Polychromatic light for circadian support and visual comfort

Susanne Seitinger, PhD

Artificial Light at Night 2015

PHILIPS

Acknowledging Research Team

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The Natural Power of Light

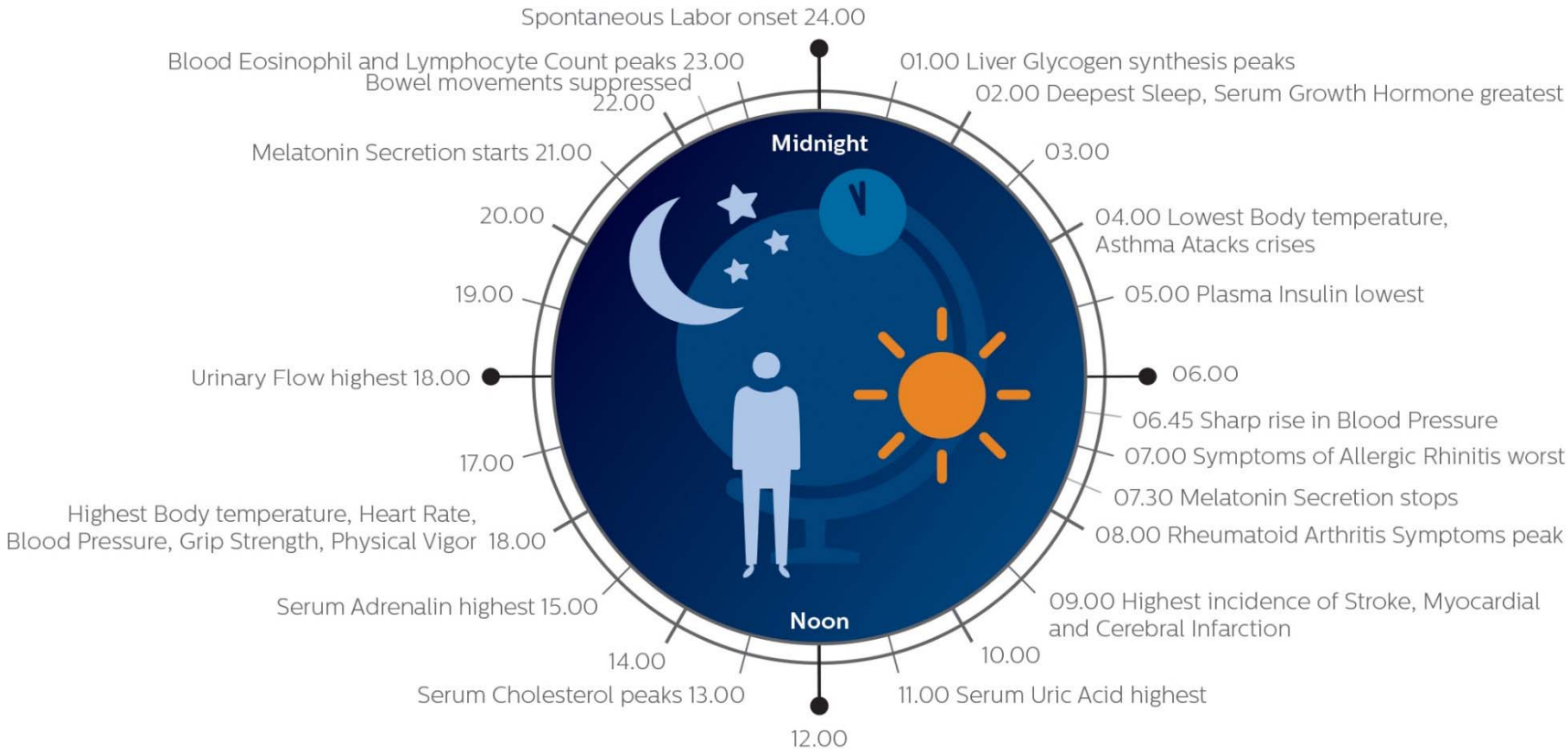
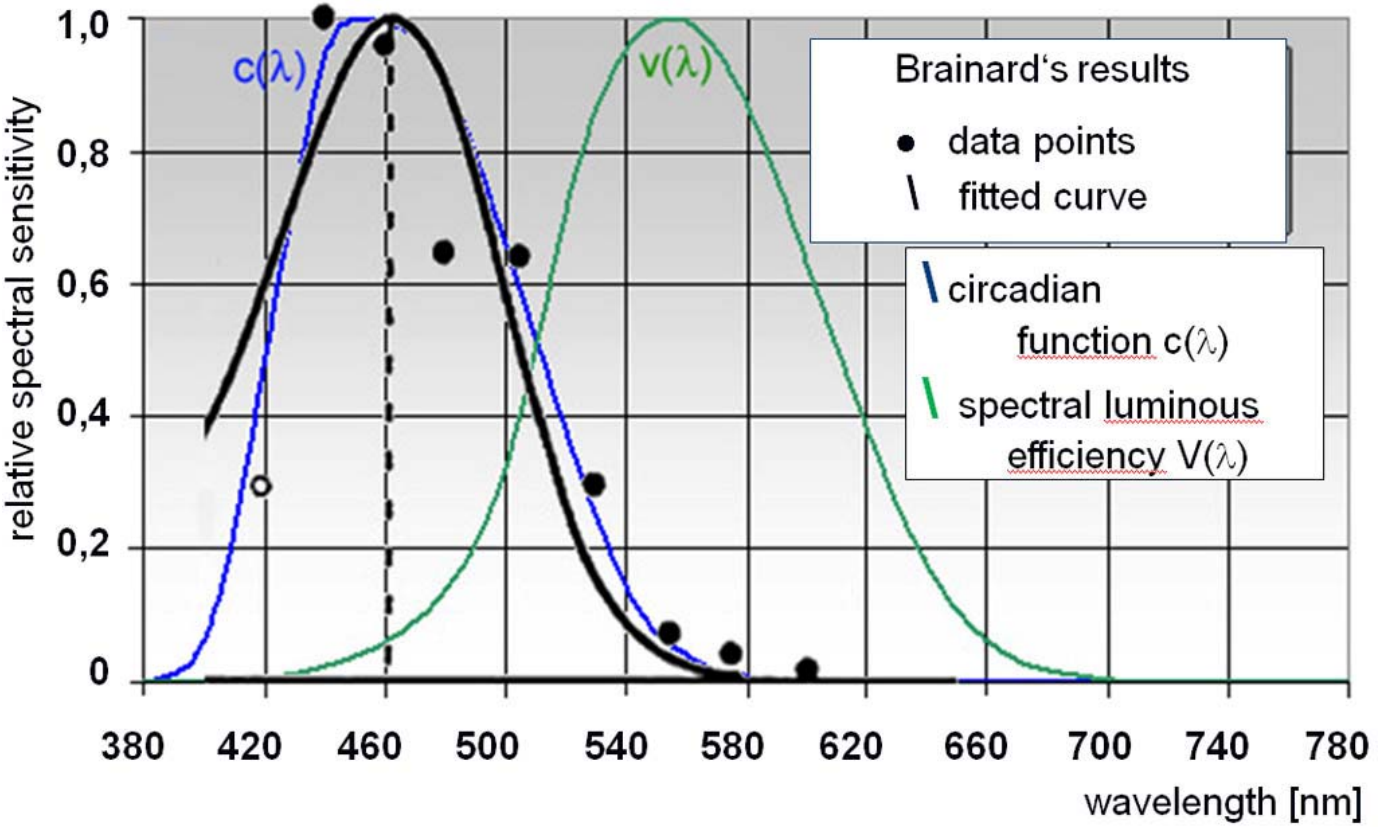


