

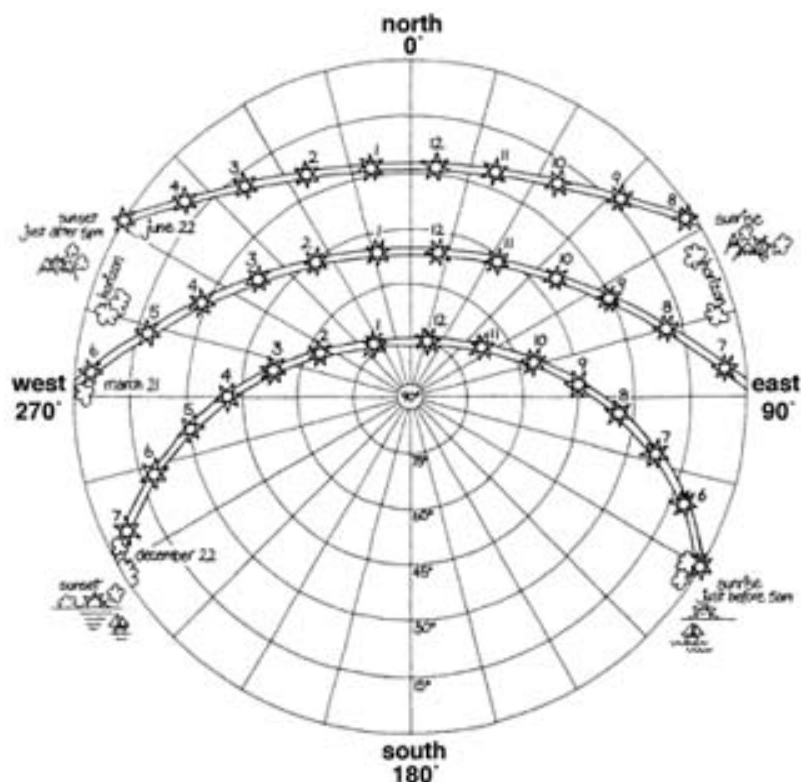
# Emulating the Sun: The Benefits of Tru-Colour LEDs During the Cooler Months.

This paper investigates how high quality lighting can be used to benefit one's mood and health during the shorter days of cooler months.

## SAD, Winter Blues and Shorter Days

Since the 21st of December, the days have gradually been getting shorter and shorter. The end of daylight savings in Victoria, New South Wales, Tasmania, South Australia and the ACT this past Sunday heralds the beginning of the cooler months and less daylight hours. These changes can shock a person's system, resulting in symptoms similar to jet lag.

The shortening of days is due to how the earth orbits the sun. Because the earth's axis of rotation is being tilted, its orientation to the sun is constantly changing throughout the year. This is visualised below by showing the path of the sun across the sky in southern Australia.



Besides the fact that there is substantially less time that the sun is in the sky during the colder months, it also shows how the sun is predominantly located in the northern sky. If a building lacks north facing windows, the presence of natural lighting within the space decreases drastically during winter – resulting in an increased reliance on electronic lighting.

Seasonal Affective Disorder (SAD) occurs in 10%-20% of the population and is the result of having less access to natural light. It is classified as a mood disorder in which people who have normal mental health throughout most of the year experience depressive symptoms, most commonly being winter depression or the 'winter blues'.

In 2001, Dr Wehr and Dr Rosenthal ran an experiment on SAD and found that patients with seasonal depression release nocturnal melatonin for a longer duration than other patients in the winter. Wehr and Rosenthal identified similarities in people who suffered from SAD with other mammals that exhibit seasonal behaviour. These physiological changes could be due to the fact that slowing down, sleeping more and conserving energy in the winter months provides a survival advantage.

The most extensively studied treatment for SAD is light therapy. Because the body's circadian clock is regulated by light exposure to the retina, when the sun rises later each day people's circadian clocks change. When people are required to wake up at the same time year-round, their bodies can fall out of sync with their circadian rhythm during winter, disturbing their sleep, mood and wellbeing.

