Circadian Lighting

But first - about me!

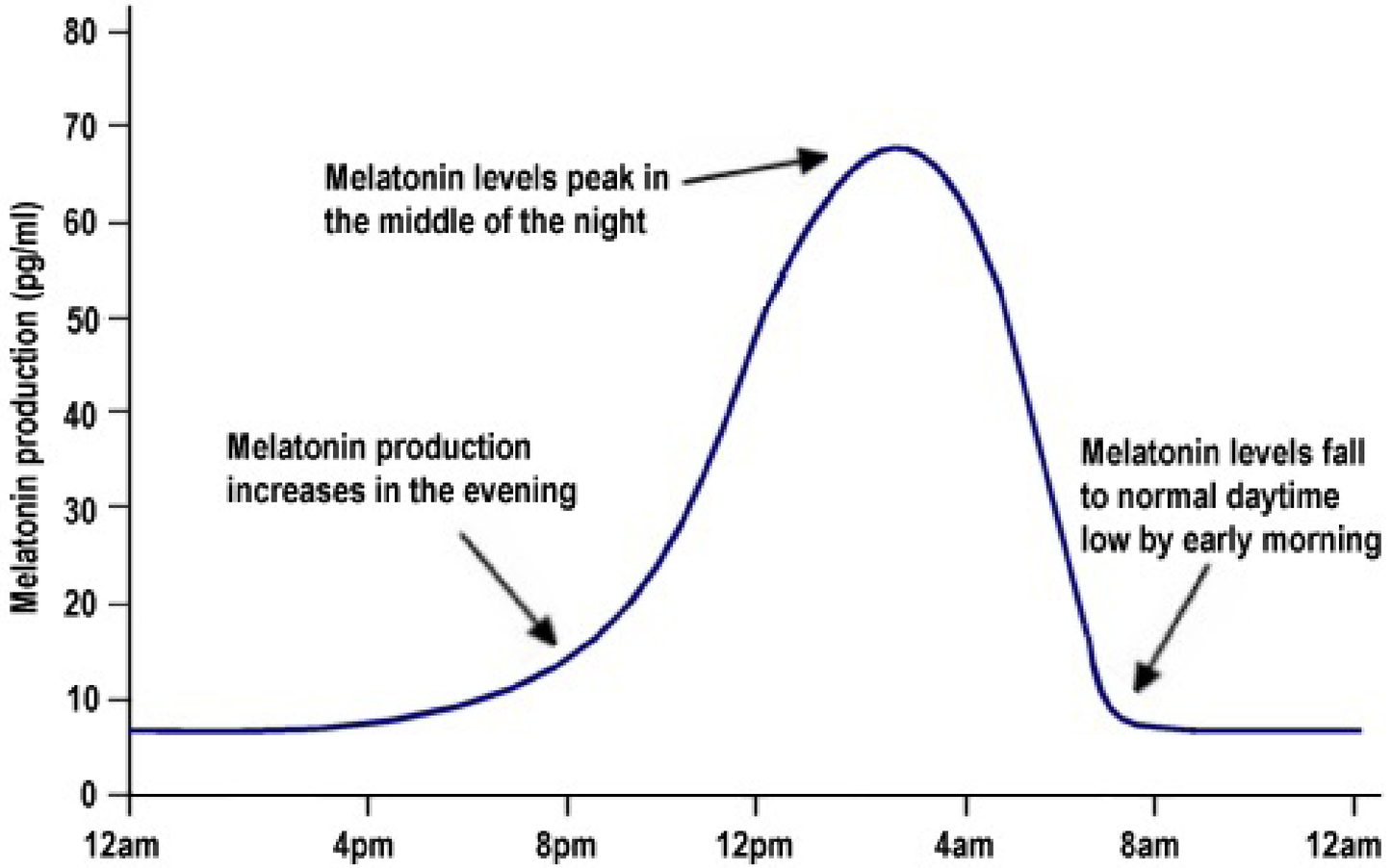
Neil Knowles

- 25 years experience in lighting design
- Twice winner of Lighting Design Awards plus many shortlisted awards
- Founder of Elektra Lighting

1. Body clock and natural cycles
2. Regulation and the third receptor
3. Black body curves
4. Cool White vs Warm White
5. Summary

