Universitäre Psychiatrische Kliniken Basel

Universität Basel

Licht und Schatten: Wie Licht unsere Gesundheit/Wohlergehen beeinflusst

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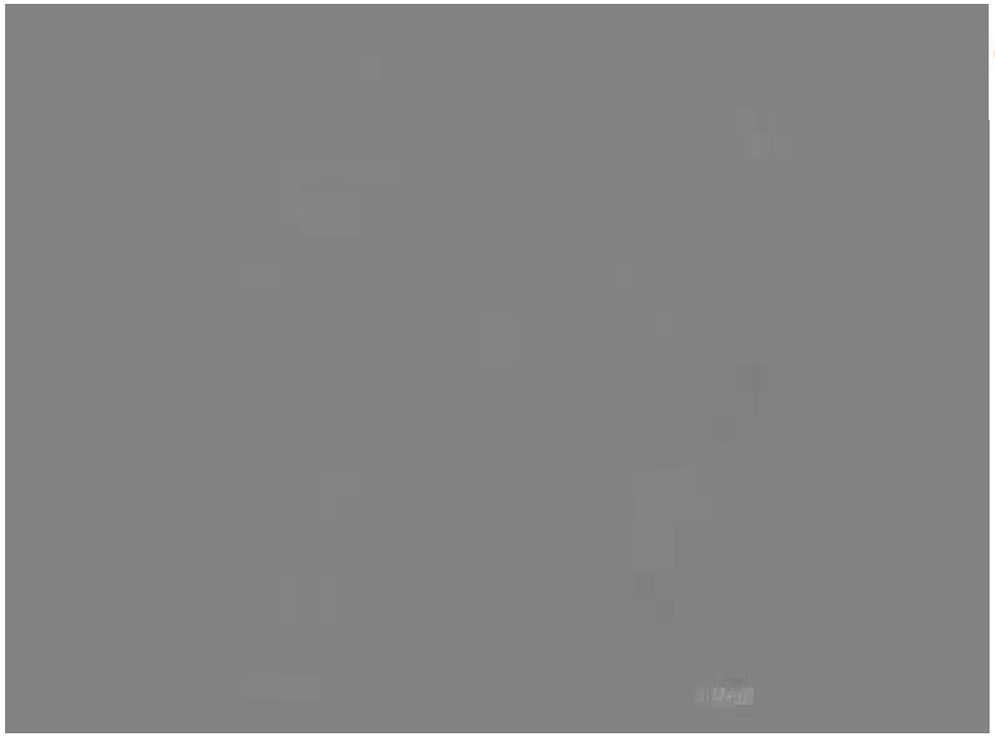
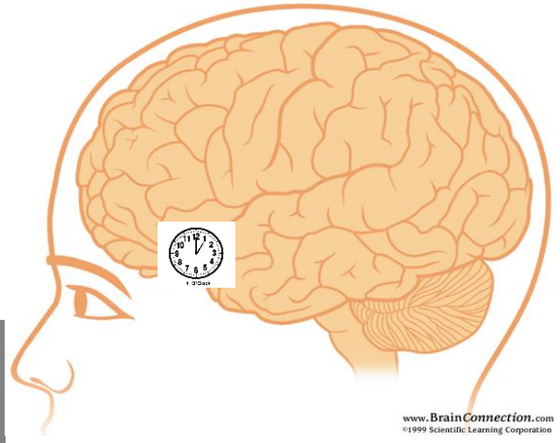
University of Basel, Switzerland

