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

PROCEEDINGS of CIE 2016 "Lighting Quality and Energy Efficiency"

3 - 5 March 2016

Melbourne, Australia

CIE x042:2016

UDC: 628.9
535.24

Descriptor: Lighting. Illuminating engineering
Descriptor: Photometry

THE INTERNATIONAL COMMISSION ON ILLUMINATION

The International Commission on Illumination (CIE) is an organization devoted to international co-operation and exchange of information among its member countries on all matters relating to the art and science of lighting. Its membership consists of the National Committees in about 40 countries.

The objectives of the CIE are:

1. To provide an international forum for the discussion of all matters relating to the science, technology and art in the fields of light and lighting and for the interchange of information in these fields between countries.
2. To develop basic standards and procedures of metrology in the fields of light and lighting.
3. To provide guidance in the application of principles and procedures in the development of international and national standards in the fields of light and lighting.
4. To prepare and publish standards, reports and other publications concerned with all matters relating to the science, technology and art in the fields of light and lighting.
5. To maintain liaison and technical interaction with other international organizations concerned with matters related to the science, technology, standardization and art in the fields of light and lighting.

The work of the CIE is carried out by Technical Committees, organized in seven Divisions. This work covers subjects ranging from fundamental matters to all types of lighting applications. The standards and technical reports developed by these international Divisions of the CIE are accepted throughout the world.
A plenary session is held every four years at which the work of the Divisions and Technical Committees is reported and reviewed, and plans are made for the future. The CIE is recognized as the authority on all aspects of light and lighting. As such it occupies an important position among international organizations.

LA COMMISSION INTERNATIONALE DE L'ECLAIRAGE

La Commission Internationale de l'Eclairage (CIE) est une organisation qui se donne pour but la coopération internationale et l'échange d'informations entre les Pays membres sur toutes les questions relatives à l'art et à la science de l'éclairage. Elle est composée de Comités Nationaux représentant environ 40 pays.

Les objectifs de la CIE sont :

1. De constituer un centre d'étude international pour toute matière relevant de la science, de la technologie et de l'art de la lumière et de l'éclairage et pour l'échange entre pays d'informations dans ces domaines.
2. D'élaborer des normes et des méthodes de base pour la métrologie dans les domaines de la lumière et de l'éclairage.
3. De donner des directives pour l'application des principes et des méthodes d'élaboration de normes internationales et nationales dans les domaines de la lumière et de l'éclairage.
4. De préparer et publier des normes, rapports et autres textes, concernant toutes matières relatives à la science, la technologie et l'art dans les domaines de la lumière et de l'éclairage.
5. De maintenir une liaison et une collaboration technique avec les autres organisations internationales concernées par des sujets relatifs à la science, la technologie, la normalisation et l'art dans les domaines de la lumière et de l'éclairage.

Les travaux de la CIE sont effectués par Comités Techniques, organisés en 7 Divisions. Les sujets d'études s'étendent des questions fondamentales, à tous les types d'applications de l'éclairage. Les normes et les rapports techniques élaborés par ces Divisions Internationales de la CIE sont reconnus dans le monde entier.
Tous les quatre ans, une Session plénière passe en revue le travail des Divisions et des Comités Techniques, en fait rapport et établit les projets de travaux pour l'avenir. La CIE est reconnue comme la plus haute autorité en ce qui concerne tous les aspects de la lumière et de l'éclairage. Elle occupe comme telle une position importante parmi les organisations internationales.

DIE INTERNATIONALE BELEUCHTUNGSKOMMISSION

Die Internationale Beleuchtungskommission (CIE) ist eine Organisation, die sich der internationalen Zusammenarbeit und dem Austausch von Informationen zwischen ihren Mitgliedsländern bezüglich der Kunst und Wissenschaft der Lichttechnik widmet. Die Mitgliedschaft besteht aus den Nationalen Komitees in rund 40 Ländern.

Die Ziele der CIE sind:

1. Ein internationales Forum für Diskussionen aller Fragen auf dem Gebiet der Wissenschaft, Technik und Kunst der Lichttechnik und für den Informationsaustausch auf diesen Gebieten zwischen den einzelnen Ländern zu sein.
2. Grundnormen und Verfahren der Messtechnik auf dem Gebiet der Lichttechnik zu entwickeln.
3. Richtlinien für die Anwendung von Prinzipien und Vorgängen in der Entwicklung internationaler und nationaler Normen auf dem Gebiet der Lichttechnik zu erstellen.
4. Normen, Berichte und andere Publikationen zu erstellen und zu veröffentlichen, die alle Fragen auf dem Gebiet der Wissenschaft, Technik und Kunst der Lichttechnik betreffen.
5. Liaison und technische Zusammenarbeit mit anderen internationalen Organisationen zu unterhalten, die mit Fragen der Wissenschaft, Technik, Normung und Kunst auf dem Gebiet der Lichttechnik zu tun haben.