1. Body Clocks

Melatonin Production



1. Body Clocks

Core temperature

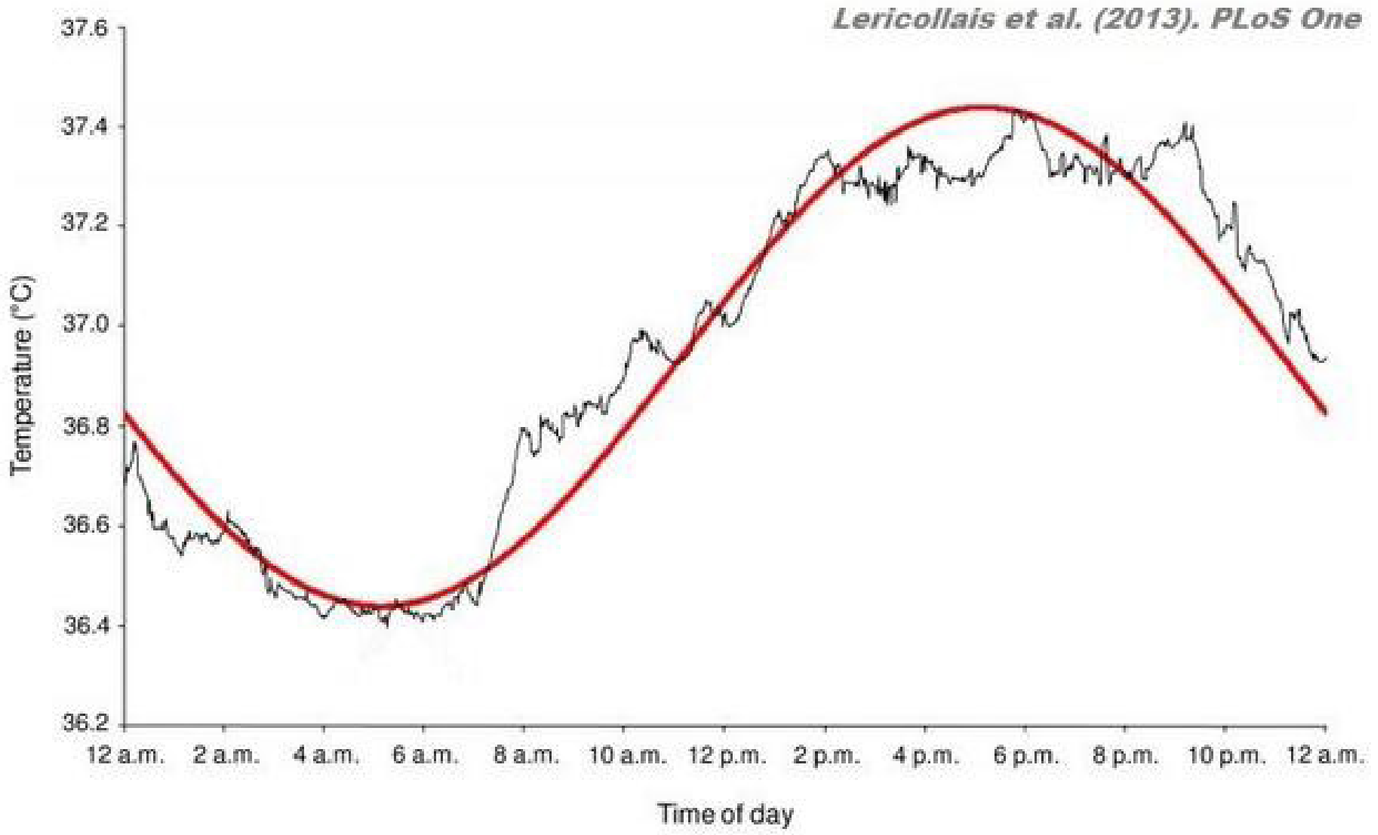


Figure 2. Circadian rhythm of gastrointestinal temperature. Mean values (black line) recorded every 60 s during 24-h period are shown. The mean best-fit curve (red line) between the experimental data and the cosine curve of the 20 participants is shown ($r = 0.97$). Red vertical arrow illustrates the beginning of the three morning test sessions.

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1. Body Clocks

- Isolate people in a space with no clocks and their body clocks drift - to between 24.5 and 25 hours

- Something is regulating the natural clock cycle to bring it into line

1. Body Clocks

Without correct regulation, increased incidence of:

- Stress
- Diabetes
- Lower life expectancy
- Bipolar Disorder
- Obesity
- Productivity

