



lightculture)
INSPIRED LIGHT

**BEYOND
VISION™**

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A new era in workplace lighting is evolving. Young, dynamic business cultures, operations and associated work patterns are generating exacting demands on office lighting. Emerging lighting technologies and new knowledge of non-visual pathways offer exciting opportunities for lighting products to meet these demands. Poorly designed products and light quality can compromise staff health and performance in a variety of ways because their pathology is so extensive.

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INTRODUCTION

Since the discovery of the intrinsically photosensitive Retinal Ganglion Cell (ipRGC) at the beginning of the century, much research has been focused on its purpose and performance, and a great deal has been learnt.

The team at Light Culture have closely followed these developments, attending international conferences delivered by research leaders, and working closely with the International WELL Building Institute to develop a product family that offers unparalleled performance for workplace lighting.

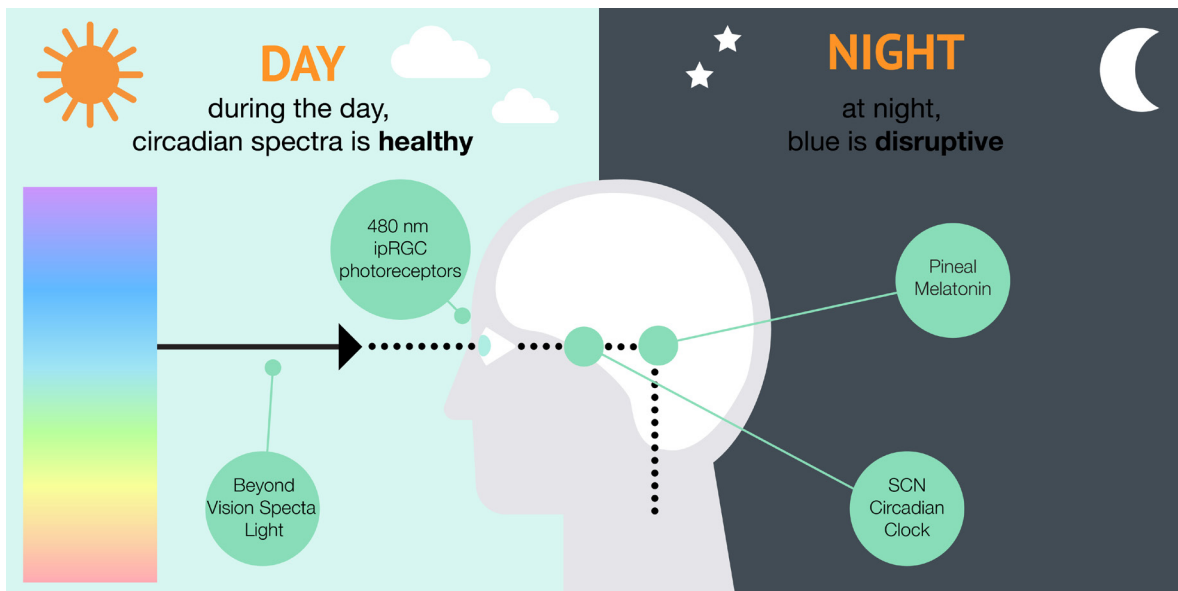


EVOLUTION

Human beings have evolved to function under daylight. With the advent of artificial light, it seemed we could adequately replicate daylight to perform a wide variety of tasks at any time of the day. However artificial light is not daylight – spectral depletions occur for commercial and technical reasons. Since the introduction of artificial light there have not been sufficient generations for us to adapt to this dramatically changed spectra, leaving us with a biological hunger for daylight. Fenestration in buildings is very important, but workplaces often receive insufficient natural daylight, so artificial light needs to supplement our basic needs.

THE NON VISUAL PATHWAY

Nearly all creatures have adapted to a 24 hour light-dark cycle by developing biological rhythms, commonly called circadian rhythms. In humans, these rhythms are regulated in the suprachiasmatic nucleus (SCN), located in the hypothalamus region of the brain. The periodicity is influenced by the light-dark cycle that a person is exposed to. Disruption to this cycle has an influence on the secretion of hormones such as melatonin and cortisol. This can lead to maladies such as; poor sleep, alertness (or awakeness), effects on performance, and even increased risk of more serious ailments such as diabetes, obesity, and cancer.



BENEFITS

- Synchronised circadian rhythms
- Melatonin suppression
- Improve alertness
- Improve health and well being



The discovery of the ipRGC has uncovered a great deal of knowledge about circadian lighting and our sleep-wake cycle. ipRGCs in the retina produce a response to bright corneal illuminance to express the photopigment melanopsin, which drives the non-visual pathways (circadian rhythms) and the suppression of melatonin production by the pineal gland. Interestingly, the location of the ipRGC cells is largely in the lower section of the retina, corresponding to light entering the eye above the horizon, as would be expected from a mammal that has evolved under daylight.