Die Arbeit der CIE wird durch Technische Komitees geleistet, die in sieben Divisionen organisiert sind. Diese Arbeit betrifft Gebiete mit grundlegender Natur bis zu allen Arten der Lichtanwendung. Die Normen und Technischen Berichte, die von diesen international zusammengesetzten Divisionen ausgearbeitet werden, sind auf der ganzen Welt anerkannt.
Alle vier Jahre findet eine Session statt, in der die Arbeiten der Divisionen berichtet und überprüft werden, sowie neue Pläne für die Zukunft ausgearbeitet werden. Die CIE wird als höchste Autorität für alle Aspekte des Lichtes und der Beleuchtung angesehen. Auf diese Weise erhält sie eine bedeutende Stellung unter den internationalen Organisationen.

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CIE Central Bureau
Babenbergerstrasse 9, A-1010 Vienna, AUSTRIA
Tel: +43(1)714 31 87
e-mail: ciecb@cie.co.at
www.cie.co.at

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CIE Central Bureau
Babenbergerstrasse 9
A-1010 Vienna, AUSTRIA
Tel: +43(1)714 31 87
e-mail: ciecb@cie.co.at

www.cie.co.at

The following table provides an overview of the oral presentations, presented posters and posters presented at the conference. The papers are published in the proceedings in consecutive order of presentation. Papers that have not been submitted are marked as such (“n.s.”).

The authors are responsible for the contents of their papers.

Please note: For direct access of a paper click on the respective page number.

TUNING LIGHT TO SEE AND FEEL BETTER: THE HUMAN VISUAL AND NON-VISUAL RESPONSES TO SPECTRAL VARIATIONS IN LIGHT

Hurlbert, A.[1], Aston, S.[1], Pearce, B.M.[1]
[1] Institute of Neuroscience, Newcastle University, Newcastle upon Tyne, UNITED KINGDOM
Anya.hurlbert@ncl.ac.uk

Abstract

The advent of tuneable, multi-channel LED light source technology enables vision scientists to probe better the human response to light, yielding greater understanding of how human physiology has adapted to natural environmental illuminations. At the same time, novel lighting technology allows designers to tune lighting to shape human behaviour in different environments. In this talk, I will discuss the effects of spectral tuning of light in terms of both the visual and non-visual systems, and their possible interactions.

Keywords: Colour constancy, LED illumination, non-visual pathway

1 The optimisation of human colour constancy for daylight chromaticities: laboratory experiments

Colour constancy is the perceptual phenomenon by which object colour remains constant despite changes in the illumination spectrum – a yellow banana appears yellow whether illuminated by tungsten light or morning daylight. Colour constancy depends on multiple mechanisms in the human visual system (Hurlbert, 2007, Foster, 2011), and, although a textbook example of a perceptual constancy, it is not universally perfect for all surfaces and all illuminations – a fact captured by colour appearance models.

To examine the dependence of colour constancy on illumination, we have developed an illumination discrimination task which measures colour constancy by determining discrimination thresholds for illumination changes in particular chromatic directions (parametrised by unit distances in a perceptually uniform space (Lu*v*)) (Pearce et al., 2014). Using tuneable multi-channel LED light sources to generate changing illuminations in real time, we find that thresholds for discriminating illumination changes are highest – i.e. colour constancy is best - for "blue-ish" daylight illuminations. Conversely, colour constancy is worst for atypical illuminations (Pearce et al., 2014). That is, thresholds (in ΔE_{uv}) for discriminating illumination changes in 'red', 'green' or 'yellow' chromatic directions are significantly lower than for changes in the 'blue' direction.

These results suggest that colour constancy is optimised for naturally encountered illuminations, and that stability of object colour may be achieved even under changing illuminations, provided these changes occur for cooler temperatures along the daylight locus.

1.1 Illumination discrimination at non-neutral adaptation points

The "blue bias" in illumination discrimination, and colour constancy, has been shown for scenes with neutral mean chromaticity, when the participant is adapted to a neutral (D67) illumination (Pearce et al., 2014). In further experiments, we have shown that the relative thresholds for the four chromatic directions depend on the scene surface ensemble, and specifically, on the mean scene chromaticity, as demonstrated with simulated scenes on a computer display (Krieger et al., 2015).

We have further investigated the extent to which the "blue bias" also holds for adaptation points biased away from a neutral chromaticity point (Aston et al., 2015), as described in the following sections.