Centre for Chronobiology

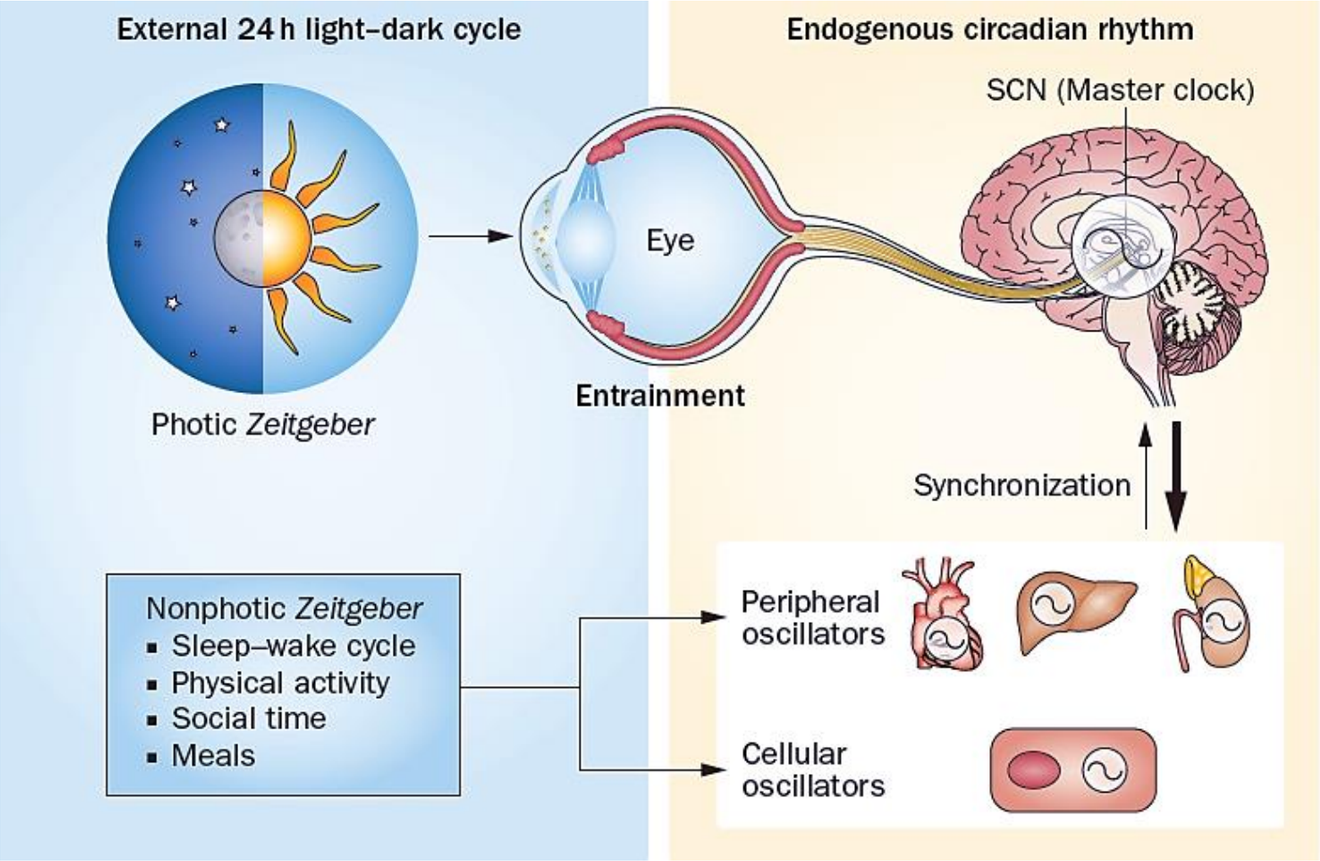
2. Tageslichtsymposium
Fachveranstaltung
der Hochschule Luzern – Technik & Architektur und der
VELUX Schweiz AG.
17.06.2021, online