... and lots more

2. Body Clock Regulation and the third receptor

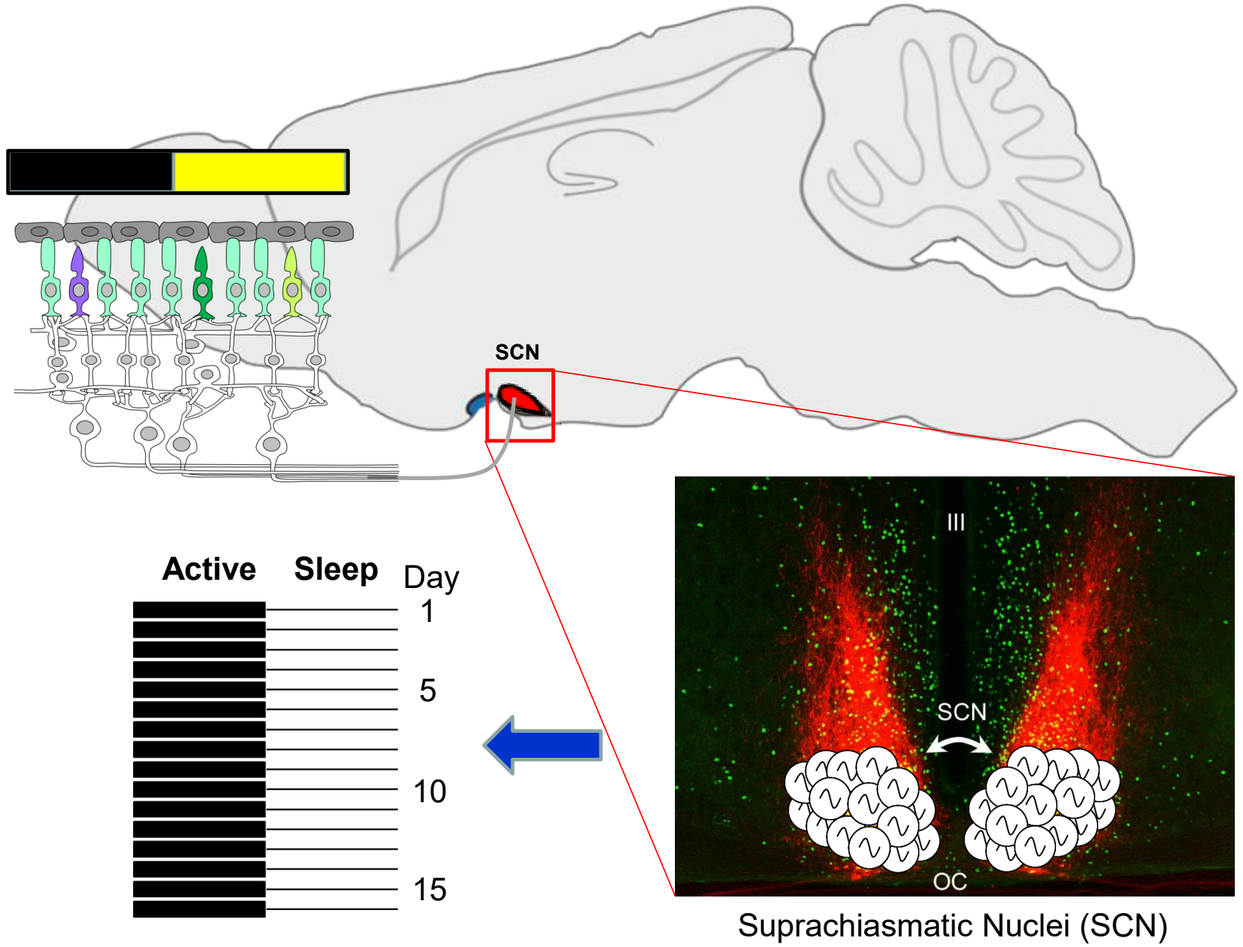
The following slides from a presentation by
Professor Russell Foster
Discoverer of the 3rd receptor

