



# THE SCIENCE OF CIRCADIAN RHYTHM LED LIGHTING

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Publisher: Walalight, LLC

Imagine a bright sunny summer day. You go outside for your favorite activity; golfing, fishing, gardening, hiking, bicycling and so forth. You are awake and active, but at night you sleep like a baby. Why does this happen? Congratulations, you have established a natural healthy Circadian Rhythm and are experiencing Circadian Rhythm Wellness.

**O**ur bodies have evolved over thousands of years to follow a natural 24-hour light-dark cycle. We naturally sleep when it gets dark and wake when the sun rises. Eventually, cavemen invented a fire torch of amber color to see at night and then Edison invented lighting 150 years ago, causing havoc to our internal body systems. The introduction of this artificial light interferes with our master clock, which is known as our Circadian Rhythm. Conformance to an appropriate Circadian Rhythm is crucial for our overall health and wellbeing. The natural light cycle interacts with our bodies and regu-

lates our hormone levels.

Natural light conditions are reflected in the physical structure of the eye, with cones being tuned to daylight and rods to night time light conditions. There is another form of light sensor in the eye discovered more recently that does not contribute directly to sight yet plays a role in secretion of Melatonin: the intrinsically photosensitive retinal ganglion cells (ipRGC). Humans are diurnal (daytime) beings, while some other animals are nocturnal, so our normal pattern of wakefulness and activity is during the daytime.

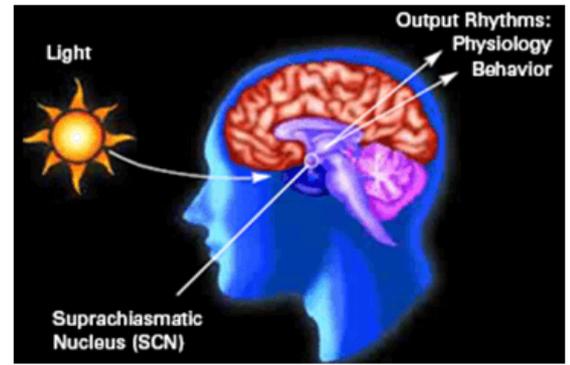
During the past ten years' brain scientists have discovered that in addition to patterns of light being transmitted via the optic nerve to the visual center in the brain, there is also a branch that transmits data regarding light conditions to a command center in the brain called the suprachiasmatic nucleus (SCN).

The SCN processes the light data and sends command signals to several glands in the endocrine system to either secrete or suppress secretion of certain hormones critical to normal body function. The pineal gland, in the hypothalamus in the brain, suppresses secretion of Melatonin in the

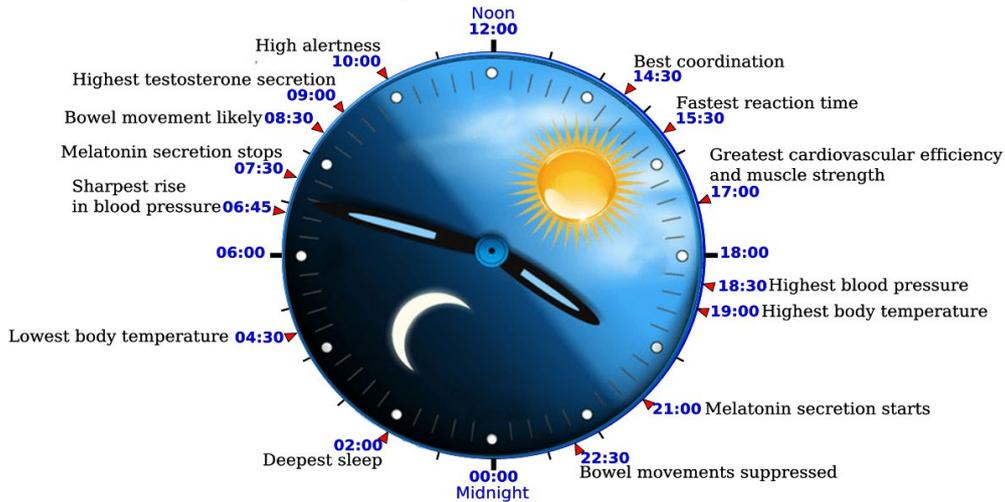
presence of bright white light, specifically when the SCN has identified a narrow 30 nanometer band of light spectrum (out of 330 nanometers of human visible light spectrum) from 450 to 480 nanometers. When melatonin secretion is suppressed we become more alert. Melatonin secretion normally occurs when exposure to the bright white light diminishes, e.g. at sundown, but only does so if the trigger has been set by bright white light exposure earlier in the day. Melatonin also serves as a powerful antioxidant which

floods the body with natural anti-cancer agents while we sleep.