Two «rice grains» in the brain





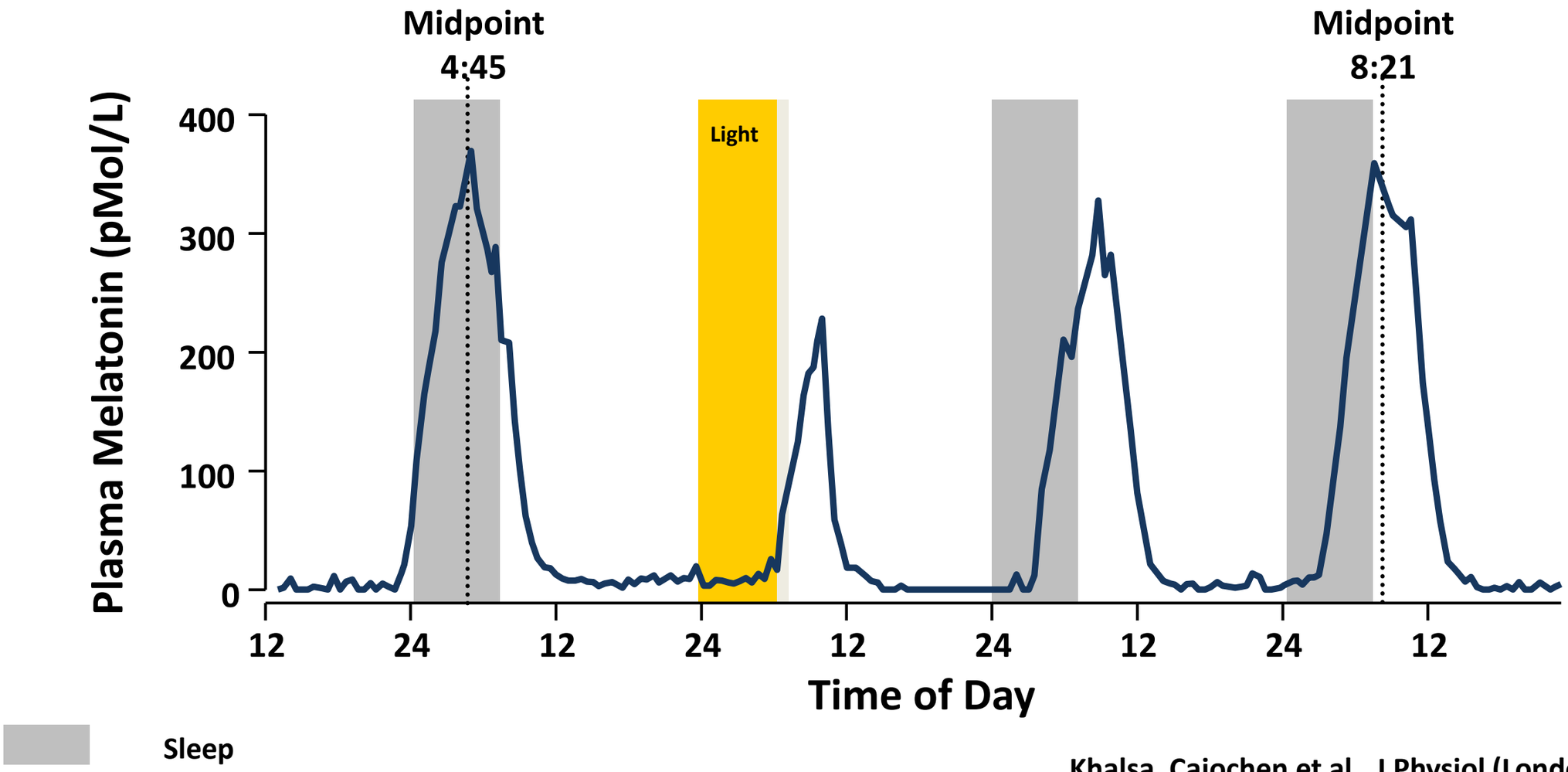
Light is the most important Zeitgeber !



Buttgereit, Smolen, Coogan, Cajochen, Nat Rev Rheumatol, 2015

Licht und Circadianrhythmik

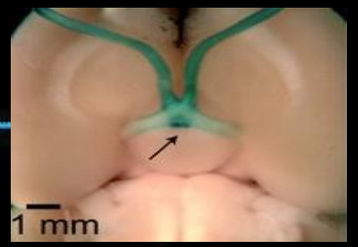
Melatonin der beste Zeiger der inneren Uhr