and very clever man

2. Body Clock Regulation and the third receptor

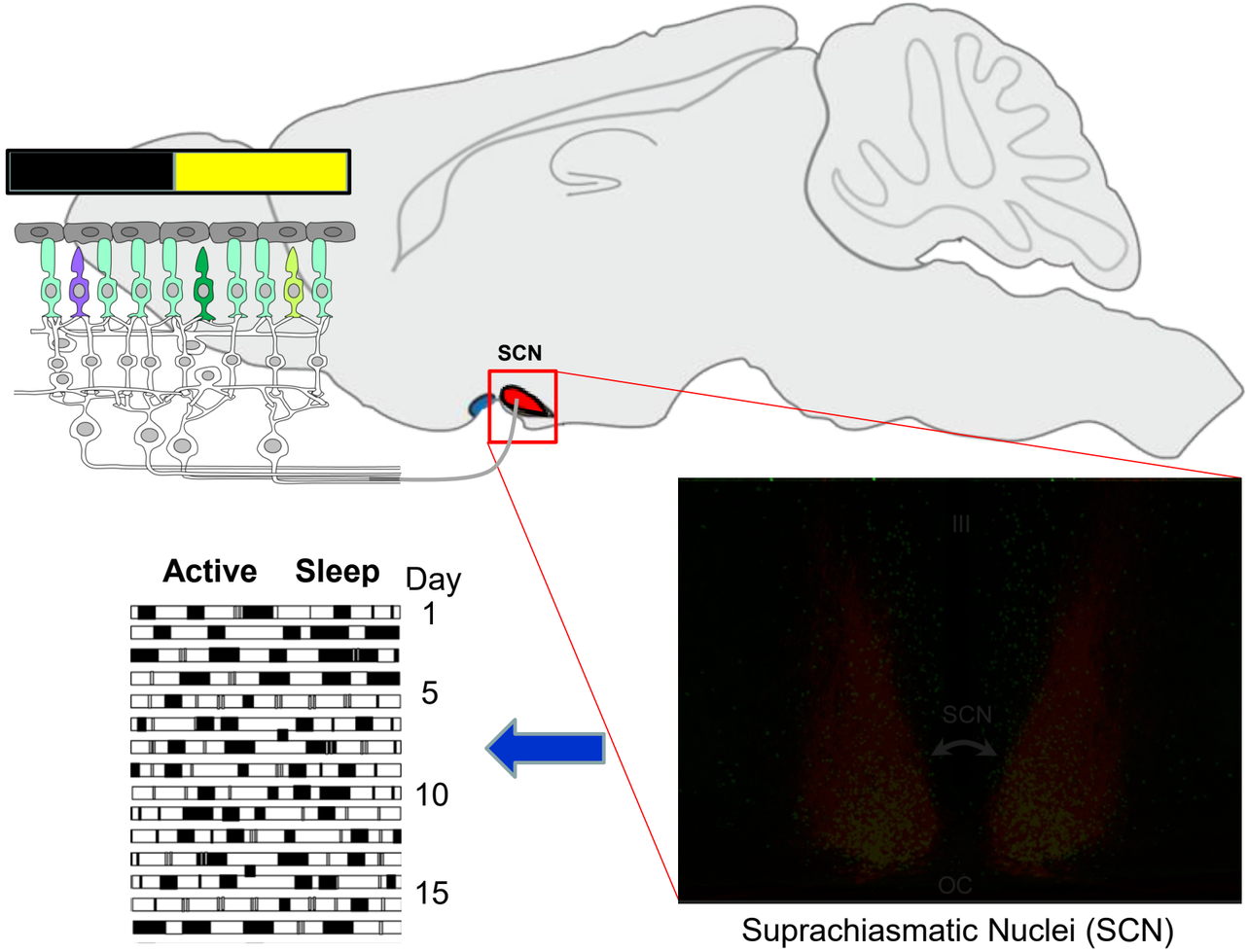
Studies on Mice

2. Body Clock Regulation and the third receptor



Suprachiasmatic Nuclei (SCN)

2. Body Clock Regulation and the third receptor



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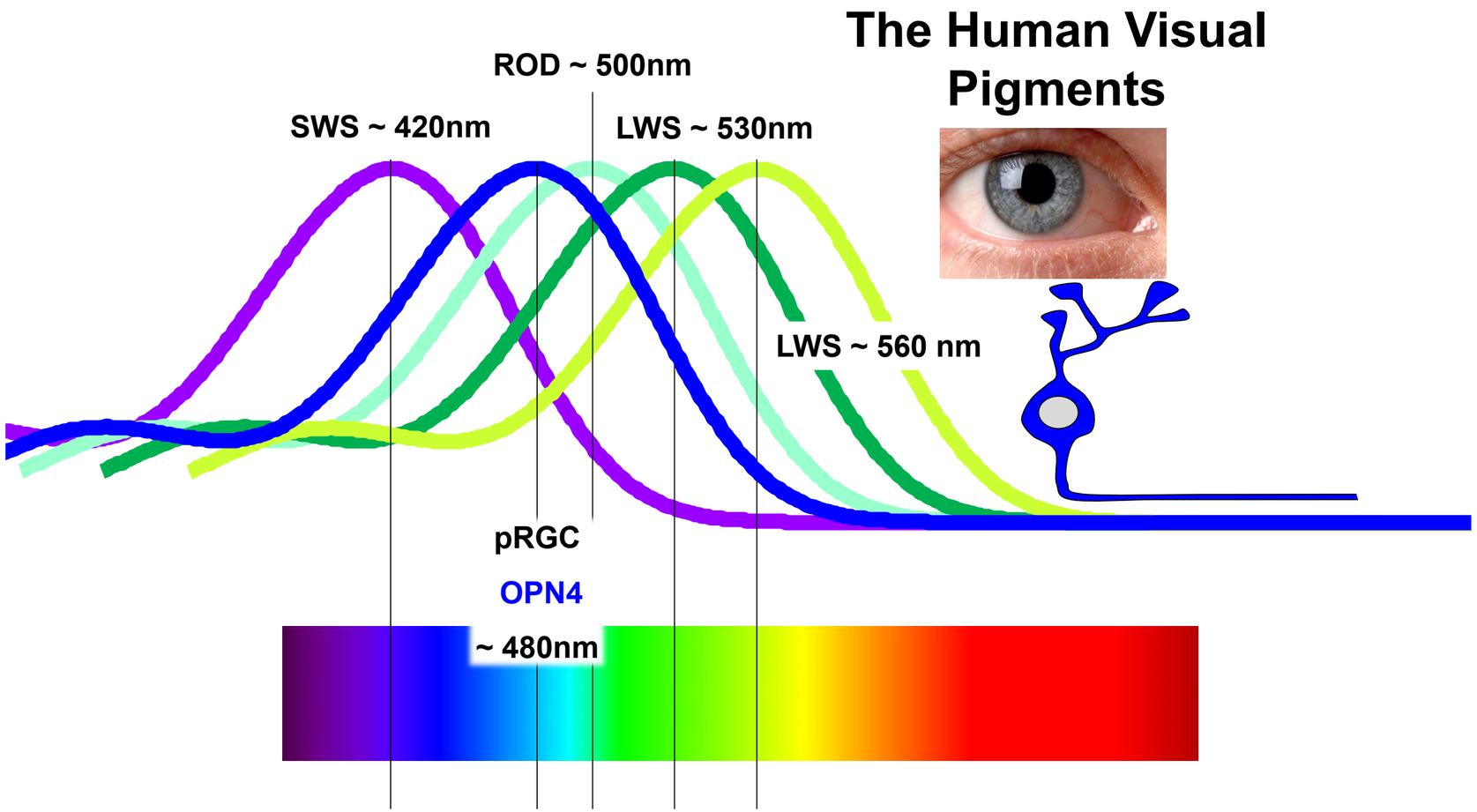

