Proper light at the proper time

Light is a powerful biological stimulus

INTERVIEW | LUC SCHLANGEN (HUMAN TECHNOLOGY INTERACTION TU/E) BY MICHIEL DE BOER (MOESASJI)

In modern society humans spend around 90% of their time indoors. This has all kinds of impact on our lives, but it is only since recently that we started to discover how a lack of daylight can compromise our physiology, wellbeing and functioning. Luc Schlangen - Senior Researcher at TU/e and Division Director "Photobiology & Photochemistry" within the International Commission on Illumination (CIE) - is studying the visual and non-visual effects of light on humans since 2005. After years of research within Signify (Philips Lighting), he continues his journey at TU/e in collaboration with ILI since March.

The work of Schlangen is ignited by the discovery of a new photoreceptor in the human eye in 2002 by scientist David Berson at Brown University. Next to the well-known rods and cones, the human eye is equipped with the retinal photoreceptor ipRGC, an intrinsically-photosensitive retinal ganglion cell. This photoreceptor senses light via its blue-light-sensitive photopigment melanopsin. Schlangen: "We now know these ipRGCs play a major role in the regulation of our sleep-wake cycle and the daily 24-hour/circadian rhythm of our body clock and physiology."

DEPENDENT ON LIGHT

Every day again, light adjusts the circadian rhythm of humans (and most of the animals). Light in the morning helps the body to "wake-up" and get ready for action. Schlangen: "Paradoxically, our internal clock tends to tick a little slow: by itself, it needs longer than 24 hours to make a complete cycle. We use the daylight to adjust and reset our clock as to secure entrainment to the 24 hour rhythm of day and night. Studies show that spending a day in settings with bright light helps to feel more awake, alert and energetic across the day. Moreover, it facilitates a good night's sleep. Sufficient daytime light exposure is a powerful biological signal and important to secure our wellbeing, productivity and vitality."

NEGLECTING NATURAL CONDITIONS

In modern life however, we tend to neglect the natural conditions that have been our circadian guides for a hundred thousand of years. Today we spend most of our lives indoors, under light conditions that are much less bright than the natural light conditions outdoors. Office lighting is typically designed to deliver around 500 lux, which is deemed sufficient to perform office tasks, and lots of offices don't even make it to 500 lux. However, the typical illuminance outdoors on an overcast day reaches 10.000 lux easily. Direct sunlight brings the meter up to 100.000 lux. Our daytime light exposure under these natural (outdoor) circumstances is therefore a factor 20 to 200 higher than in indoor settings. Next to this, the widespread use of electrical light and electronic devices has resulted in an excessive exposure to light in the late-evening hours and at night. These unnatural lighting conditions compromise our sleep quality, circadian rhythm, performance, wellbeing and health.

CHALLENGES IN RESEARCH

Scientists, the lighting industry, lighting designers, lighting practitioners and stakeholders are actively developing insights, products and solutions that effectively combine the visual and non-visual effects of lighting in a beneficial way. The difficulties in this field are many. First, good lighting field studies are complex, time consuming and expensive to run. Second, while

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the beneficial effects of light on mood and sleep are relatively well established, it is much more difficult to quantify such effects in economic terms and to substantiate return on investment for lighting installations that are more supportive for health and wellbeing. Furthermore, there are large interindividual differences in sensitivity to light and in light exposure history: more prior light exposure (for instance by spending more time outdoors) typically reduces sensitivity to subsequent light exposures.

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Schlangen: "A good field study usually involves several weeks of data collection, in which one test group with an active lighting condition is compared to a control group with a standard lighting condition. Preferably, this is done in a crossover design and without too much interference of daylight. When daylight is too abundant, this reduces the contrast between the active lighting condition and the control lighting condition, thus reducing the chance of finding a difference between the two lighting conditions. In a study by Gimenez et al (J Sleep Research, 2017), we installed a dynamic lighting system in patient rooms of a cardiology ward at the Maastricht University Medical Center. The system offered bright and blue rich light in the mornings and gradually dimmed and used warm light in the evenings. For the patients in the test group, their amount of sleep improved. Although better sleep can be expected to support recovery, we were unable to substantiate any effects of the test lighting on patient wellbeing or hospital length-of-stay. This underscores how difficult it is to scientifically prove such positive effects of light. It also explains why so many companies and care institutions are unwilling to invest in lighting systems that provide more illumination than the minimally prescribed value of 500 or 300 lux. Things would be much simpler when we could just state: Install a 2,000 lux system and you will gain a 12% productivity in a workplace, or an 8% reduction in medication prescription on a hospital ward.

STANDARD

Another point is that we are merely at the beginning of standardization of the non-visual effects of light for human (and animal) health and wellbeing. Recently, CIE has published an international standard (CIE S 026:2018) that defines a good metrology to measure and quantify light for its ability to stimulate each of the five photoreceptor classes (rods, cones, ipRGCs) that can contribute to eye-mediated non-visual responses to light. In the CIE committee that wrote this standard, we decided to express the activation of every photoreceptor type by a (test) light condition, in terms of the amount of lux of standard daylight (D65) that produces the same photoreceptor activation. For the melanopsin-encoded photoreception of ipRGCs, this new quantity is called "melanopic equivalent daylight illuminance" or melanopic EDI, and it is expressed in lx (of standard daylight D65). In many cases, light settings with a high melanopic EDI produce stronger non-visual responses as compared to light settings with a low melanopic EDI."

HEALTHY BUILDINGS

The importance of having the right quantity and quality of light at the right time is underestimated, while potentially this is as important as indoor air quality. In order to realize so called Healthy Buildings, lighting installations should be made more health and sleep friendly by providing dynamic changes in intensity and spectrum across the day, mimicking the outdoor light conditions as much as possible. Schlangen: "We are discovering more and more about the non-visual effects of light and the metrology behind them. This will improve the design and implementation of lighting systems as critical instruments to create healthy indoor environments for human beings."

On October 3rd 2019, a new edition of the CIE position statement on "proper light at the proper time" is published.
Find it at: bit.ly/2Vlq62P

ABOUT LUC SCHLANGEN

Luc Schlangen received his PhD from Wageningen University in 1995. He has worked for more than 20 years at Philips Research Laboratories and Philips Lighting/Signify in Eindhoven. March 2019, he accepted a researcher position at the Eindhoven University of Technology, reinforcing the ILI research activities in the Human Technology Interaction group. Luc actively contributes to various standardization processes in CEN, DIN, CIE and ISO. He has chaired the CIE JTC9 committee which recently published a new global standard with light metrology for ipRGC-influenced responses to light. Per June 2019 Luc is director of CIE Division 6 "Photobiology and Photochemistry".

Current activities with ILI:

- Grant-project author 'To improve sleep by reducing evening blue light exposure'
- Discussing research plans with GGzE (mental health institution) on light therapy and lifestyle \ interventions in clinical and non-clinical populations.
- Mentoring ongoing student research project in VieCuri Hospital Venlo, effects of a dynamic lighting installation on quality of sleep and wellbeing in a Coronary Care Unit
- Initiator and co-author of the 2019 CIE position statement on "proper light at the proper time"
- Actively participating in research projects (in lab and field settings) exploring the effects of dynamic indoor environments (lighting and temperature) on comfort wellbeing, health and performance
- Organization of CIE/ICNIRP symposium "Measurement of Optical Radiation and Impacts on Photobiological Systems", probably end August 2020 at TU/e.