Khalsa, Cajochen et al., J Physiol (London) 2003

Non-classical Photoreceptor

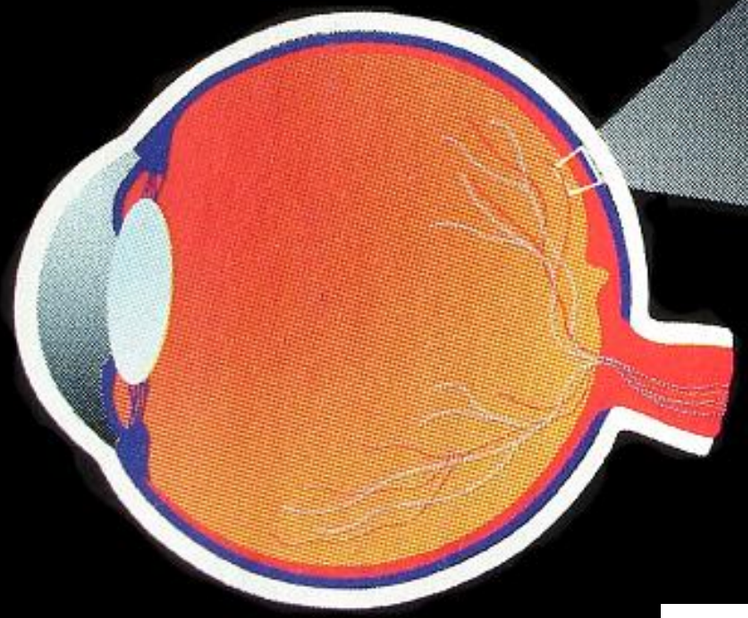
intrinsically photosensitive retinal ganglion cells
(iPRGs, Melanopsin)

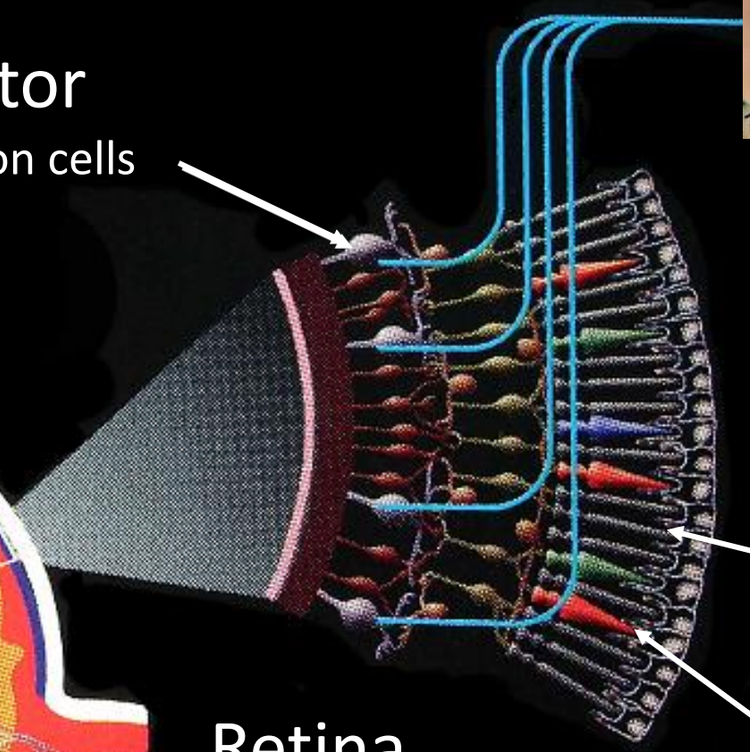


SCN
(circadian Pacemaker)