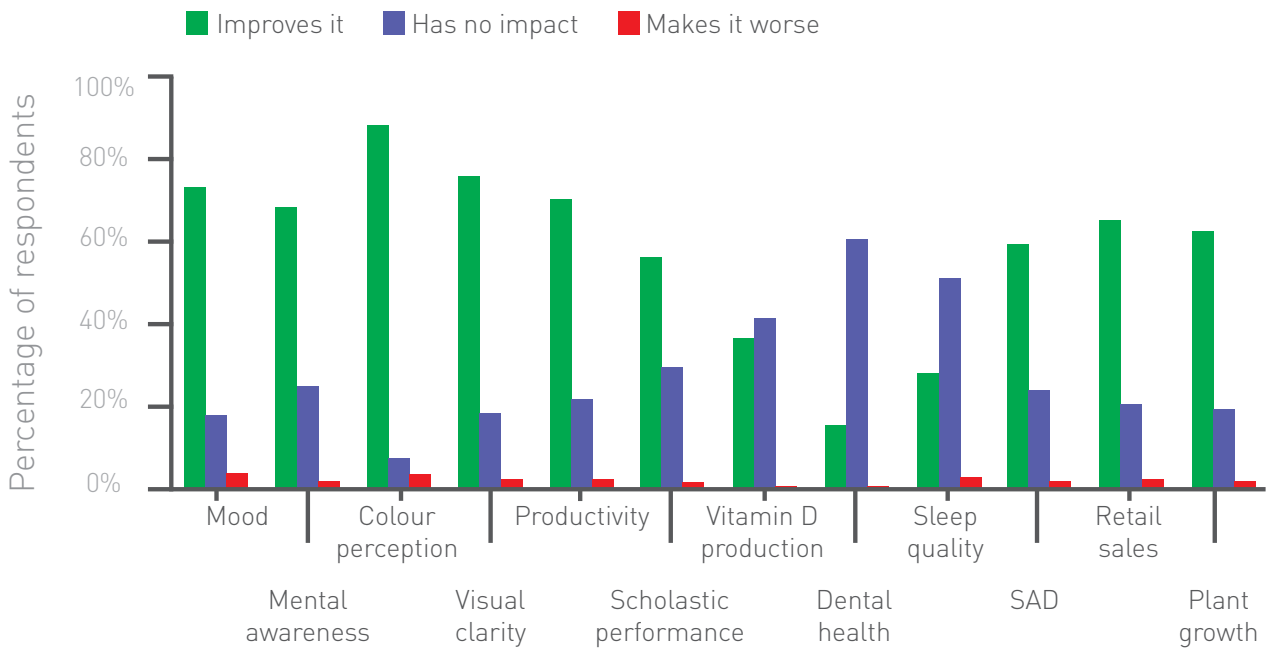
## Positive Effects of Light that Emulates the Sun

Natural light's ability to regulate the body's circadian rhythm is not the only positive benefit. The effect of how things look in natural light compared to common artificial light sources has a number of benefits. These benefits can be obtained if lights with similar properties to natural light are used.

Lights that have a high Colour Rendering Index (CRI) and a full and even spectral power distribution (SPD) are able to replicate natural light from the sun better than standard LEDs and fluorescent lighting. Light sources that have gaps and large variation in SPD can cause people to view colours differently and miss subtleties in textures and other aesthetic details. Light sources that have a full and even SPD allow for greater perception of colours and textures, providing the viewer with better visual acuity and leading to positive psychological benefits.

Preferences for natural light are substantial and may reflect the positive psychological associations produced in the natural environment. The positive effect induced by lighting that is closely matched to daylight may, in fact, help improve mood and motivation and thus increase productivity (Ott Biolight Systems, 1997).

In April 2003, the National Lighting Product Information Program (NLPIP) conducted a survey asking lighting specifiers, electrical contractors and facility managers about the impact of lighting that closely emulates natural light has over other types of artificial lighting. The below graph shows the results and illustrates the strong positive reaction survey takers had when asked about the importance of high quality lighting.