Image credit: Schlangen, L. (2014) “The e! ect of light on our sleep/wake cycle,” White Paper Circle of Light. www.lighting.philips.com/main/connect/Lighting_University/Assets/Daily-sleep-wake-cycles-whitepaper-FINAL.pdf

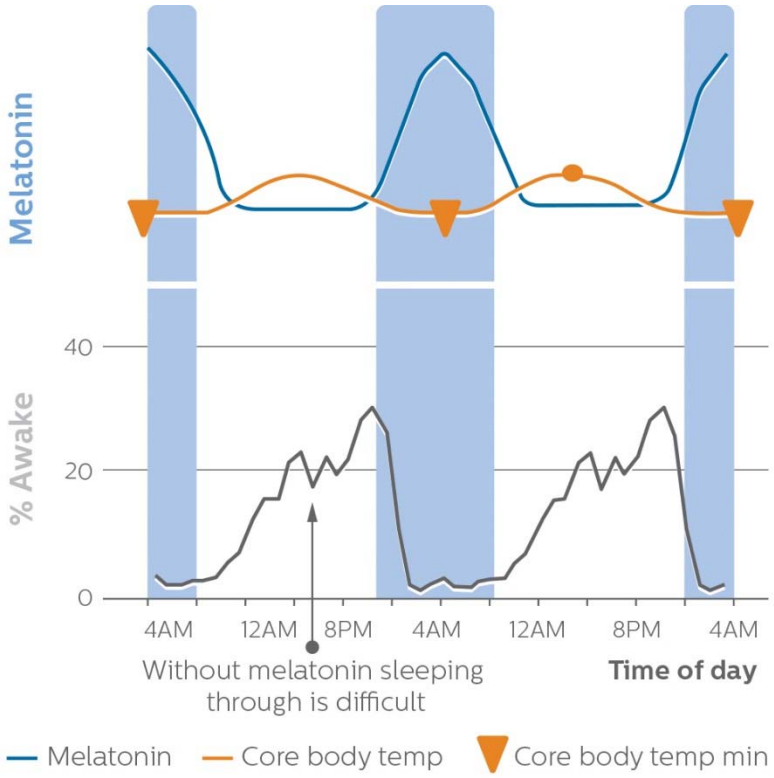
Light Regulates Our Circadian Rhythm

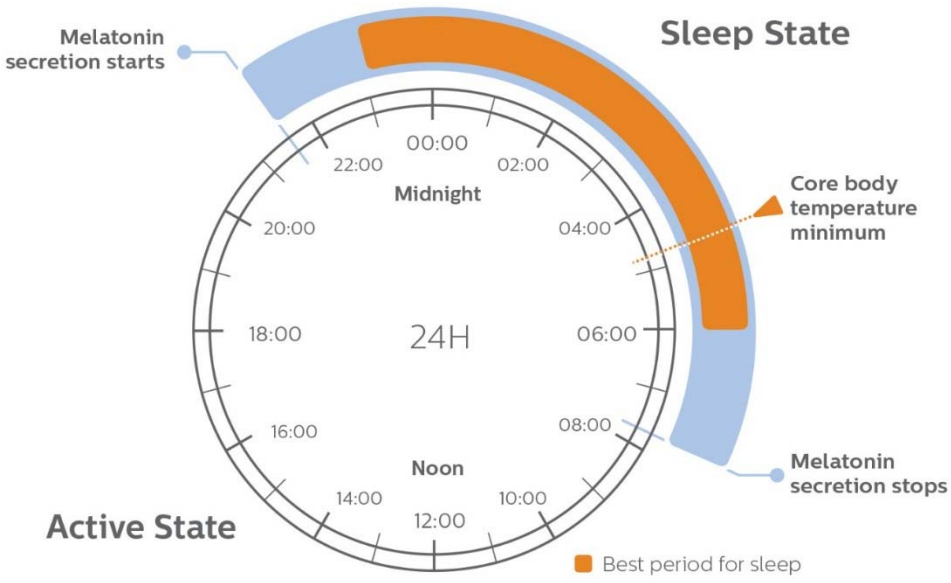


Brainard's action spectrum for circadian light

Photo Credit: https://spie.org/Images/Graphics/Newsroom/Imported-2011/003442/003442_10_fig1.jpg

Light Regulates Our Melatonin Secretion





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Cancer Center Quiet Room

Duke Medical Center, Durham, North Carolina

Tasked with the challenge of providing a multipurpose, contemplative space for a wide range of moods and emotions, Cline Bettridge Bernstein Lighting Design (CBBLD) organized the Cancer Center's Quiet Room with the tranquility of nature in mind.

Architectural Lighting July-August 2013 DESIGN AWARDS
Lighting Design: Cline Bettridge Bernstein
Photographer: Les Tood, Duke Univeristy Photography, Durham, N.C.
http://www.archlighting.com/healthcare-projects/best-use-of-color-color-duke-university-medical-c.aspx