Light at a wavelength of around 480nm is the primary zeitgeber to this response, with shorter and longer wavelengths having a rapidly decreasing effect. Typical LED chips for lighting primarily produce blue light. They are coated with a phosphor material to convert the emitted blue into a broader



spectrum white light. The resulting Spectral Power Distribution (SPD) has a peak at 450nm and a corresponding trough at 480nm. These LEDs were designed to achieve a spectrum of light which is seen efficiently by our eye's cones, and consequently have a high efficacy (lm/W). However since the ipRGCs are sensitive to a very different spectrum of light, these LEDs have little effect on our circadian system.

Alternative phosphor materials are under research to shift the peak, without having a negative impact on overall efficacy, but little of commercial value is available at present.



DAY & NIGHT

Put simply, blue light at 480nm is most effective at suppressing melatonin secretion, a process necessary during daytime for alertness and well being. Blue light at any wavelength should be avoided at night time, particularly in the 2 hour period before sleep, to encourage the production of melatonin by the pineal gland. Melatonin is sometimes referred to (not inaccurately) as the sleep hormone. The benefits of a good sleep pattern are well known, and much has yet to be uncovered. Melatonin synthesis during this period has also a great many other health benefits.

THE METRICS

Several established metrics are recognised, by which the potency of the spectrum, to deliver a desired melatonin suppression, are measured. Most common are EML (Equivalent Melanopic Lux) used by the International WELL Building Institute, and Circadian Stimulus (CS), developed by the Lighting Research Centre (LRC). Both these systems use a different calculation method, and arrive at different figures, and both have merit. They are competing metrics, but not

conflicting. Beyond Vision™ have chosen to use the EML method, in line with WELL, although CS values can also be calculated. EML is calculated using a Melanopic Ratio (MR) which is the ratio of the melanopic response to the visual response, based off measurements taken every 5nm across the visible spectrum. NATA laboratories now provide this service, and many light meters are available that can accurately measure the values directly.



OTHER FACTORS

Spectral composition and melanopic lux are the keystones to good circadian lighting, but many other factors are equally important.

DIRECTION – Benefits only derive from corneal illuminance so the concept of horizontal lux on the working plane is of little consequence. All calculations of EML are based on vertical illuminance at the eye, whether standing or seated. Luminaires with optical systems that offer high vertical illuminances (yet still manage glare) will be more effective.

DURATION – Whilst mornings are considered most important, high EML can be beneficial during all hours of daylight. Dimming systems can be used to reduce general lighting levels, and hence EML, later in the afternoon period.

WELL BUILDING STANDARD

The WELL Building Standard was launched in 2014, after 6 years of research and development. It is the premier standard for buildings, interior spaces and communities seeking to implement, validate and measure interventions that support and advance human health and wellbeing. It is now utilised in more than 30 countries.

V2 is the latest version of the standard, and was constructed following advice

from “concept advisories” from many countries. There are 10 concepts within the document, light being one. 9 lighting features are assessed, and points awarded for compliance. The circadian feature (L03) alone, awards 3 points maximum.

Achieving the available lighting points within the WELL Building Standard requires close attention to the selection and layout of artificial lighting products. Using traditional office

luminaires will likely lead to higher than required horizontal illuminance on the working plane, increased glare, and Lighting Power Densities above those required under Section J6 of the NCC.