The adrenal gland is also largely controlled by the SCN based on light conditions in an opposite way from melatonin. Cortisol secretion is stimulated in the presence of bright white daylight and suppressed normally at night. Cortisol serves as a wakeup call to the body, raising our core body temperature, heart rate, and blood pressure from a sleep state, and is also a factor in normal digestion. If the SCN does



Conceptual Diagram of Suprachiasmatic Nucleus



not signal the adrenal gland to secrete cortisol, we may be tired and listless. Changes in our digestive system could cause abnormal processing of foods especially carbohydrates and can be a factor in hypoglycemia associated with diabetes.

that accompany it, including depression and circulatory issues, among others.

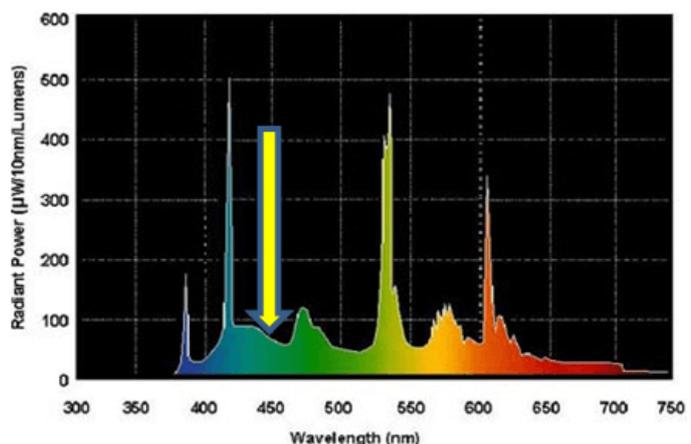
The problem of proper light exposure cannot be solved by simply increasing the level of fluorescent light.

People that lack exposure to natural sunlight are prone to have issues with mental and physical well-being resulting from abnormal hormonal secretion. The result can be sleep deprivation, also known as Circadian Disruption and the many issues

Unfortunately, traditional lighting does not provide the specific spectrum of light required between 450 and 480 nanometers for normal secretion of Cortisol and suppression of Melatonin. Even with specialized "natural" light fluorescent tubes the required light spectrum is at a low point in providing the critical spectrum (450-480 nm) while there are peaks on either side of the narrow band.

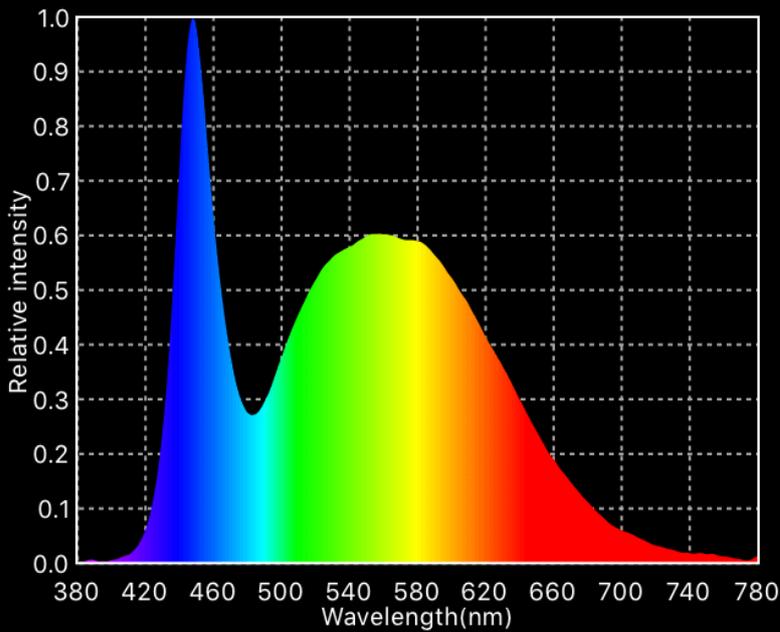
Fortunately, LED lighting is far more controllable in terms of light spectrum as well as in terms of dimming and low glare if well designed. Light being emitted from a source can be measured in spectral power density (SPD) at specific light spectrums measured in nanometers.