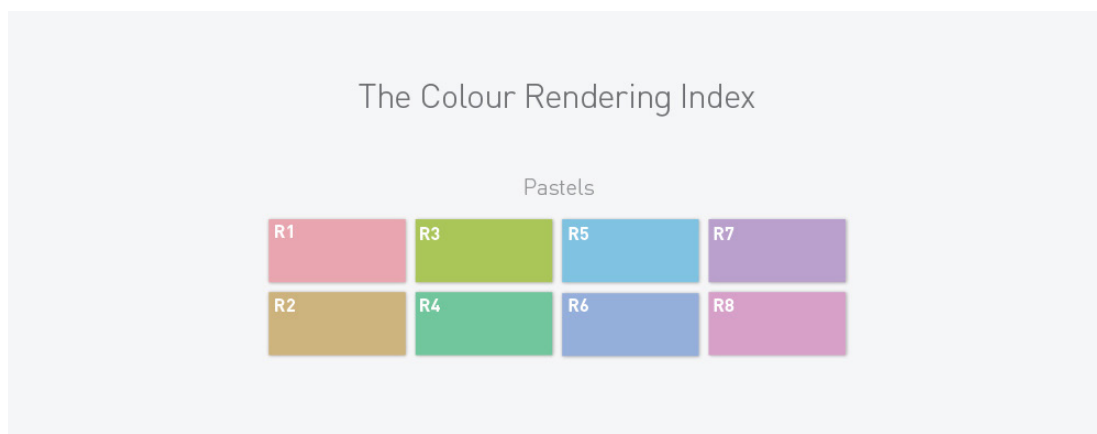
## Recreating the Sun

Previously, many researchers used daylight as the benchmark to which to compare the color rendering of artificial lights. The reason for this was because daylight was the best lightsource to use to:

1. Display a great variety of colours;
2. Distinguish between slight shades of colour, and;
3. Make the colours of objects around us obviously look natural. (11)

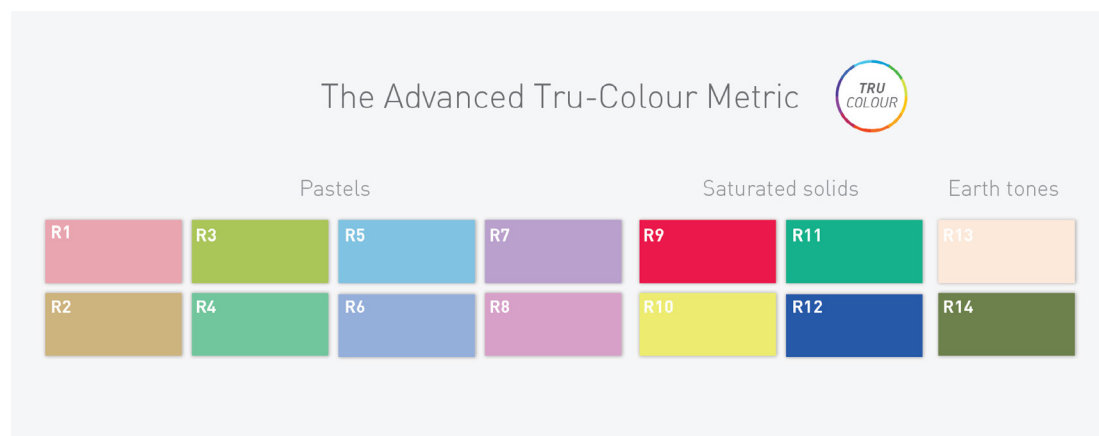
Only in the last 50 years has the International Commission on Illumination (CIE) created a standard of referencing the CRI to a black body of a similar colour temperature. This closely matched incandescent bulbs and was able to be easily changed for different correlated colour temperatures (CCT).

The Colour Rendering Index (CRI) is a method of measuring a light's ability to illuminate different colours using a number from 0 – 100. There are 8 standard colours that are used when testing for CRI, as shown below.



A 'perfect' white light is made up of all possible wavelengths of visible light combined and is said to have 100CRI. Therefore, a light with 80CRI would be missing 20% of the light wavelengths that make up the visible spectrum.