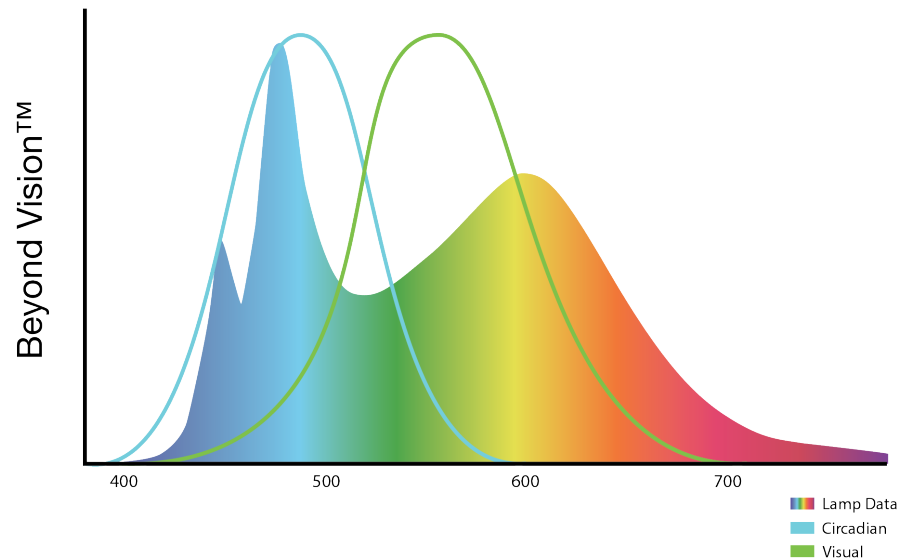
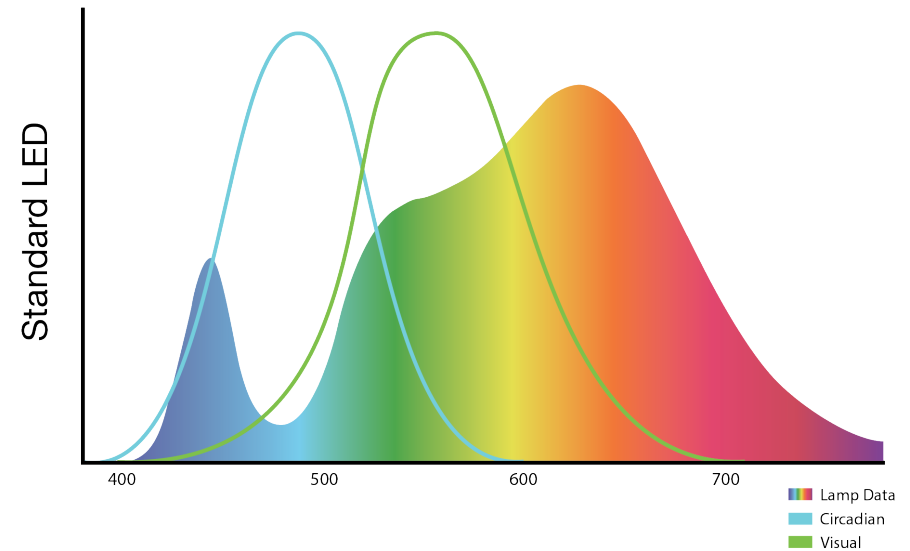
COLOUR TUNABLE

Historically, colour tunable lighting has been offered as the go-to solution for best circadian results. This pathway can be very misleading. Standard colour tunable systems can offer high melanopic ratios, but these are realisable only in the high colour temperature range (CCT greater than 5000K and up to 6500K). Light at this colour temperature is visibly blue, and can feel unnatural for many people. Depleted emissions in the warm spectra (660nm) also result in poor skin tones and red rendering.

BEYOND VISION™

Beyond Vision™ is a Light Culture enterprise brand, utilizing the latest LED technology available to achieve outstanding circadian performance without compromising on reliability and efficacy. High performance 4000K LEDs are supplemented with a cyan enhanced spectrum with peak emittance at 480nm. Optimised phosphor coatings achieve a Colour Rendering Index of 80 with an R9 (a saturated red colour, critical for making humans look healthy) of more than 50.

Diffusion provides for the blending of the wavelengths, resulting in a uniform appearance.





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A BEYOND VISION™
CAPABLE PRODUCT

The overall result is a Melanopic ratio of 0.986 at 4200K, producing more than 40% more Equivalent Melanopic Lux than a standard 4000K LED producing the same vertical illuminance. The impacts of this are huge:

- Meeting the WELL Building Standard with 30% less luminance intensity (and hence glare) than standard 4000K LEDs.
- A spectrum of light which meets both the visual and non-visual needs for humans in indoor working environments. All at a pleasant 4200K colour temperature.
- Great colour rendering to make environments and their occupants look natural, but with an impressive efficacy to enable compliance with the NCC.
- At last a simple solution to meet the biological needs of the human body without the need for a complex lighting control system or discomforting blue lighting.

*Interested in using
Beyond Vision™?*

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DEFINITIONS

Equivalent Melanopic Lux: A metric for determining the amount ipRGCs stimulus at a certain location.

Melanopic Ratio: The ratio between the human eye's visual response and non-visual response for a specific spectrum of light.

Circadian Rhythm: The natural cycle in our brain, controlled by the Suprachiasmatic Nucleus, to control the release of hormones within our body and regulate our sleeping pattern.

NCC: National Construction Code of Australia, a performance-based code containing all Performance Requirements for the construction of buildings.

ipRGC: intrinsically photosensitive Retinal Ganglion Cell. The photoreceptor within the human eye said to be primarily linked to controlling our circadian rhythm.

Spectral Power Distribution: A measure of the relative power at a range of wavelengths for a specific light source.

CCT: Correlated Colour Temperature. The 'colour' of a light source perceived by the human eye, measured in degrees Kelvin.

CRI: Colour Rendering Index. A light source's ability to render colours in comparison to a standardised reference light source such as incandescent or daylight.

For more information regarding the
Cultura range and Beyond Vision™
capable products, visit our website:
www.lightculture.com.au

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