Eye

A dual sensory organ

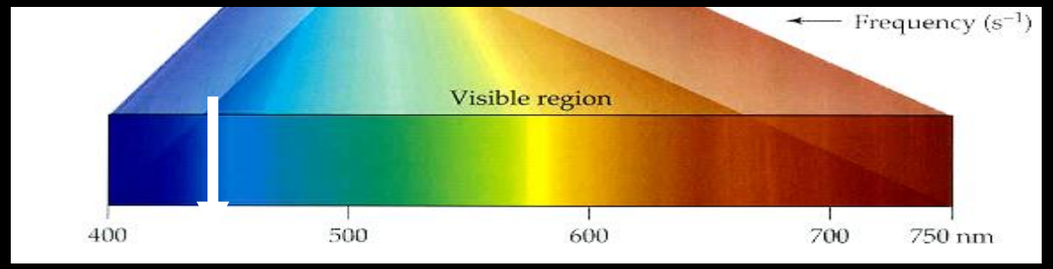




Retina

Rods

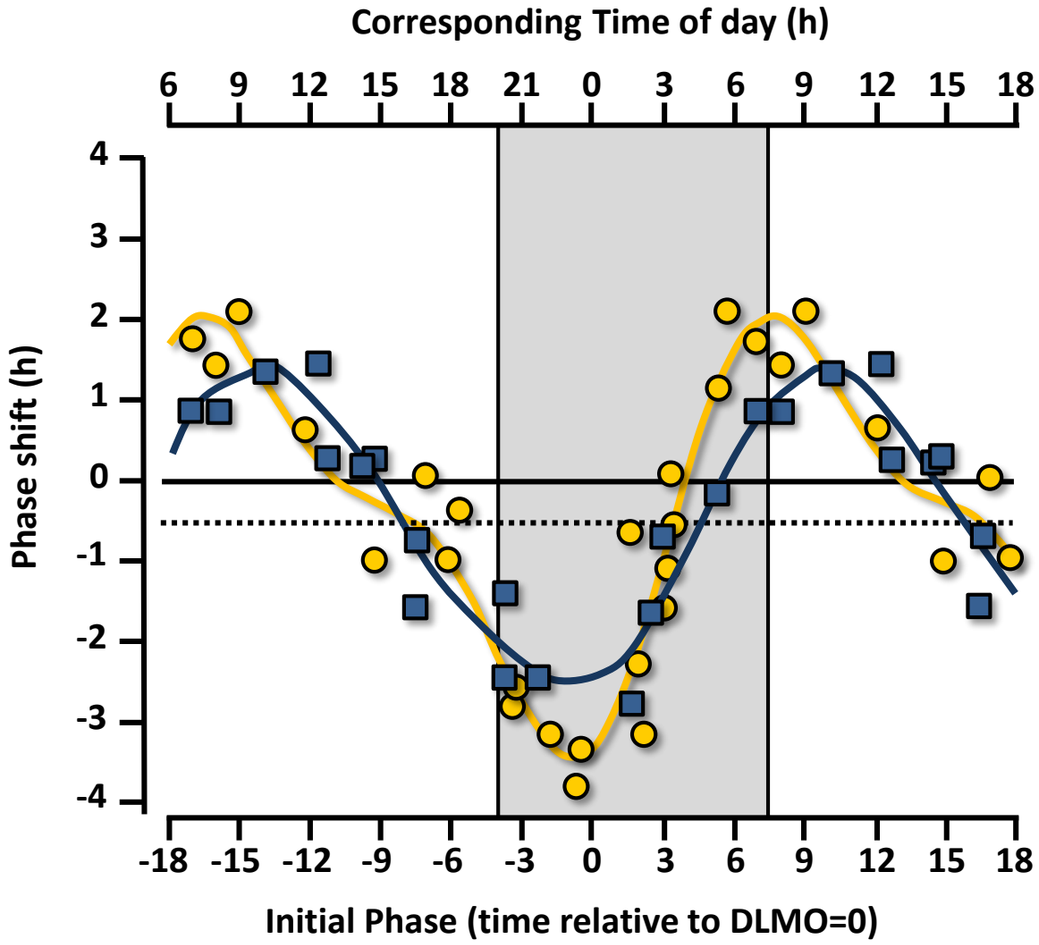
Cones



Hattar et al. Science, 2002
Berson et al. Science, 2002

Light and circadian phase

Phase-Response Curve



75 % of the resetting response

- 6.7 hours 10'000 lux polychromatic white light
- 6.5 hours blue light (480 nm) 11.8 μWcm^{-2}, 11.2 lux)

Khalsa, Cajochen et al., J Physiol (London) 2003
Rüger, et al., J Physiol (London) 2013