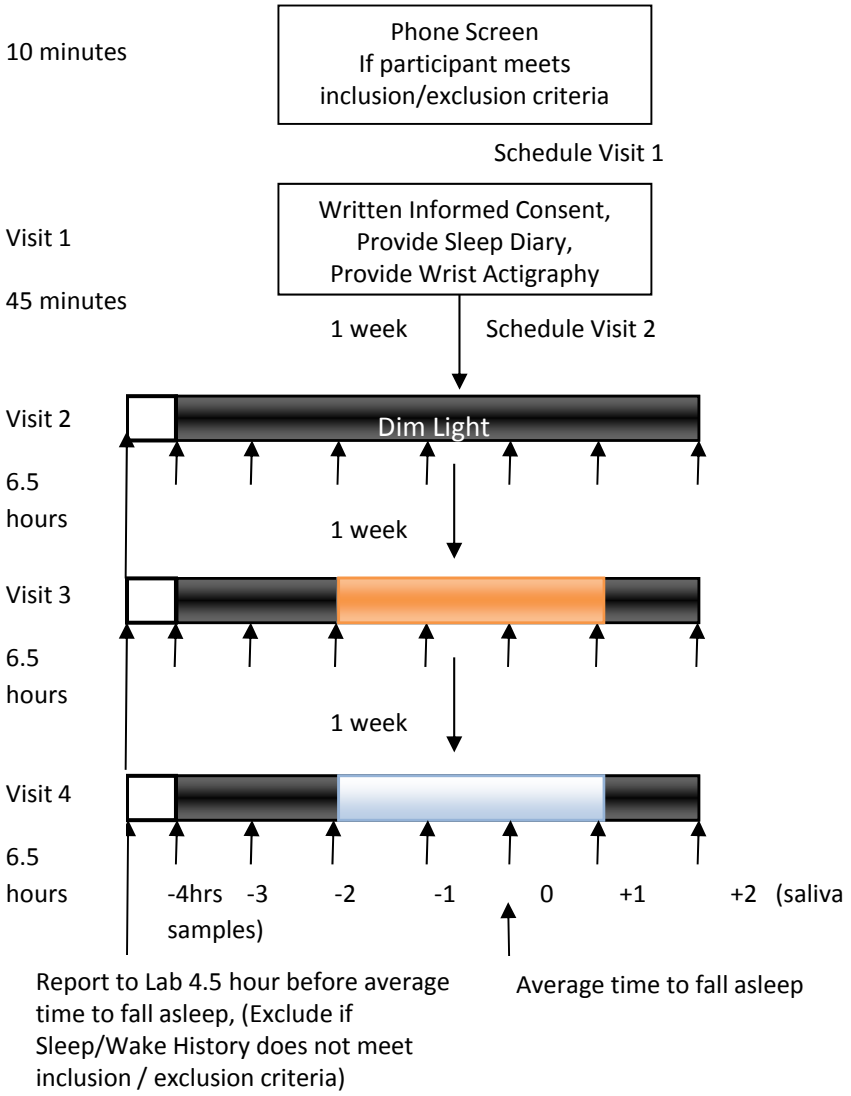
Purpose and Hypotheses

The primary objective of the study was to investigate the effect of light (lumens and spectrum) on melatonin production.

- Hypothesis: Bright light that includes blue spectrum will suppress endogenous salivary melatonin secretion more than lower lumen light in the amber-red spectrum.

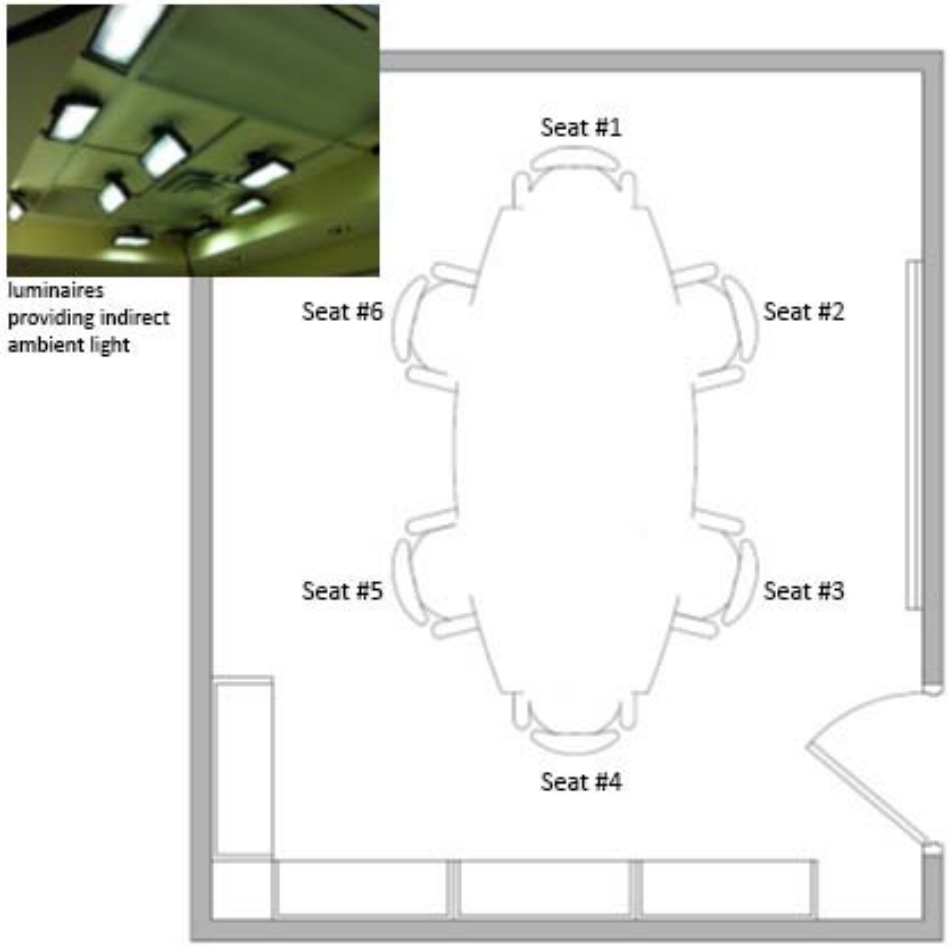
- Hypothesis: The secondary objective was to investigate whether light in the amber – red spectrum with adequate lumens to read and perform desired tasks will not suppress melatonin significantly from a baseline condition with dim light (<2 lux).

Study Overview



Study Flow Diagram and Schedule (Part II).