2. Body Clock Regulation and the third receptor

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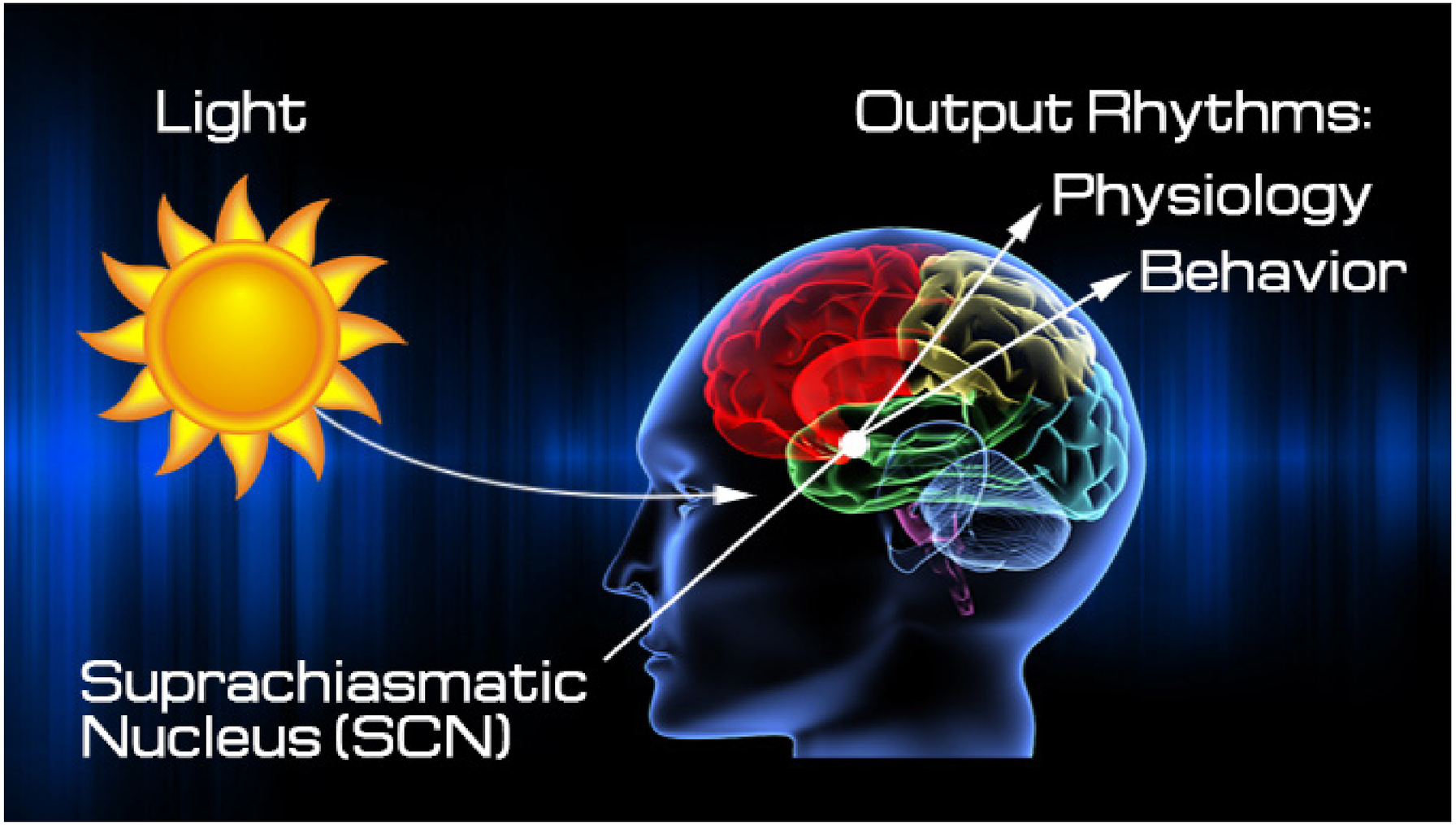


2. Body Clock Regulation and the third receptor

How much light, when?

- 1200 lux
- 20 minutes in the morning

(but: controversial)