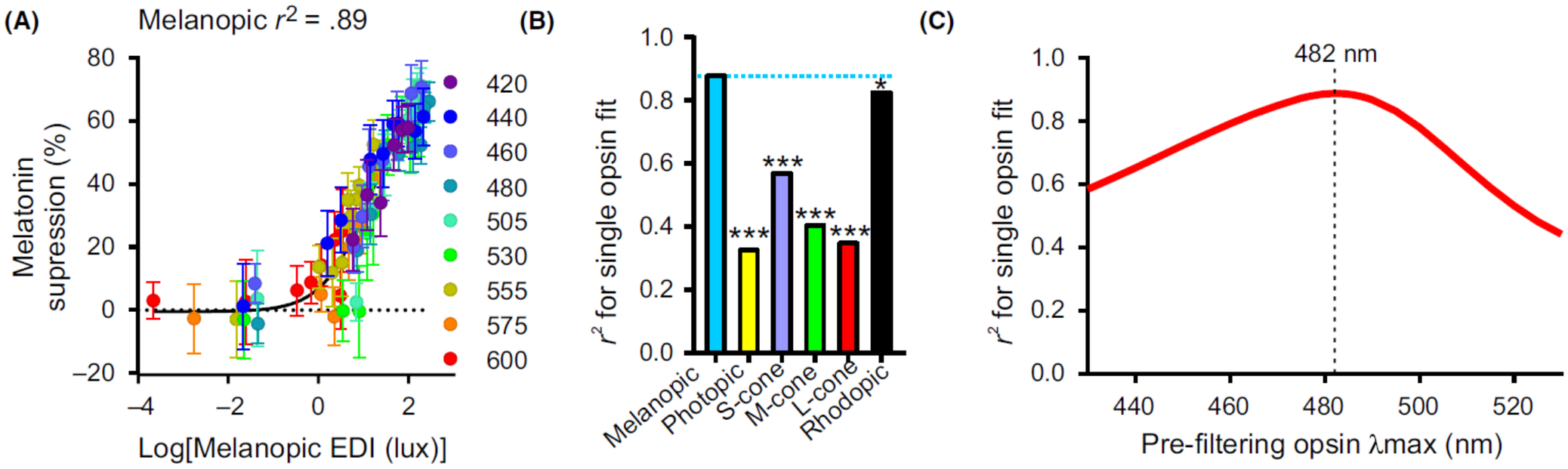
Received: 30 October 2019 | Revised: 28 February 2020 | Accepted: 27 March 2020
DOI: 10.1111/jpi.12655

ORIGINAL ARTICLE

Journal of Pineal Research
WILEY

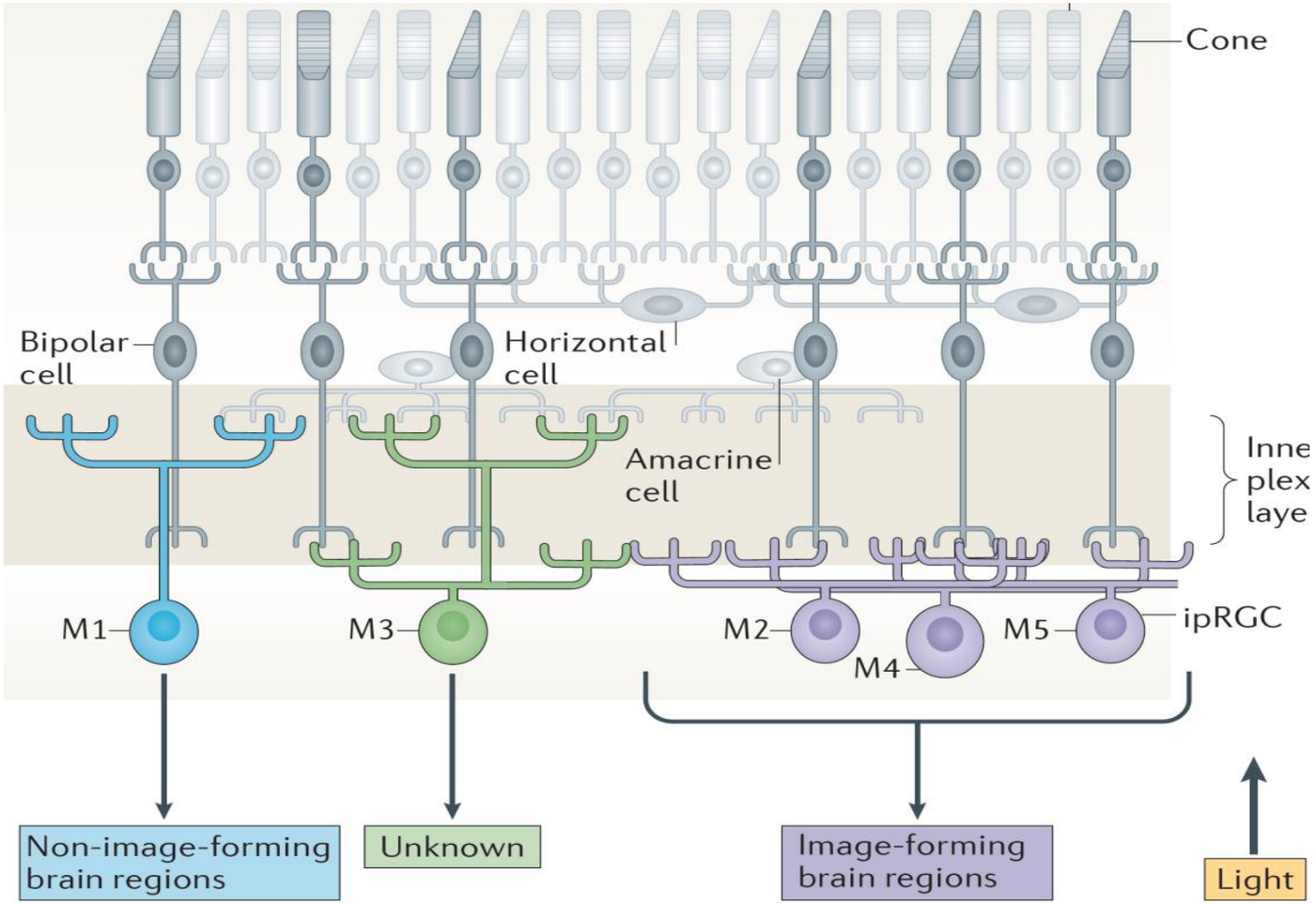
Melanopic illuminance defines the magnitude of human circadian light responses under a wide range of conditions