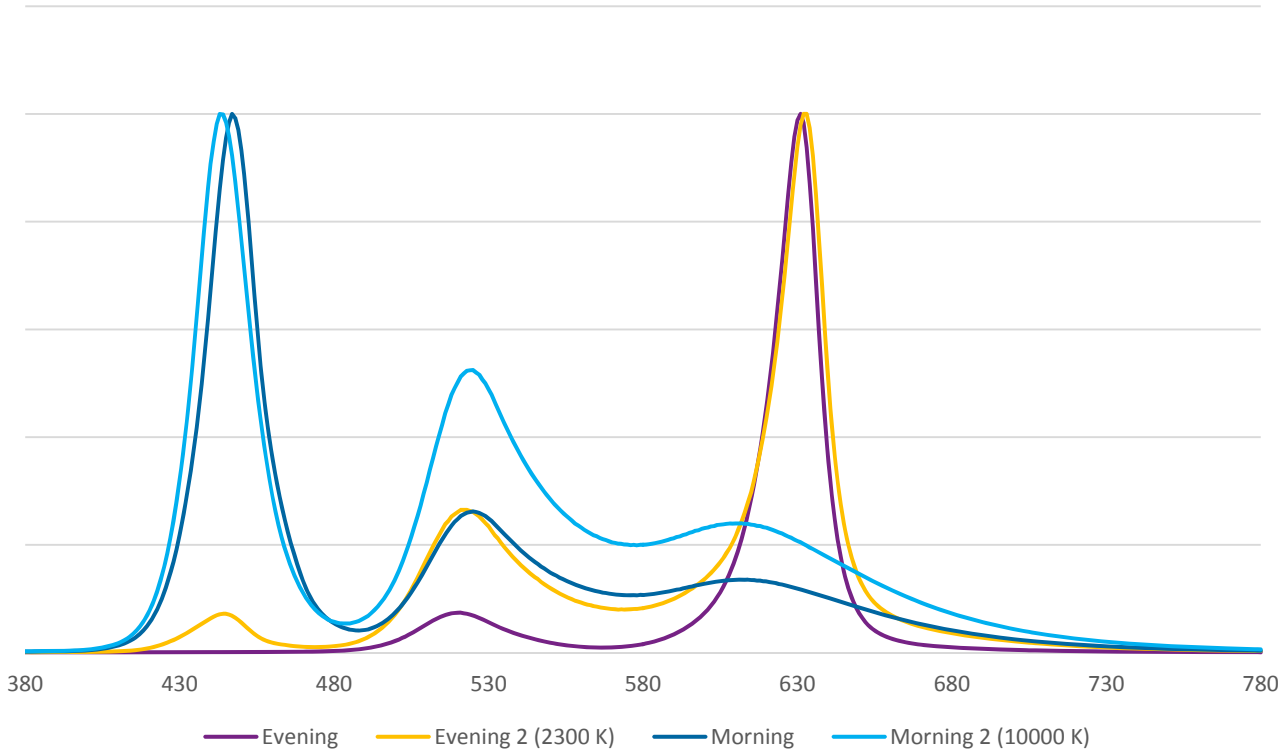
Experimental Conditions



Experimental Conditions. Room size approximately 12 feet by 15 feet.

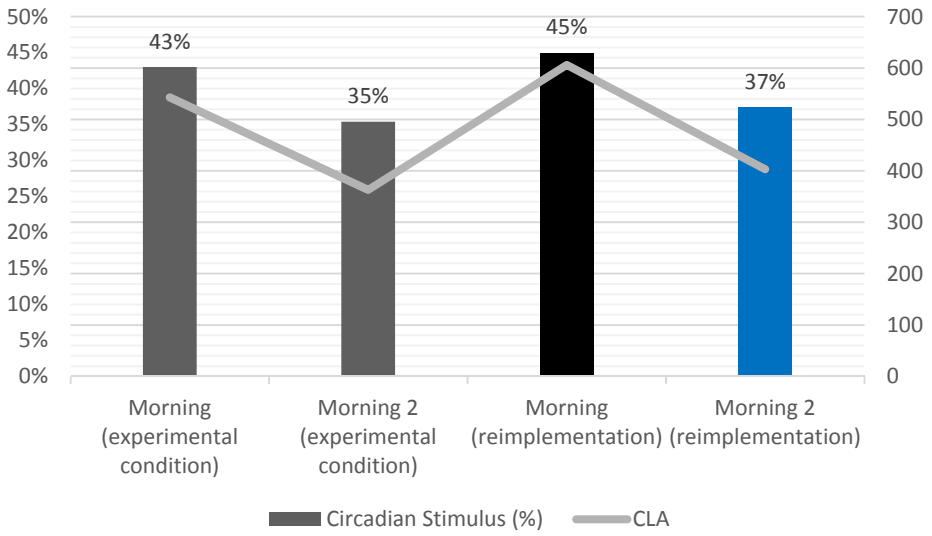
Experimental Conditions

Experimental Settings	
Morning	Morning 2 (10000 K)
1.484	1.054
Experimental Settings	
Evening	Evening 2 (2300 K)
0.246	0.502

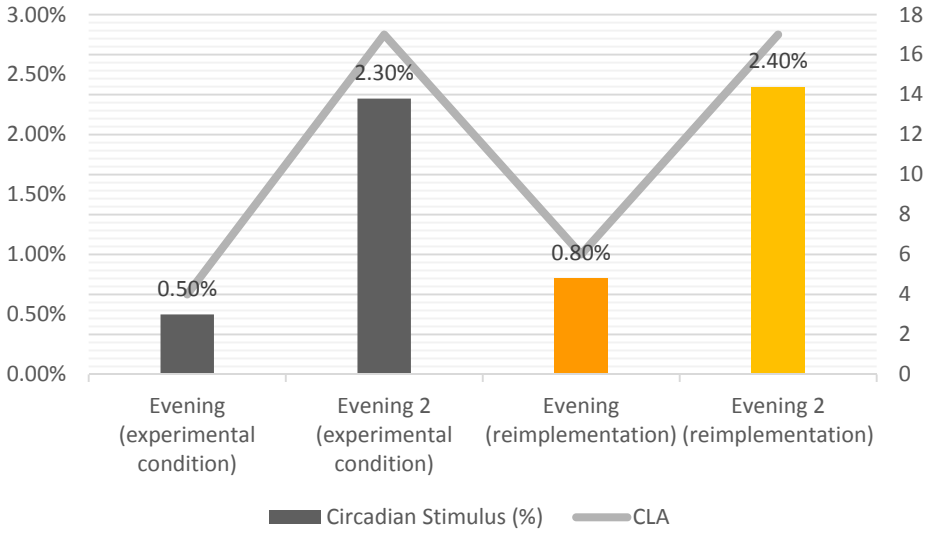


Comparison of spectral power distributions normalized for peak irradiance for the four experimental lighting conditions.

Expected Circadian Stimulation



Circadian stimulus and CLA) analyzed for all studied experimental and non-experimental evening and morning lighting conditions.



