

1 Recommendations for Healthful Lighting and Non-Visual Effects of Light

1.1 Description of research

Although light is defined as electromagnetic radiation that provides the stimulus for vision, we now know conclusively that photodetection also has many other essential physiological and psychological effects in humans and other organisms. Fundamental photobiology research adds to this knowledge base daily. However, targeted research, performed in concert with applied lighting scientists, will be required to put this knowledge to use as part of integrated lighting recommendations and designs.

1.2 Key research questions

In May 2016, CIE published a detailed research agenda for this topic ([CIE 218:2016](#)). Selected examples are given here:

- What pattern of daily light and dark exposure (intensity, spectrum, timing, duration) best supports well-being, both for circadian regulation and acute effects during waking hours (e.g. alertness, emotion, social behaviour)? How does this vary throughout life, from infancy to old age?
- In addition to circadian regulation, what physiological and psychological processes are influenced by ocular light detection?
- There are known medical uses of light to treat certain skin disorders and hyperbilirubinemia. There is speculation that inadequate light exposure during childhood contributes to the development of myopia. These ideas lead to the general question: Are there behavioural or physiological effects of extra-ocular absorption of optical radiation that should influence lighting recommendations?

1.3 Justification of the need for the proposed research topic

- The advances in photobiology and psychology offer the potential to use light exposure both for medical treatment (e.g. phototherapy for mood disorders) and to improve well-being in healthy people. This has excited many people, witness the series of existing CIE publications and current activities on this topic.
- Advances in lighting and controls technologies offer unprecedented opportunities to save energy along with opportunities to enhance health and well-being. A comprehensive research effort will direct the development of these new technologies to the benefit of all.
- Today's market seems to include some applications of "human centric lighting" that go beyond what scientists would say that firmly established knowledge can support. Lighting has the potential for positive and negative effects on humans when applied in the right or wrong way, respectively. As in all emerging fields of knowledge, including "human centric lighting", continuation and strengthening of research activities are needed to further enhance knowledge and to develop clear evidence-based guidance for users on how to avoid negative and achieve positive effects of light for humans.
- In parallel, environmental considerations lead to pressure to reduce interior light levels, whether provided by daylight and or electric lighting systems, in order to reduce energy use for both lighting and space conditioning (heating and cooling). This appears to be in opposition to the current knowledge, which suggests that most people receive too little optical radiation each day. More knowledge on dose response relationships for physiological and psychological effects of optical radiation is needed to resolve this conflict. This requires metrics that characterize radiation dose and their implementation into measurement instruments and protocols.
- A small number of people experience a range of health conditions due to the spectral emission of light sources or due to the temporal characteristics of light received at the eye. Apart from photo-induced epilepsy, little is known about the triggers for these health conditions. It is important that consideration is given to these issues to ensure that some sectors of the community are not unnecessarily excluded from electrically lit environments.

1.4 Related current activities in CIE

JTC 4 (D3/D6)	Visual, Health, and Environmental Benefits of Windows in Buildings during Daylight Hours
JTC 14 (CIE/ISO)	Integrative Lighting
DR 6-43	Illuminators for Treatment of Infant Hyperbilirubinemia
DR 6-44	Optical Radiation Hazard Measurements in the Workspace
DR 6-46	Second International Workshop on Circadian and Neurophysiological Photoreception
DR 6-47	The Role of Light and Lighting Conditions in the Prevention, Development and Mitigation of Myopia: a Literature Review
RF-02	Matters relating to temporal light modulation

1.5 Existing CIE publications

CIE 139:2001	The Influence of Daylight and Artificial Light on Diurnal and Seasonal Variations in Humans - A Bibliography
CIE 158:2004/2009	Ocular Lighting Effects on Human Physiology and Behaviour
CIE 218:2016	Research Roadmap for Healthful Interior Lighting Applications
CIE 227:2017	Lighting for Older People and People with Visual Impairment in Buildings DOI: 10.25039/TR.227.2018
CIE S 026/E:2018	CIE System for Metrology of Optical Radiation for ipRGC-Influenced Responses to Light DOI: 10.25039/S026.2018
CIE TN 003:2015	Report on the First International Workshop on Circadian and Neurophysiological Photometry, 2013
CIE TN 008:2017	Final Report CIE Stakeholder Workshop for Temporal Light Modulation Standards for Lighting Systems
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
October, 2019	Position Statement on Non-Visual Effects of Light - Recommending Proper Light at the Proper Time, 2nd edition (October 3, 2019)
April, 2020	α -opic Toolbox and User Guide for implementing CIE S 026 DOIs: 10.25039/S026.2018.TB, 10.25039/S026.2018.UG