Timothy M. Brown



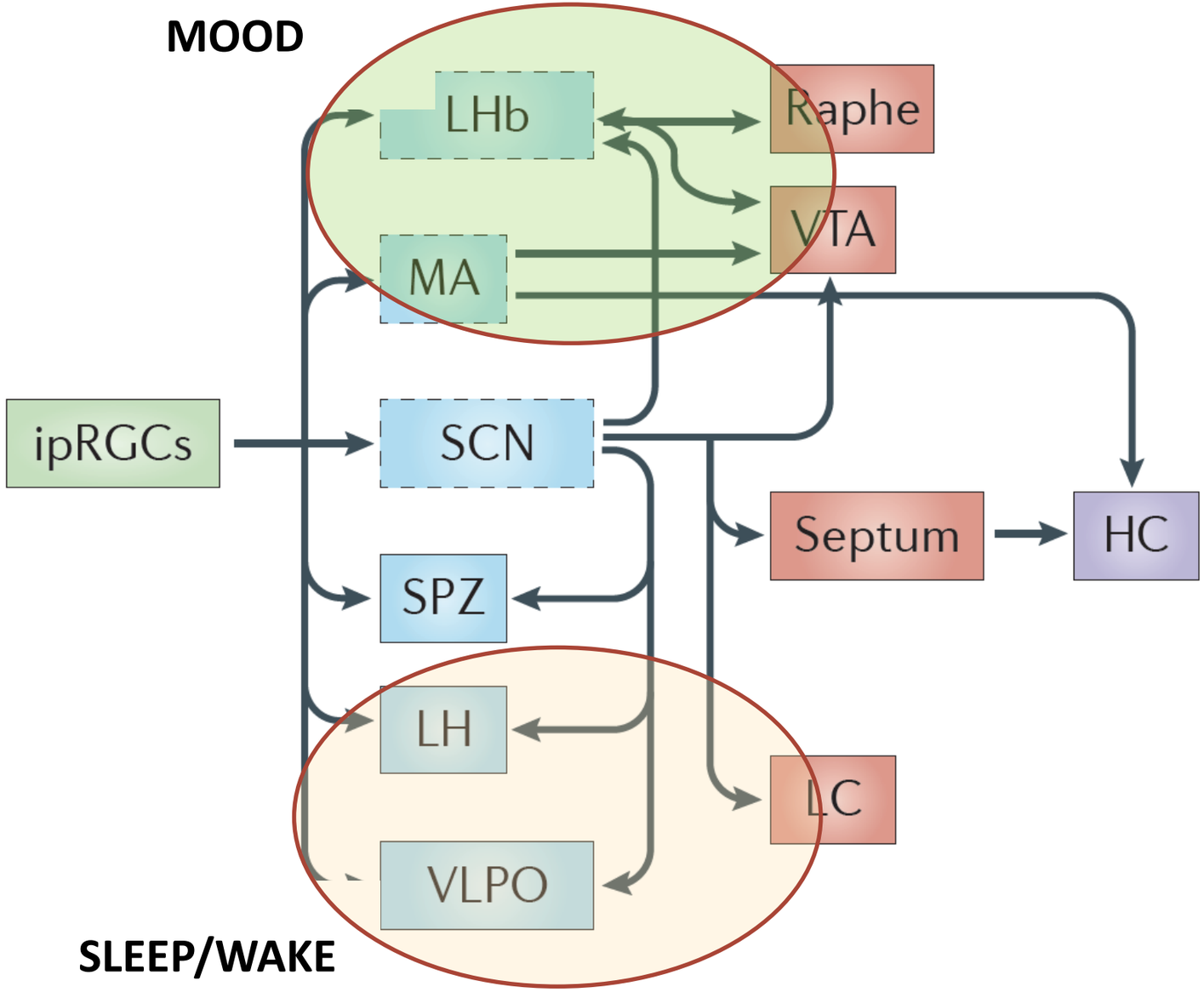
Die photopische Beleuchtungsstärke ist ein weniger verlässlicher Prädiktor für die Melatoninunterdrückung als die melanopische Beleuchtungsstärke