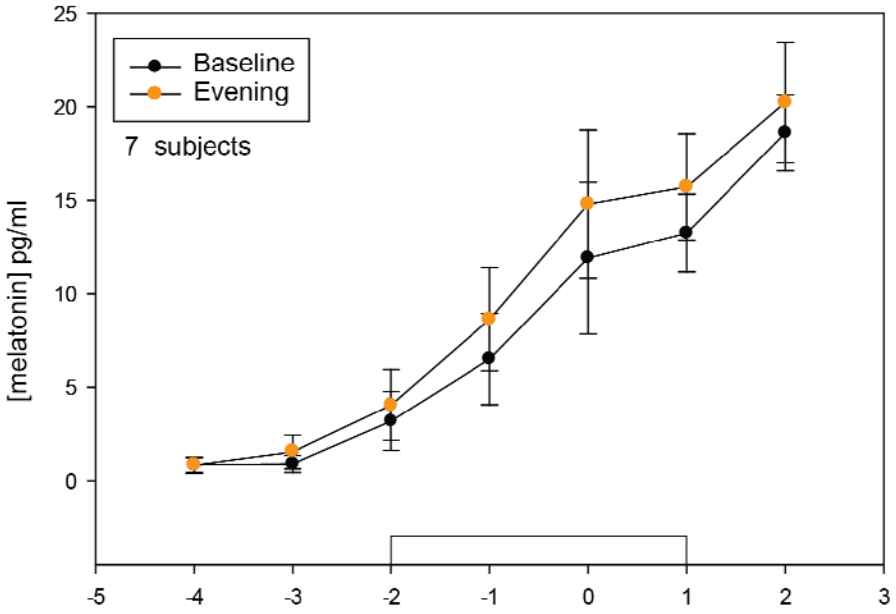
Experimental Conditions

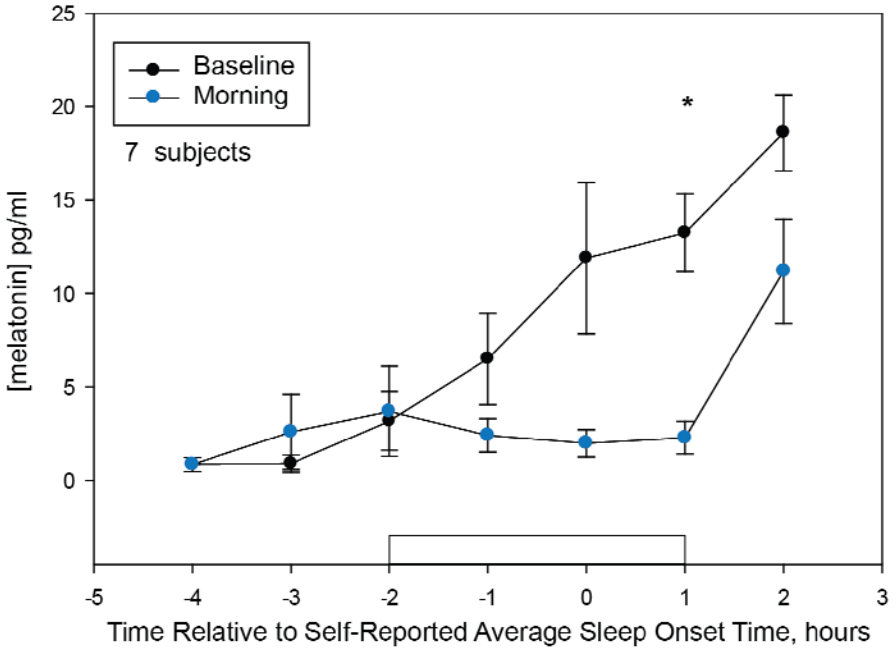
Light Setting	Average horizontal illuminance on the table top (lux)	Average vertical illuminance entering the eye (lux)	Average vertical illuminance entering the eye looking at table (lux)
Dim Light	4	2	1
Evening	35	13.8	9
Morning	1149	432	269
Evening 2	81	29	25
Morning 2	1144	432	275

Average illuminances around the table.