3. Black Body Curves

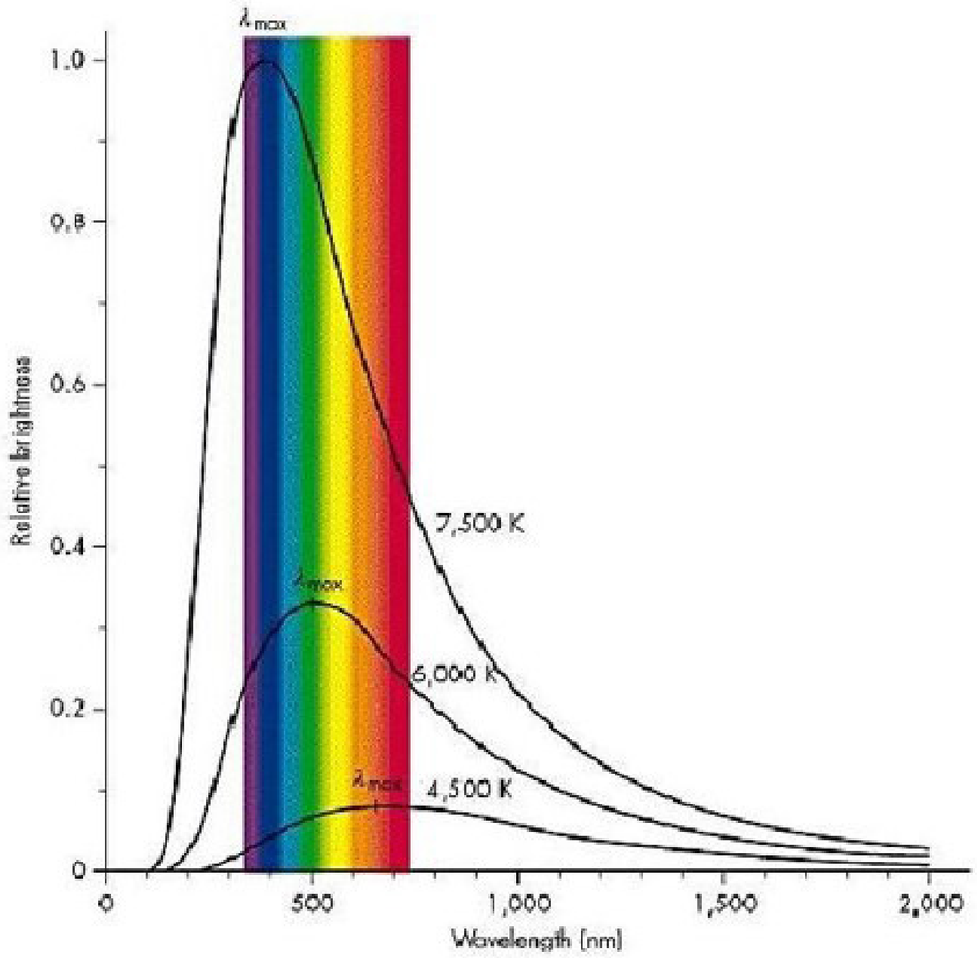
A short detour into quantum mechanics

3. Black Body Curves

First red hot....

Then white hot...

3. Black Body Curves



Planck's Law

$$B_\nu(\nu, T) = \frac{2h\nu^3}{c^2} \frac{1}{e^{\frac{h\nu}{k_B T}} - 1}$$

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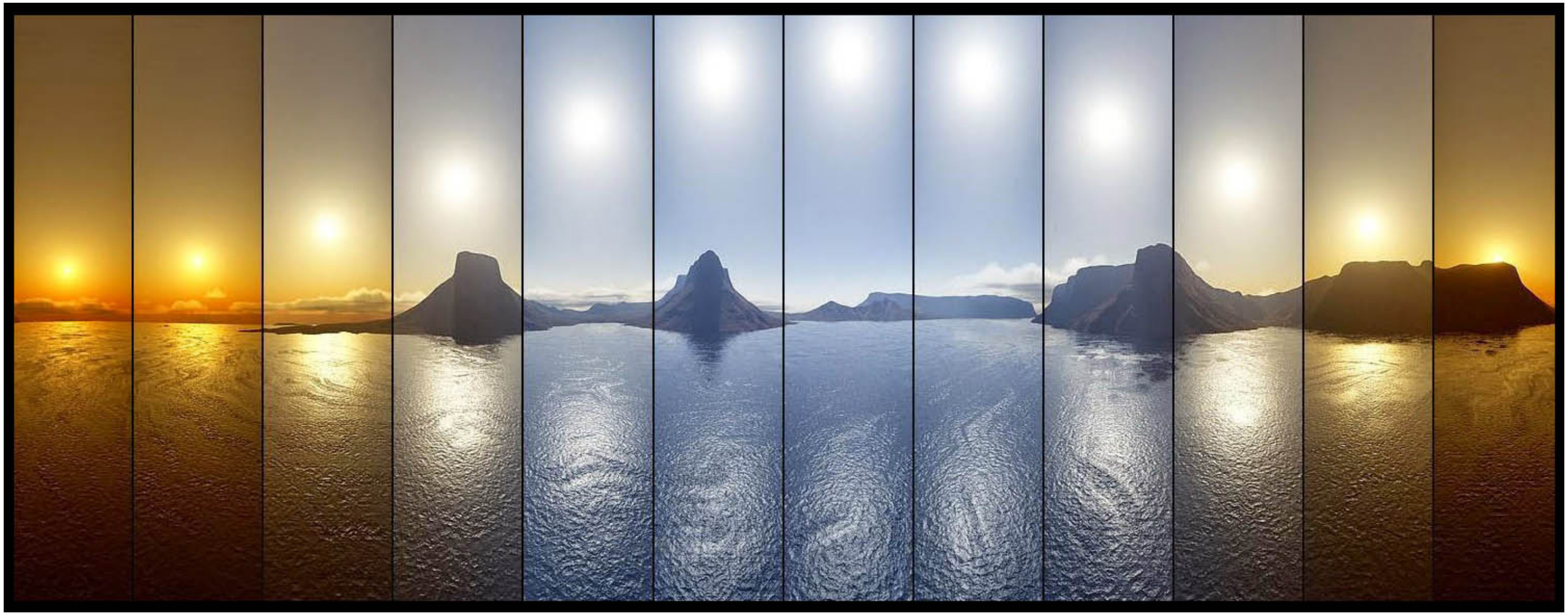
4. Cool White vs Warm White

What do these curves and colours actually look like?

Heat an object to 2000K, or 5000K, what colour is it?

