International Commission on Illumination
Commission Internationale de l'Eclairage
Internationale Beleuchtungskommission

CIE Position Statement on Non-Visual Effects of Light

RECOMMENDING PROPER LIGHT AT THE PROPER TIME

June 28, 2015

Background

The definition of light identifies it as the electromagnetic radiation that stimulates vision. However, we now know conclusively that photoreception in the eye leads not only to vision but also to effects on human physiology, mood and behavior, often summarized as non-visual effects of light. Research on such effects intensified at the beginning of this millennium. It was fueled by the revolutionary detection of a new class of photoreceptors in the human eye that detect optical radiation but do not contribute to image formation. These photoreceptors were first identified in connection with their role in circadian regulation, particularly of the hormone melatonin, and for this reason one reads of circadian or melanopic effects. We are learning now that these photoreceptors influence many other processes as well. In recent years the catchphrase "Human-Centric Lighting" (HCL) has come to describe lighting that is intended to address all of these effects.

The basic evidence for the new photoreceptors, called melanopsin-containing or intrinsic photosensitive retinal ganglion cells (ipRGC), and the first identified implications for lighting have been summarized in CIE 158:2004 (which was revised to become 158:2009, including Erratum 1). CIE continued to explore this topic with two expert symposia in 2004 and 2006, with workshops at its Session meetings in 2007 and 2011, and by initiating several technical committees. Other societies also responded with events, debates, and discussion concerning how best to incorporate this knowledge into lighting practice.

Scientists, the lighting industry, lighting designers and other stakeholders in the lighting community have continued to identify options and to design products and solutions that make use of non-visual lighting effects in a beneficial way, despite the fact that the established knowledge in this field is still premature. Among the few points of general agreement is that the non-visual effects of light exposure depend on the spectrum, intensity, duration, timing and temporal pattern (light history) of the light exposure.

In order to give further guidance to all interested parties on the future use of non-visual effects of light for human health and performance, while at the same time avoiding possible risks, CIE will be presenting two new publications on the state of science in this exciting research field:

1. How to measure light with respect to non-visual effects: Technical Note of CIE DR 6-42 (TN 003)

One of the greatest limitations to making concrete recommendations for healthy non-visual light exposures has been the difficulty in characterizing the impact of ipRGC exposures. In 2013, an independent workshop of leading scientist in the field of quantifying light for non-visual effects took place in Manchester, with support from a moderator and a reporter from CIE. This workshop resulted in a scientific consensus and agreement concerning the action spectrum of the ipRGC photoreceptor and a strategy for quantifying the stimulus for non-visual input into the human photoreception system, recognizing the interaction between all of the photoreceptors (Lucas et al. 2014). CIE TN 003 gives comprehensive information on the workshop and its outcome. This technical note will be freely available from the CIE web site, together with a calculation toolbox to facilitate consistent stimulus calculation and intercomparison of results.

2. Identifying the Proper Light: Technical Report of CIE TC 3-46

The Manchester workshop concluded that non-visual responses are subject to complex signal processing in the central nervous system and influenced by as-yet-unresolved interactions of photoreceptive units. The missing understanding of the input-output characteristics between light stimulus and the resulting non-visual response seems to make tailored light application for a desired lighting effect impossible. On the other hand, observations in laboratory and application studies show beneficial effects on human health and performance, using lighting systems developed on the basis of very general ideas concerning how to translate basic scientific findings into lighting design specifications. The main principles for these observations have been to increase the light levels and/or change spectral composition during daytime in order to increase the input into the ipRGCs and to do the opposite in the recovery phases of evening and night, by reducing light input to these cells. Thus there may be “low hanging fruits” in terms of application opportunities in this field, but this still needs clarification.

Even prior to the confirmation that ipRGCs constitute a separate retinal photoreceptor class to the rods and cones, there was a fundamental difference of opinion between those who would see this new information incorporated into lighting practice immediately, and those who argued for a more cautious approach with stronger evidence both for beneficial effects and to eliminate unintended adverse consequences. CIE TC 3-46 WD “Research Roadmap for Healthful Interior Lighting Applications” focuses on identifying the gaps in current knowledge for a safe and beneficial future use of light including non-visual responses. The report also delivers a research roadmap and tools for a systematic and sound understanding of the biological system to enable predictions with respect to biological outcome on the basis of the input characteristics. The purpose of this report is to focus research attention on the knowledge gaps that most impede the development of recommendations for interior lighting.

Further CIE Strategy

CIE is setting up a new Joint Technical Committee between the relevant Divisions[1] to follow up on the results of the Manchester workshop and translate the scientific consensus into a first international standard on quantifying irradiance with respect to stimulation of all ocular photoreceptors. To address the issues of safe and healthy applications, CIE will coordinate with ISO/TC 274 and other interested stakeholders on guidance for those who are beginning to apply lighting in new ways, to intentionally include non-visual effects, with a particular emphasis on achieving integrated recommendations for high-quality lighting. This dual approach shall lead to an improved and comprehensive understanding of the lighting effects on humans and to more healthful interior lighting in the future.

References

CIE 158:2009 Ocular Lighting Effects on Human Physiology and Behaviour.

CIE x027:2004 Proceedings of the CIE Symposium 2004 on Light and Health: Non-Visual Effects, 30 Sep. - 2 Oct. 2004, Vienna, Austria.

CIE x031:2006 Proceedings of the 2nd CIE Expert Symposium "Lighting and Health", 7-8 September 2006, Ottawa, Ontario, Canada.

CIE TN 003:2015 Report on the First International Workshop on Circadian and Neurophysiological Photometry, 2013 (in press)

Lucas, R.J., Peirson, S.N. et al. (2014). Measuring and using light in the melanopsin age. Trends Neurosci 37(1): 1-9.

[1] D1 „Vision and Colour“, D2 „Physical Measurement of Light and Radiation“, D3 „Interior Environment and Lighting Design“, D6 „Photobiology and Photochemistry“

About CIE

The International Commission on Illumination – also known as the CIE from its French title, the Commission Internationale de l´Eclairage – is devoted to worldwide cooperation and the exchange of information on all matters relating to the science and art of light and lighting, colour and vision, photobiology and image technology.

With strong technical, scientific and cultural foundations, the CIE is an independent, non-profit organization that serves member countries on a voluntary basis. Since its inception in 1913, has been accepted as representing the best authority on the subject. As such the CIE is recognized by ISO as an international standardization body, publishing global standards on the fundamentals of light and lighting.

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