Results

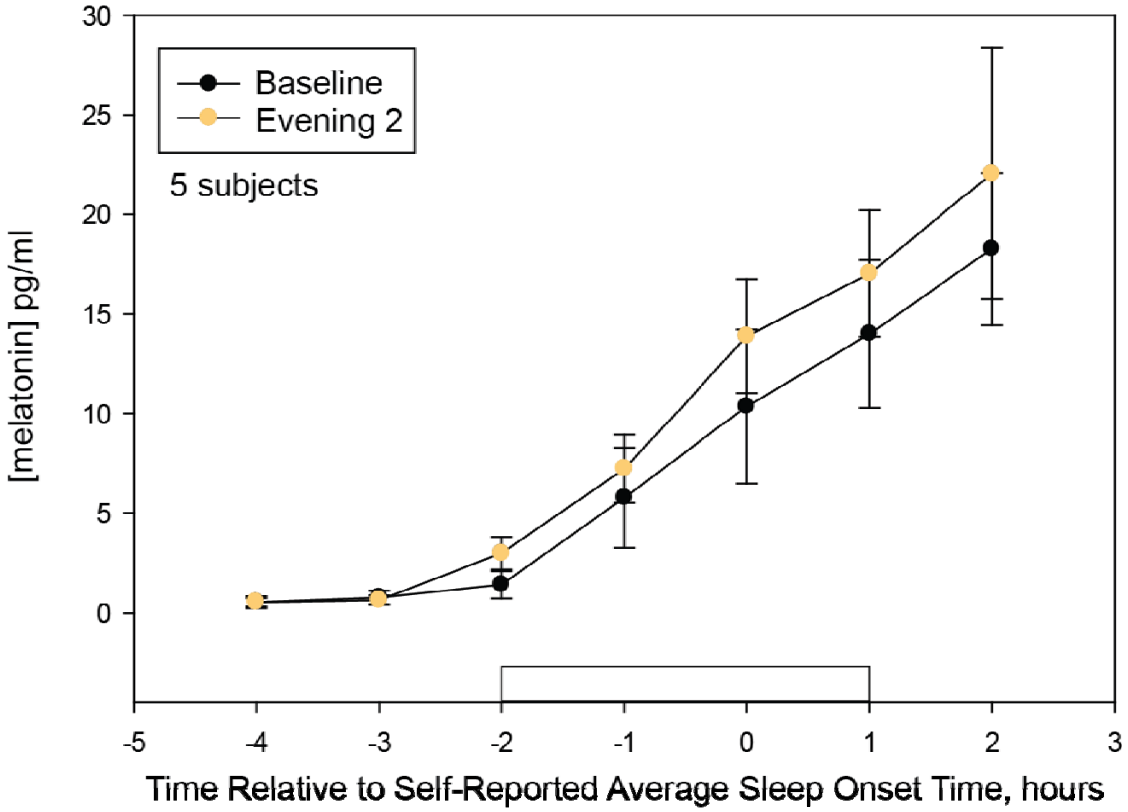
Two Novel Ambient Lighting Conditions





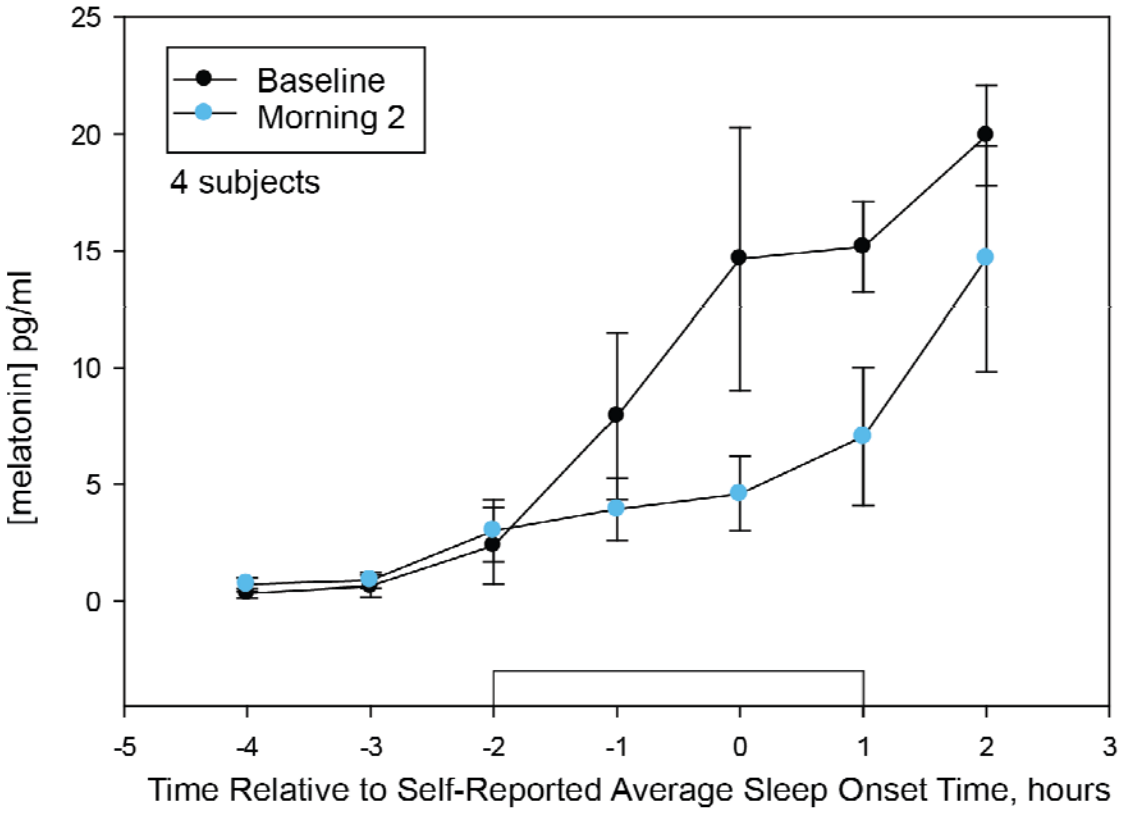
Results

Better White Light for the Evening – 2300 K



Results

Better White Light for the Evening – 10000 K



Visual Comparison of Settings

2300K 3500K 4500K 6500K 9500K

Discussion

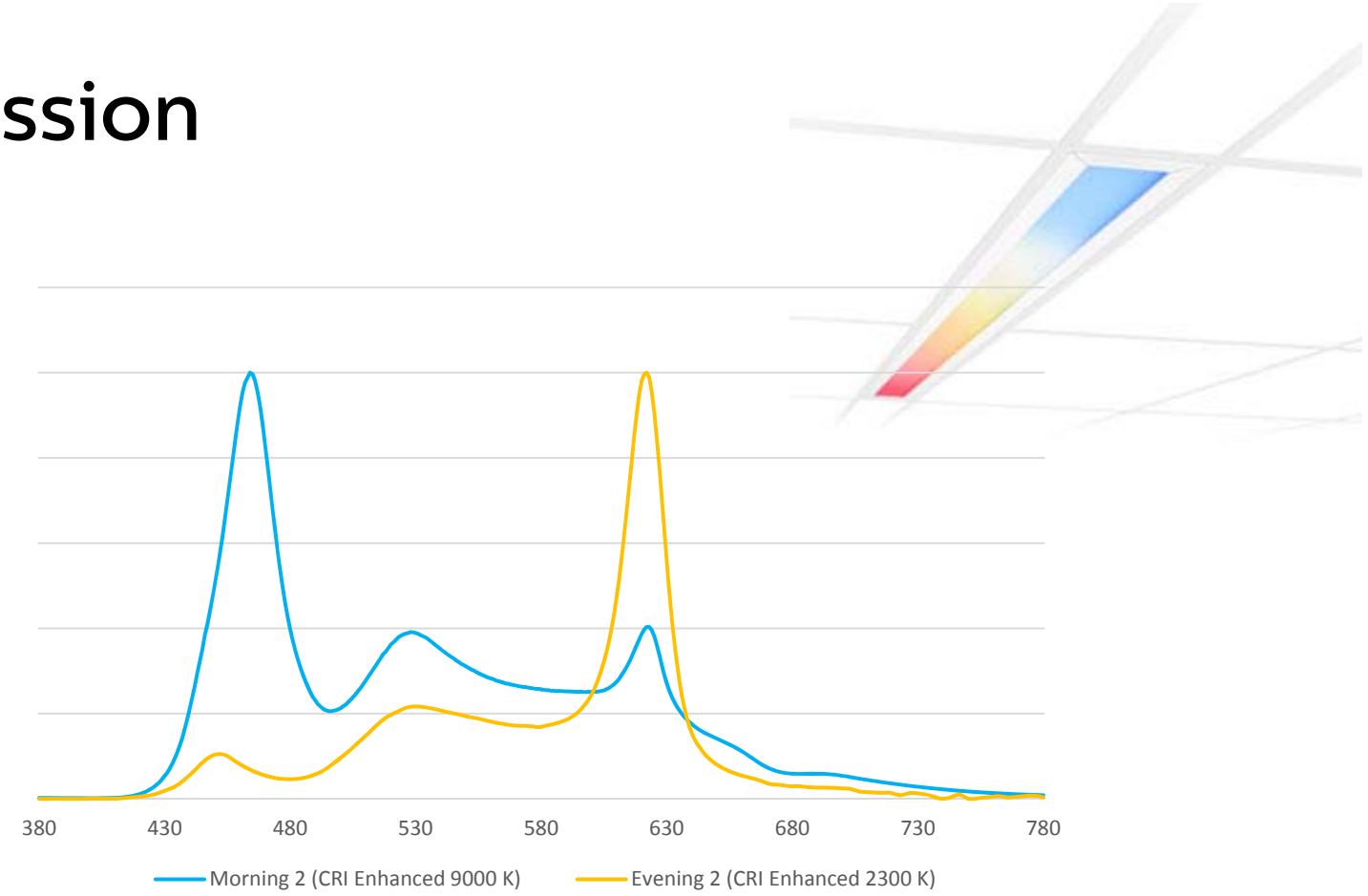
Experimental Settings		Translation of Experimental Settings on Commercial Lighting Platform	
Morning	Morning 2 (10000 K)	Morning	Morning 2 (9000 K)
1.484	1.054	2.134	1.326

Ratio of melanopic equivalent illuminance to photopic illuminance ratio for morning light settings.

Experimental Settings		Translation of Experimental Settings on Commercial Lighting Platform	
Evening	Evening 2 (2300 K)	Evening	Evening 2 (2300 K)
0.246	0.502	0.172	0.458

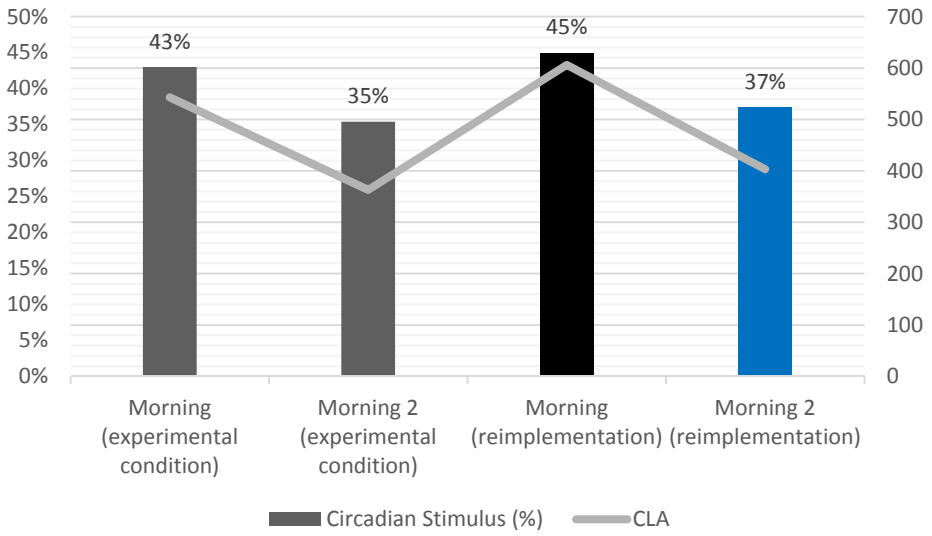
Ratio of melanopic equivalent illuminance to photopic illuminance for evening light settings.