4. Cool White vs Warm White

4. Cool White vs Warm White



4. Cool White vs Warm White

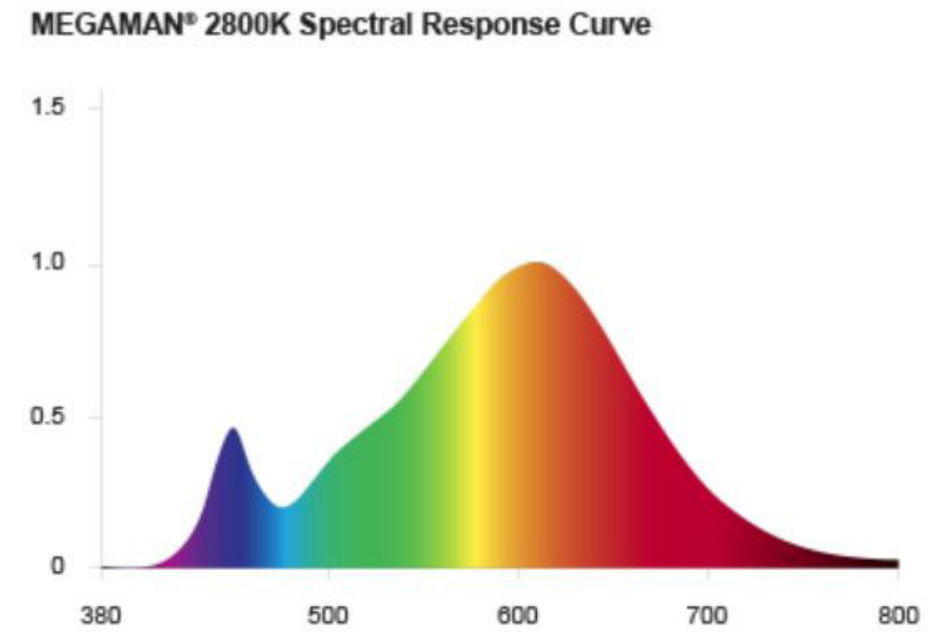


Diagram 3: MEGAMAN® 2800K Spectral Response Curve

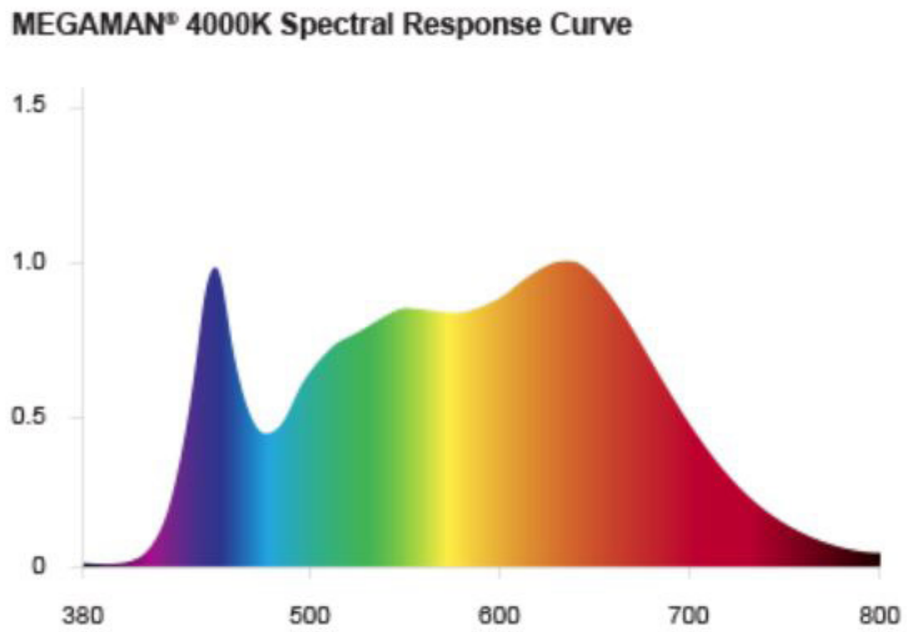


Diagram 4: MEGAMAN® 4000K Spectral Response Curve

5. Summary

- Humans have natural body clocks
- These are regulated by light
- Only a specific frequency works (sky blue / 480 nm)
- Lighting can be manufactured to emit this frequency
- High levels of blueish light in the morning kickstarts your cycle

5. Summary

Useful tips for life:

- Screens emit blue light. This goes straight to your SCN and keeps you awake at night. Turn off devices 1 hour before sleep