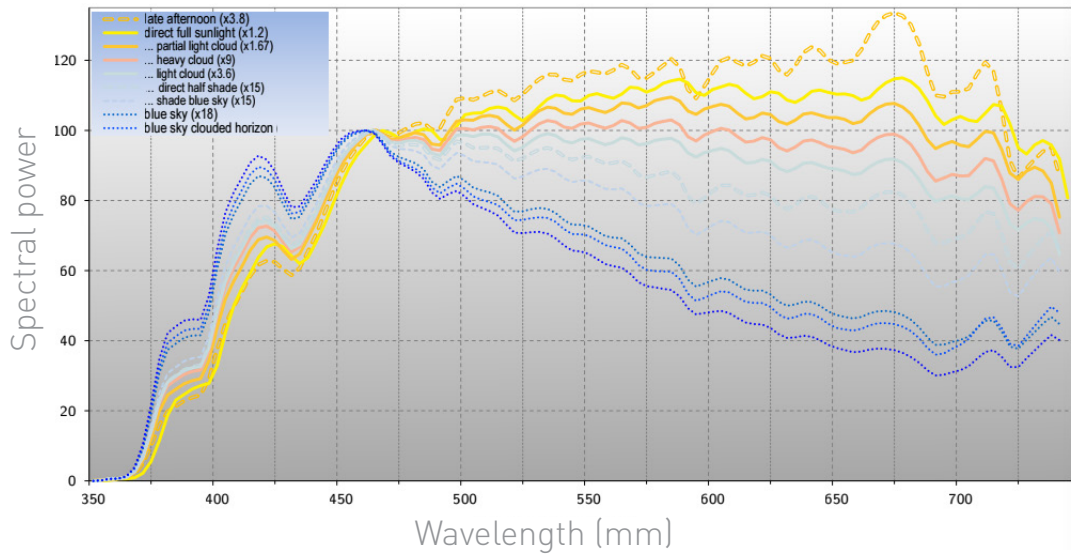
Unfortunately, because the CRI method only uses the standard palette of 8 pastel colours (R1 to R8), saturated colours such as red, yellow, green and blue are optional extras and are not taken into account into the lights final CRI score. Due to there being only 8 colours used in CRI calculations, many light sources with a high CRI perform well for colours R1- R8 but poorly for other colours, such as R9 the saturated red.



Brightgreen's advanced colour rendering metric Tru-Colour, surpasses CRI, by measuring a light's ability to represent high levels of 14 key colours on the visible spectrum, including R9, to enhance the appearance of interior spaces. The R9 value is a key colour, particularly for emulating the natural light quality of the sun. Lights that achieve high levels of the R9 red tone enhance the aesthetic quality of interior spaces, adding depth to richer colours and evening bringing out the healthy rouge in skin tones. Lights that score high R9 levels, amongst other saturated colours, are also required to recreate afternoon sunlight, that when used appropriately can elongate the amount of perceived sunlight the user experiences in a day.

Traditional less efficient light sources, such as incandescent and halogen lights, render reds easily, whereas other sources such a fluorescent, metal halide and LEDs can struggle. Due to this many LED manufacturers don't disclose there R9 values.

The graph on the next page shows how the spectral distribution of sunlight changes in the afternoon. An increase in spectral power of red and orange wavelengths can be seen in afternoon sunlight. By representing high R9 levels, Tru-Colour LEDs better emulate natural afternoon light.



<http://www.lrc.rpi.edu/programs/nlpip/lightinganswers/fullspectrum/claims.asp>

## Summary

The above research outlines the potential benefits of using high quality interior lighting to combat the negative effects that shorter winter days have on people's mood and sense of wellbeing. While further research is required to quantify the benefits of lighting that comes closer to emulating the colour spectrum of the sun, the research cited in this paper indicates that by simulating the lighting of summer months Tru-Colour LEDs could help minimise the effects of the "winter blues".

In addition to enhancing interior spaces by making them appear more natural, lights that feature an even spectral power distribution and high levels of a broad spectrum of colours could potentially improve sleep cycles, mood and overall sense of wellbeing during seasons with less daylight hours.

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