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Lighting for Sleep and Wellness With Changing Work Patterns: an Advisory Think-piece

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Lighting for sleep and wellness with changing work patterns

An advisory think-piece

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1. Access to natural light during Covid 19 restrictions

Covid 19 has had a massive impact on our work patterns and other behaviour, particularly during lockdown and other varied, on-going restrictions. These restrictions are likely to be with us for some time and varied until a vaccine is widely available. Very many people during this period are either working from home or engaging in blended work activities and restricted leisure behaviour that effectively results in them spending less time outdoors. Even the time spent commuting to work where it includes an amount of walking can allow our bodies synchronise with the time of day. This think-piece discusses how we can mitigate against the effects of some Covid 19 restrictions in order to maximise our wellness. In particular it describes the type of lighting we need to help us stay healthy. It also describes some of the relevant research in the area of Circadian Lighting, and identifies where future research is needed in this nascent lighting research area.

2. Sleep and circadian rhythms

The importance of sleep cannot be overstated. It is well known that sleep helps us maintain a strong immune system. How the effects of light on our biological clock helps us maintain good sleeping patterns is less well known. However, this may be critically important for us during this period of restrictions and is well worth considering. Human circadian rhythms operate on a cycle slightly in excess of a 24 hours cycle (24.2 in fact). So, it is necessary to entrain our biological clock with the time of day on a regular basis[1]. This should allow us sleep better at night and stay healthy.

The non-visual effects of light are increasingly recognised as playing a significant part in our well-being by activating many diverse parts of our brain. Intrinsically, photoreceptive retinal ganglion cells (ipRGCs)[2] form a critical part of the visual system, containing a light sensitive protein called melanopsin which is linked with the suprachiasmatic nuclei (SCN) of the brain's hypothalamus region.[3] Photoreceptors include rods and cones which combine with the ipRGCs to affect the human circadian system. There is evidence that there are several sub-types of ipRGC connected to other parts of the brain. So, the SCN is not the only organ influenced by light. This is all part of on-going research, but it does appear at this early stage that the circadian system appears to be most sensitive to light in the blue part of the spectrum.[1] So, blue light can effectively suppress melatonin and promote biological daytime.[4]

Early morning daylight has a broad colour spectrum and is rich in blue light (or light at low wavelength and high energy). It seems that this light can be particularly good for us early in our day. So, during the restrictions on our movement as a result of Covid 19, we should try to expose ourselves to daylight for at least about 30 minutes or so every morning if we can get outside. For a lot of people this would normally happen every workday as they go to work. But this may no longer be the case for non-critical workers. For people who cannot get outside, for example nursing home residents, a slightly longer period of exposure to light near a window should suffice. Exercise has also been shown to influence the circadian rhythm for night-shift workers.[4] For people with SAD disorder, it has been shown that exposure to 10,000 lux for 30 minutes or 2,500 lux for 120 minutes early each day greatly inhibits this disorder.[5] Outside illuminance levels will normally be well in excess of 10,000 lux (for 70% of daylight working hours throughout the year), but this might tend to be lower on overcast winter days. Even in winter however, external illuminance can be many multiples of 10klux.

3. Melatonin

Opening our window blinds fully early in the morning when we wake will also help by curtailing melatonin in our system and allowing our circadian rhythms entrain early with the day. Conversely at night, the hormone melatonin is needed to help us sleep. Melatonin has been found in research to assist with vital processes including growth and prevention of illness such as obesity, diabetes and some forms of cancer, including breast and prostate

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cancer (all higher in night-shift workers)[1]. Melatonin influences our immune system by supporting antioxidation and coagulation of blood. It also regulates glucose levels and enzymes. In the eye it influences the production of aqueous fluid which is so important in the health of the eye.

Melatonin is released into the blood stream at night in fading light and this allows us to fall asleep. So, when our parents told us as children we needed *to go to bed early and switch off the lights to grow big*, they were right.

4. The possible impact of blue-light screens

Although research in this area is evolving, it would seem that we may be accidentally inhibiting melatonin at night by exposing ourselves to light at the blue end of the spectrum, for example by using phones, tablets and other screens. This may adversely affect our ability to sleep. There is no research confirming this one way or the other yet, and indeed if light levels are low then they may have little effect. But it would seem that when our children and grandchildren tell us to *put our gadgets away* in the evening, they may be right too. In summary, light at the blue end of the spectrum is beneficial in daytime, particularly early in the morning but not good at night-time.

5. Indoor lighting and lamp types

Light levels indoors can never compete with daylight levels outdoors. It is typically between 300 and 500 lux in working interiors and a lot lower in our homes, normally well below 100 lux on average at night-time. Selection of lamp colour (identified as colour temperature) is nonetheless very important. High colour temperatures (above 5000K) are at the blue end of the spectrum and lamps at or below 3000K are at the warm red end of the spectrum. It seems counter-intuitive to say the higher the colour temperature then the cooler the lamp; but paradoxically this is true. Lamp colour is identified by the colour of a black body at the temperatures indicated. Blue hot is hotter than red hot despite producing a cooler colour to the eye. Most people (whether they realise it or not) quite like working under cool (5000k) or intermediate (4000K) colour temperature lighting during daytime and then relax with warmer

colour lamps (3000k and below) at home in the evening. All lamps should display their colour temperature on the pack – typically anything from 2400K to 5600K. Technically it is called correlated colour temperature (CCT) as obviously modern lamps do not actually operate at anything like that temperature although outdated and inefficient incandescent lamps do operate at about 2,700K. With dimmable lamps there will be significant colour shift, typically their colour will shift to warmer as they dim. Interestingly, the spectrum of daylighting shifts in the evening too, to a warmer spectrum, so it is not surprising that our human preferences for artificial lighting have evolved similarly, i.e. cool (blue end spectrum) in the morning and warm (red end spectrum) in the evening. This is not an absolute or universal truth, but it is a strong trend. Modern LED lamps can be easily dimmed and their colour is easily changed. They can be installed so that lighting is cool in the morning, intermediate in the afternoon, and warm at night.

6. Research into circadian lighting and health

The main focus of research into circadian lighting so far has been on melatonin suppression at night. As already explained, melatonin regulates sleep. Poor sleep patterns can result in health risks. Further research is on-going however, and it is an area full of opportunity for young engineers and scientists to explore.

What has become apparent in the engineering of buildings is that lighting cannot be evaluated in the way it traditionally has just for photopic (cones under good light conditions) or scotopic (rods under poor lighting conditions) vision. The non-visual aspects of light (with ipRGCs) and the timing and duration of light are key factors in human health. The Well Building standard's equivalent melanopic lux (EML)[6,] based on spectral sensitivity, is one metric being used by lighting designers internationally. The research centre which seems most advanced in this work is the Lighting Research Centre at Rensselaer Polytechnic Institute in New York. They have developed the Circadian Stimulus (CS). This models rod and cone input to the ipRGCs. The jury is still out on how this will all be applied in practice and what impact it will have.[7,8,9] What is certain is that this is an area ripe for future research studies involving the scientific and engineering communities working together.

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The opinions expressed in this article are his own and intended simply to assist people through the current Covid 19 restrictions and to identify future research opportunities.

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