LEDs used in top quality lighting such as WalaLight Healthy LED fixtures have a perfect score of 100% SPD at the desired light spectrum as suggested by leading brain scientist. This is important, as the critical light spectrum can be passively delivered at reasonable levels of light in the ambient environment. Previously, light therapy devices required a patient actively to stare into a bright light box for two hours – which is an unpleasant experience to say the least – and not something many people can be expected to do. Delivery of the needed light spectrum passively will help assure all occupants receive the desirable light and do not require active therapy.

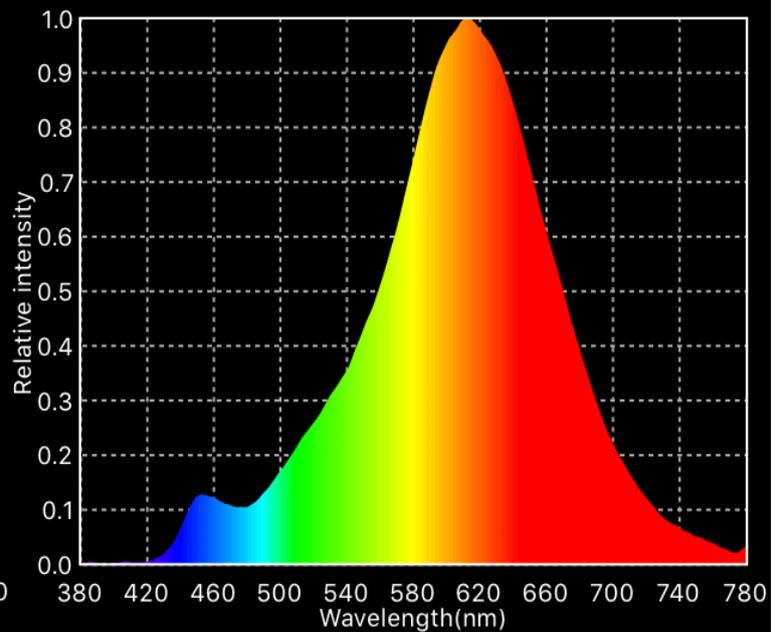


Spectral Power Density of GE "Natural Light" Fluorescent Tube

SPD CURVE OF WALALIGHT AT 6500K  
(455 NM) DAYTIME



SPD CURVE OF WALALIGHT AT 2200K  
(620 NM) – NIGHTTIME



WalaLight panels are designed as side-lit LED panels, the light is indirect light and a pleasant glow to the eye, even at the higher light levels recommended by the Illuminating Engineering Society (IES) for various types of spaces (senior living, schools, office buildings and much more). With traditional lighting, it is very difficult to even achieve the recommended light levels in a tolerable manner, and impossible to provide the critical light spectrum for circadian light. Assuring that the occupants in Senior Living Communities, Nursing Homes and Long Term Care Facilities have adequate light levels to enjoy their tasks, work and hobbies, will raise their activity levels and mental engagement.

There is a second part to the required light. While it is critical to have the bright white light especially in the morning, it is equally important to have warmer light with less blue light later in the afternoon and no blue light in the evening. If there is only bright white later in the day, melatonin secretion will continue to be suppressed causing an unhealthy event.

The WalaLight Healthy LED Lighting System lends itself to control with modern wireless radio frequency control systems such as Bluetooth Mesh and facilitates implementation of automated lighting controls on a facility-wide basis for such functions as Circadian Light scheduling. The WalaLights use both bright white and warm diodes, making it possible to control the light so the bright white is provided in the morning when needed and the warm light later in the day. This mimics how the light from the sun changes as the evening arrives.

In addition to the host of wellness benefits described above,

WalaLights can deliver up to 85% reduction in electricity consumption as well as providing maintenance-free lighting in excess of 50,000 hours. Light bulb maintenance is a significant component of facility maintenance and can free-up valuable employees to perform other maintenance tasks.