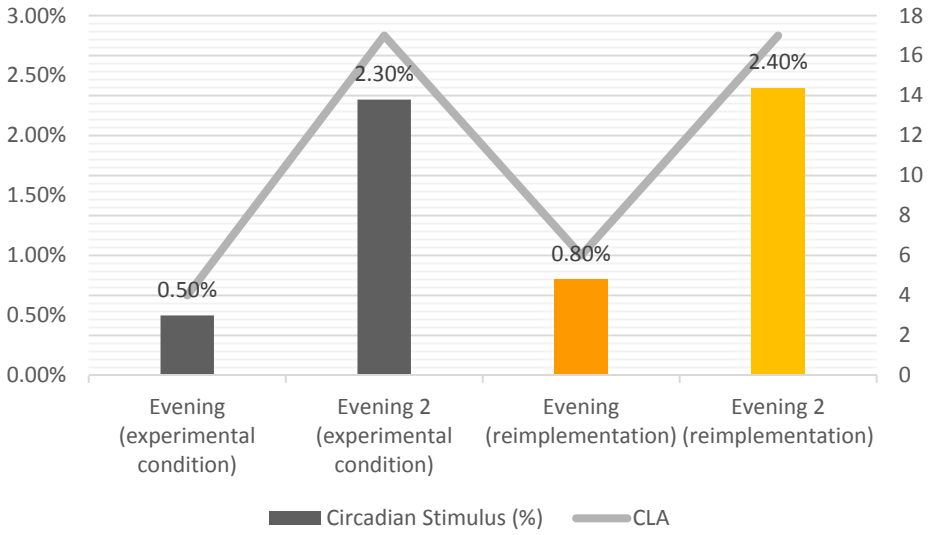
Discussion



Comparison of spectral power distributions normalized for peak irradiance for enhanced light settings morning 2 and evening 2 implemented on a commercially available 5-channel LED lighting platform.

Discussion





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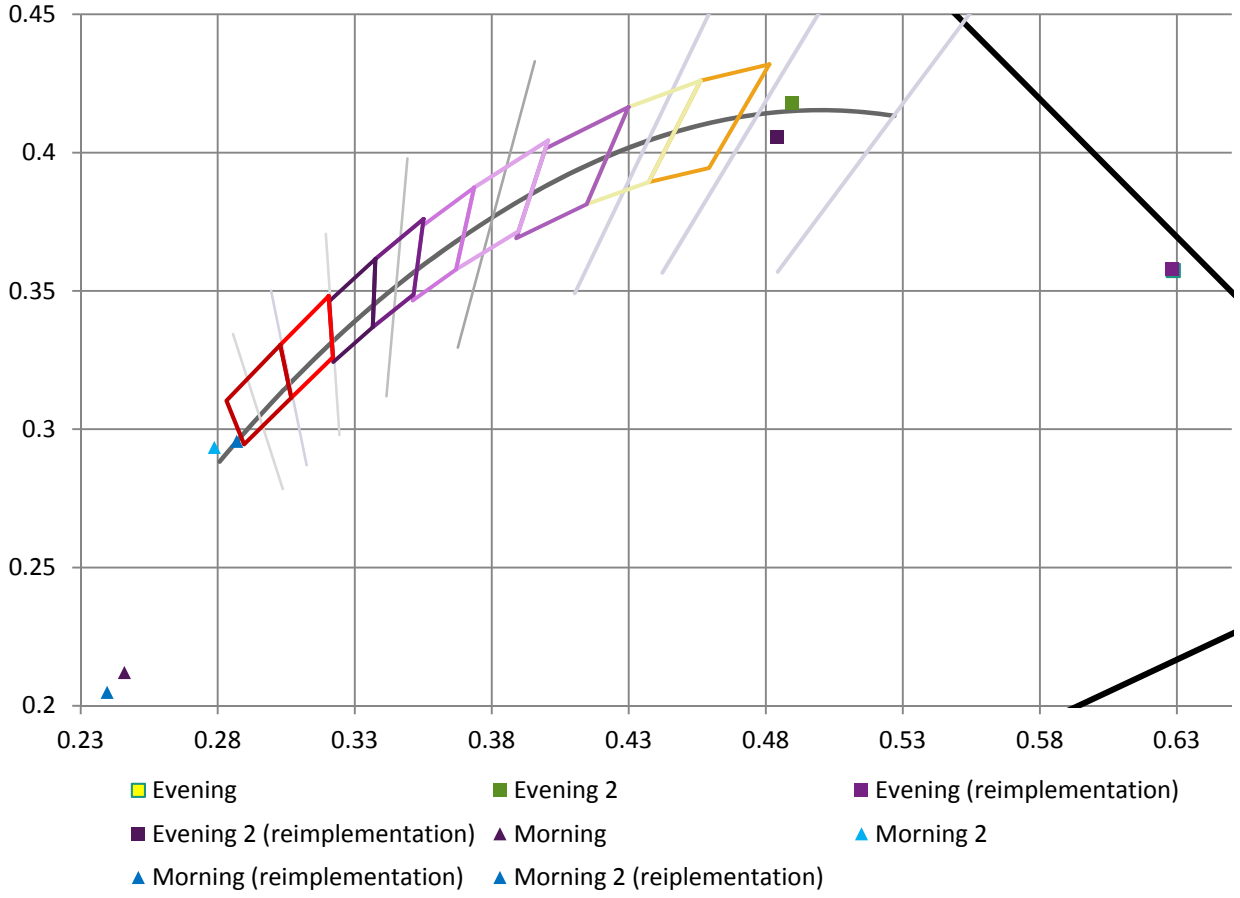
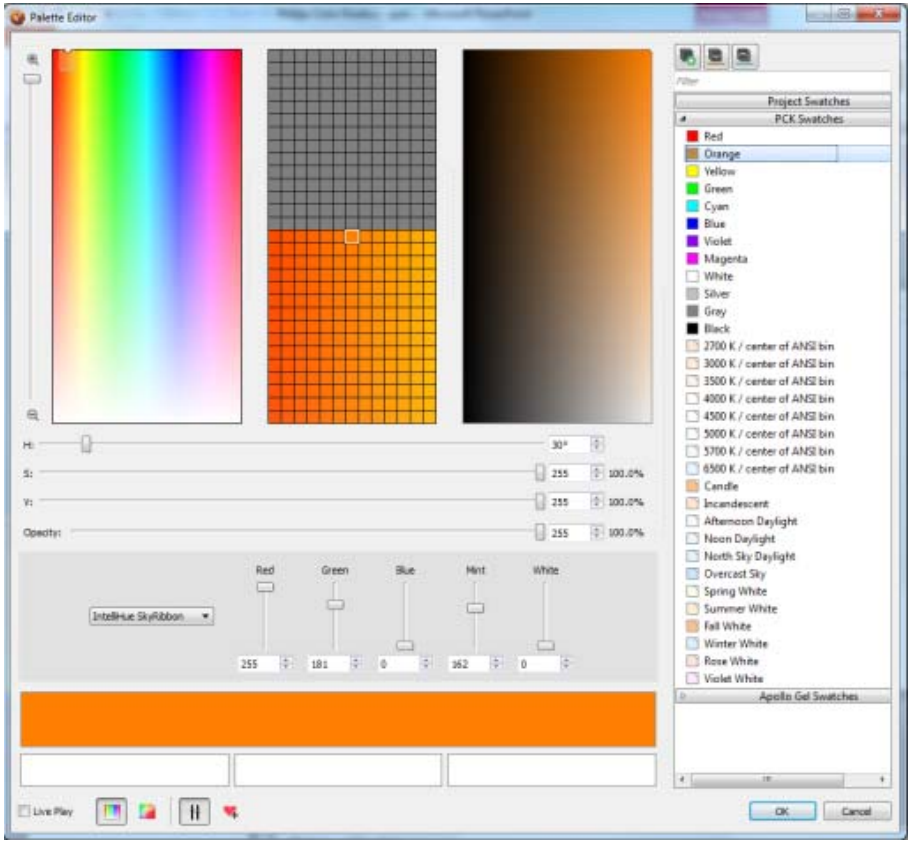
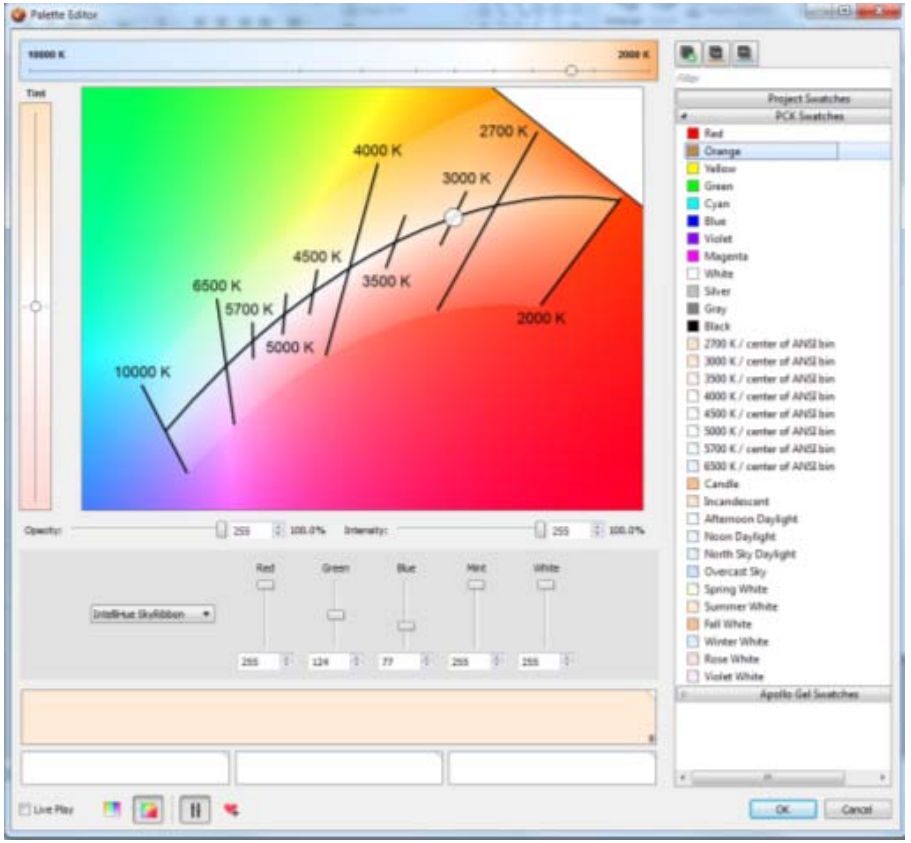


