regardless of colour vision defect. As briefly discussed previously, tritanopes may experience slight problems in detecting a yellow ball, but as the prevalence of this defect is so minute, this fact may perhaps be deemed irrelevant.

Figures

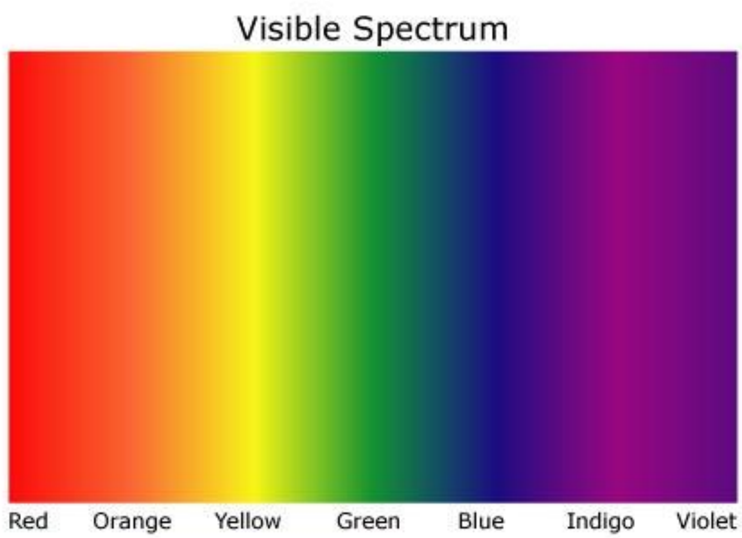

Figure (1). A basic example of a rainbow/spectrum of colours as viewed by a person with ordinary colour vision. (Image adapted from http://cronodon.com/BioTech/Plants_FAQ.html)

Figure (2). A basic example of a rainbow/spectrum of colours as viewed by a person with protanopia. Image adapted from http://blog.eyequant.com/category/eyequant-2/)

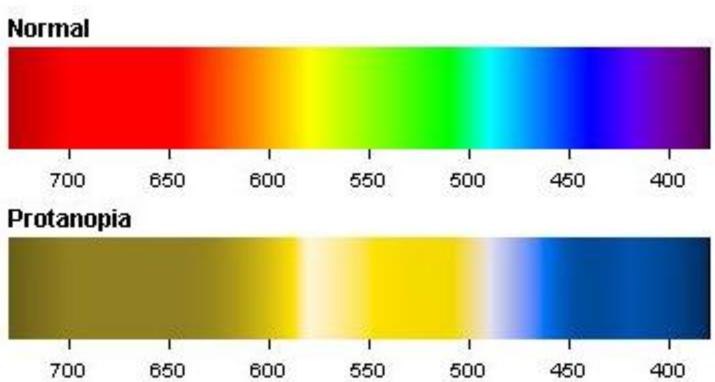

Figure (3). A comparison of the visual spectrum between a ‘normal’ and a ‘protanope’

Figure (4). A basic example of a rainbow/spectrum of colours as viewed by a person with deuteranopia. (Image adapted from http://blog.eyequant.com/category/eyequant-2/)

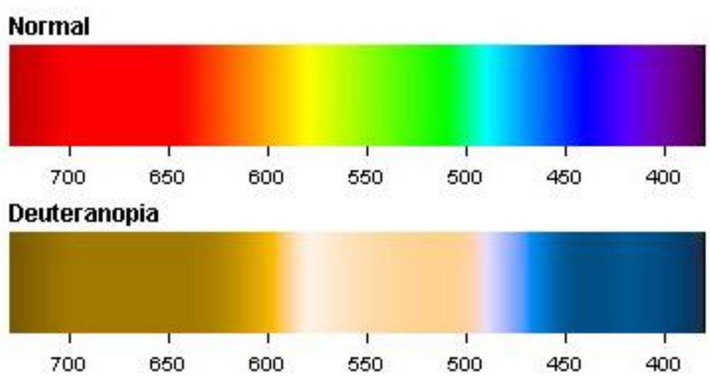

Figure (5). A comparison of the visual spectrum between a 'normal' and a 'deuteranope'

Figure (6). A basic example of a rainbow/spectrum of colours as viewed by a person with tritanopia. (Image adapted from http://blog.eyequant.com/category/eyequant-2/)

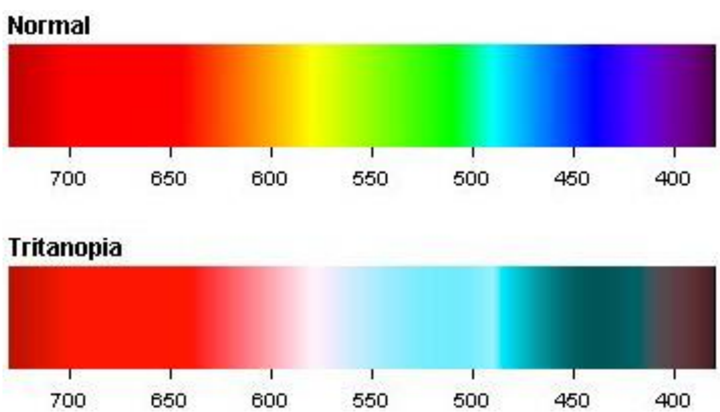

Figure (7). A comparison of the visual spectrum between a ‘normal’ and a ‘tritanope’.

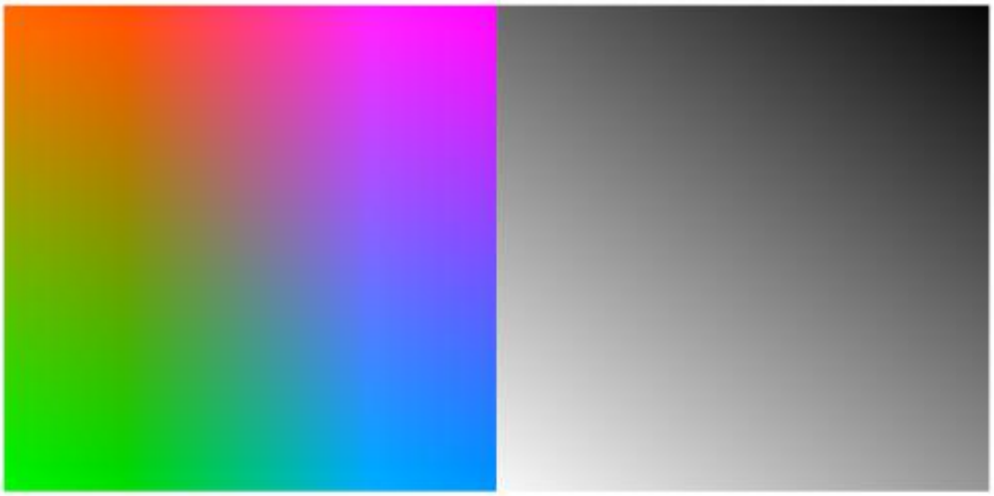

Figure (8). A comparison of the visual spectrum between a ‘normal’ and a ‘monochromat’. (Image adapted from http://entirelysubjective.com/visible-spectrum-tiny-window-into-the-world/)