The LED Light industry is constantly pushing for more efficient products and systems. Think about having an LED lighting system that generates just the right spectrum of light to suit our changing environment enabling people to reach peak performance and relaxation. That's exactly what Human Centric Lighting systems offer. The WALALIGHT® system is a passive adaptive lighting system that provides the appropriate Kelvin temperatures of lighting through smart color changing technology to alter and improve human behavior. This new model of health and human behavior control focuses on keeping people healthy in contrast to treating disorders and diseases after they develop. Careful application of this new knowledge of the biological and behavioral effects of lighting can offer significant advantages and benefits including relief of palliative symptoms.

Seniors and staff can benefit from the way CIRCADIAN RHYTHM LIGHTING simulates quality outdoor conditions indoors. In the morning, residents awake to bright white (6500 kelvin/450nm) light that releases hormones such as cortisol into their endocrine system providing energy and alertness. As the day progresses, the HEALTHY CIRCADIAN RHYTHM LIGHTING systems can adjust using an automated circadian scheduler gradually changing the light to a warm (2200 kelvin/620nm) that triggers the release of hormones such as melatonin that makes the resident relaxed and sleepy. Imagine the benefits of residents going to bed without needing medication.

For memory care, HEALTHY CIRCADIAN RHYTHM LIGHTING can help with Sundowner's Syndrome as the system can be manually adjusted to warm light by staff to help calm down Senior residents. Calm residents help facilities retain employees. Sleep is the best antioxidant there is and HEALTHY CIRCADIAN RHYTHM LIGHTING helps promote solid sleep that increases the wellness of the residents. No need to turn on bright lights in a resident room at night for the nurse or janitorial staff. These folks can simply use the wall mounted control and adjust the lights to warm and low dimming, enough to see their task but not wake up the resident. Staffing and activities can be better planned as you will understand the circadian cycle and adjust activities to optimize the activities effectiveness.

Use of Human Centric Lighting systems as a non-pharmacological aid could also potentially ease burdens on long-term care health-workers, particularly in Senior Living Communities and Long-Term Care Facilities, (CNAs, RNs, etc.) by improving patient capacity (risk of falling etc.) as well as irritability and combativeness towards nursing staff. These positions currently experience very high turnover rates because of their extreme level of demands. In some facilities, one year is at the longer end of the spectrum.

POSITION	MEAN TURNOVER RATE
DIRECT RESIDENT CARE / BEDSIDE RN	75.2 %
ADMINISTRATIVE LVN	35.3 %
DIRECT RESIDENT CARE LVN	69.1 %
ADMINISTRATIVE RN	47.6 %
CNA	97.4 %
CMA	51.6 %

Direct/bedside resident care RNs clearly had the highest turnover rate in 2016. Furthermore, data from 2016

National Healthcare Retention and RN Staffing Report indicates that the average cost of turnover for a bedside RN ranges from \$37,700 to \$58,400, which results in the average hospital suffering losses anywhere from \$5.2 to \$8.1 million. Moreover, each percent change in RN turnover costs/saves the average hospital \$373,200. 75% of long-term care nurses cited stress and overwork as primary reasons to leave, in a 2011 American Nurses Associations survey. By palpably diminishing stressors such as combative and high-risk patients through improved sleep and relaxation mechanisms, the fiscal benefits of this mechanism in terms of staff retention are perceivably high.

Via its automated Zigbee mesh passive lighting system that easily brings sunlight and nightlight without any physical effort, WalaLight enhances a wide spectrum of everyday life, including an array of facilities:

\*Senior Living, Long Term Care and Memory Care: Lighting impacts health and behavior as the sun changes throughout the day from energy daylight to moonlight, when the brain signals hormones to relax and ultimately sleep.

\*Healthcare, Hospitals and Clinics: Lighting effects outcomes for

hospitals and healthcare facilities including treatment, along with ambient lighting conducive for patient recovery and reduced length of stay in facilities

\*Education: Lighting for school improves student behavior and performance and can help regulate autism, ADD and ADHD in the class room.

\*Offices: Lighting directly leads to improved productivity and worker satisfaction.

\*Correctional: Lighting correlates to improved inmate behavior, while alleviating security concerns.

\*Fire Stations: Firemen have long shifts and their sleep/wake schedule varies greatly

WalaLight provides the appropriate spectrum of lighting through smart Kelvin changing technology. This, in turn, vastly improves behavior and performance. The focus is on keeping people healthy instead of waiting for health problems to occur, by generating the right amount of light therapy.