CIE 1931 space showing the 4 experimental conditions with their respective xy coordinates in relation to the black body locus (BBL). Note Evening overlaps with Evening (reimplementation).


Palette Editor
Project Swatches
PCK Swatches
Red
Orange
Yellow
Green
Cyan
Blue
Violet
Magenta
White
Silver
Gray
Black
2700 K / center of ANSI bin
3000 K / center of ANSI bin
3500 K / center of ANSI bin
4000 K / center of ANSI bin
4500 K / center of ANSI bin
5000 K / center of ANSI bin
5700 K / center of ANSI bin
6500 K / center of ANSI bin
Candle
Incandescent
Afternoon Daylight
Noon Daylight
North Sky Daylight
Overcast Sky
Spring White
Summer White
Fall White
Winter White
Rose White
Violet White
Apollo Gel Swatches
H:
S:
V:
Opacity:
Red
Green
Blue
Mint
White
IntelliHue SkyRibbon
Live Play
OK
Cancel


Palette Editor
10000 K
2000 K
Tint
2700 K
4000 K
3000 K
4500 K
3500 K
6500 K
5700 K
5000 K
2000 K
10000 K
Project Swatches
PCK Swatches
Red
Orange
Yellow
Green
Cyan
Blue
Violet
Magenta
White
Silver
Gray
Black
Candle
Incandescent
Afternoon Daylight
Noon Daylight
North Sky Daylight
Overcast Sky
Spring White
Summer White
Fall White
Winter White
Rose White
Violet White
Apollo Gel Swatches
Opacity:
Intensity:
Red
Green
Blue
Mint
White
IntelliHue SkyRibbon
Live Play
OK
Cancel

Conclusion

Anna Wirz-Justice and Colin Fournier summarized notes from the annual meeting of the *Society for Light Treatment and Biological Rhythms*. They present draft design guidelines and called for research cooperation among scientists, architects and lighting practitioners to build on the growing base of evidence-based design practices. These types of collaborations could lead to improved results for the general population and overcome the “placebo” effect associated with results gained in unnatural lab-based settings.

Thank you!

Contact

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Study Information

Please note this study is still in review.

Acknowledgments

The authors would like to thank Charles A. Czeisler for valuable feedback on the light selection and study design. We would also like to thank our intern Harvin Vallabhaneni and the research coordinators Barbara Lanzi and Mary MacDonald.

Funding

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Conflict of Interest Statement

SS, NP, EC and BR are full time employees of Philips Lighting. FSK and SP are full time employees of Philips Healthcare. DPW serve as a consultant for Philips Healthcare and was the Principal Investigator of this protocol.


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