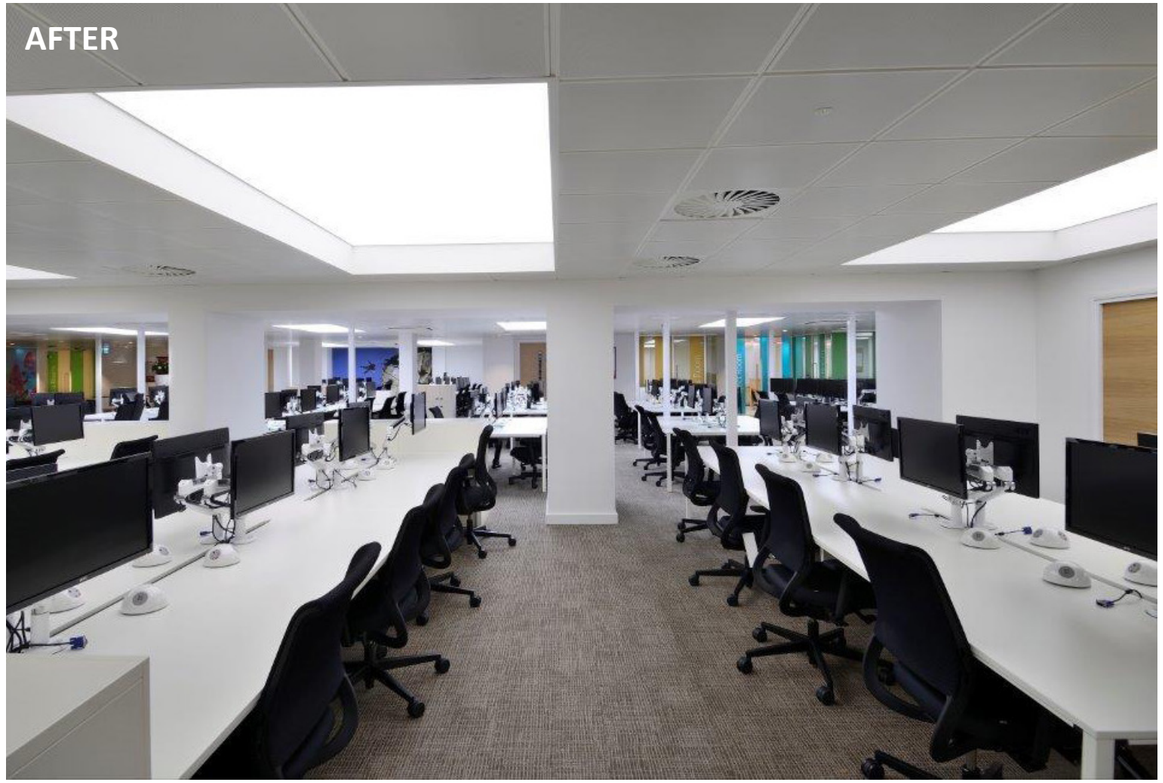
- Tired in the morning? Get out into the sunlight for as long as you can (20 minutes, 1200 lux)

- Jet lag? Adapt to local time quicker by getting up in the morning and out into the sunlight

5. Summary

Useful tips for hotels:

- no such thing as wrong colour temperature, but there is wrong time or wrong use
- All day dining - cool white will wake your guests
- Bar areas - warm white will relax them
- Spa - relaxation areas in warm, perhaps end treatment in cool



Vodafone Leeds

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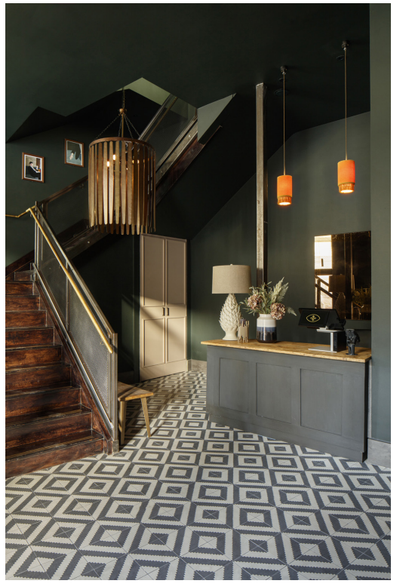

Tivoli Cinema, Bath

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6. Unknowns

What we already know	What we need to learn
There is a new non visual photoreceptor type in the human eye named intrinsically photosensitive retinal ganglion cells (ipRGCs) unrelated to vision, which have a different function to rods and cones	The exact number and location of new photoreceptor type in the human eye
Light that reaches the human eye has visual and non-visual effects- with the latter influencing our biological clock	How ipRGCs communicate to rods and cones and why?
Light has an impact on physiology of humans	The long term impact/effects of different lighting conditions
We're aware of irradiance and that this new receptor is sensitive to it, but our knowledge is still fragmented	The dose (how much is enough or too much in terms of light irradiance)?
We're also aware of the light spectrum, and that this new receptor is sensitive to specific parts of it, but our knowledge is still fragmented	Which light frequencies should be avoided (having potentially deleterious effects) and which ones should be present due to their positive effects
Exposure to light has an affect on people	The impact based on age (young children, adults, elderly)
Exposure to light has an affect on people	People are different 'chronotypes'- 'larks' or 'owls'- and lighting affects each group differently. One third of the world population has a different circadian rhythm)
Exposure to light has a significantly adverse affect on some people (approximately 1% of the population experiences hypersensitivity)	Impact based on specific light spectrum frequency. Which light frequencies should be avoided (due to potentially deleterious effects) and which ones should be present due to their positive effects
Exposure to bright light containing the blue part of the spectrum at the beginning of the day can have a stimulating impact on the body clock, and can promote alertness The exact wavelength of spectrum, timing and duration	The exact wavelength of spectrum, timing and duration
Exposure to light with the blue part of the spectrum in the early evening can stimulate wakefulness and disrupt sleeping patterns during the night	The exact wavelength of spectrum, timing and duration
Approved metrics and tools are required	What are the best tools and metrics to apply

We get all our business from recommendation. If you are working on a project which needs good lighting design, please consider passing our details to your client or project manager.

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