There are at least five subtypes of ipRGCs (M1–M5)



LeGate et al., Nature Reviews Neuroscience, 2014

Retinal and brain circuits underlying the effects of light on non-image-forming visual functions

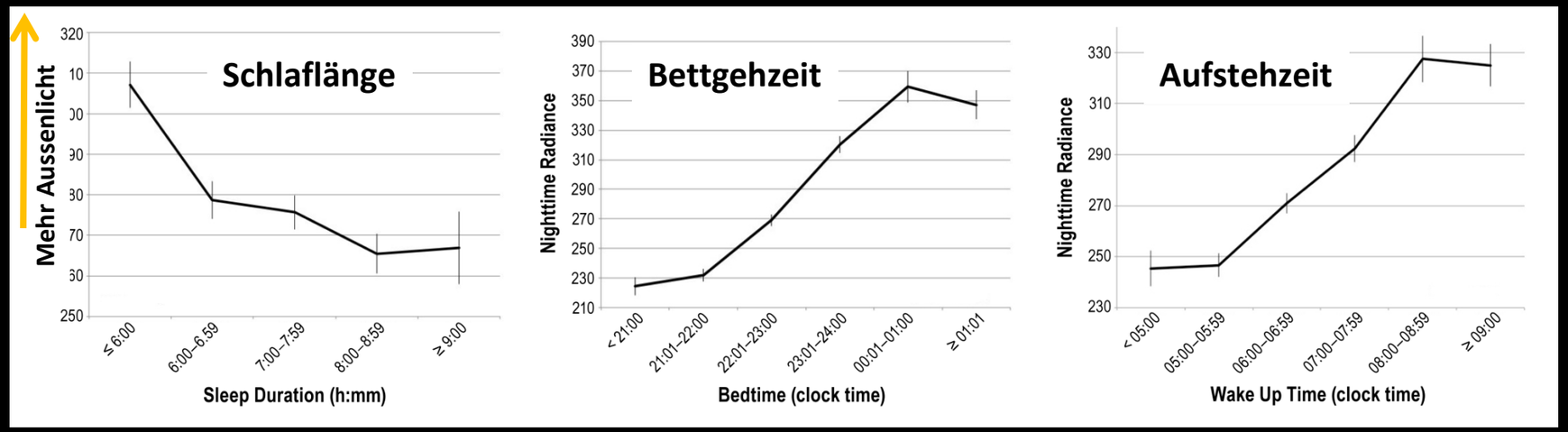


LeGate et al., Nature Reviews Neuroscience, 2014

Ist das alltagsrelevant?

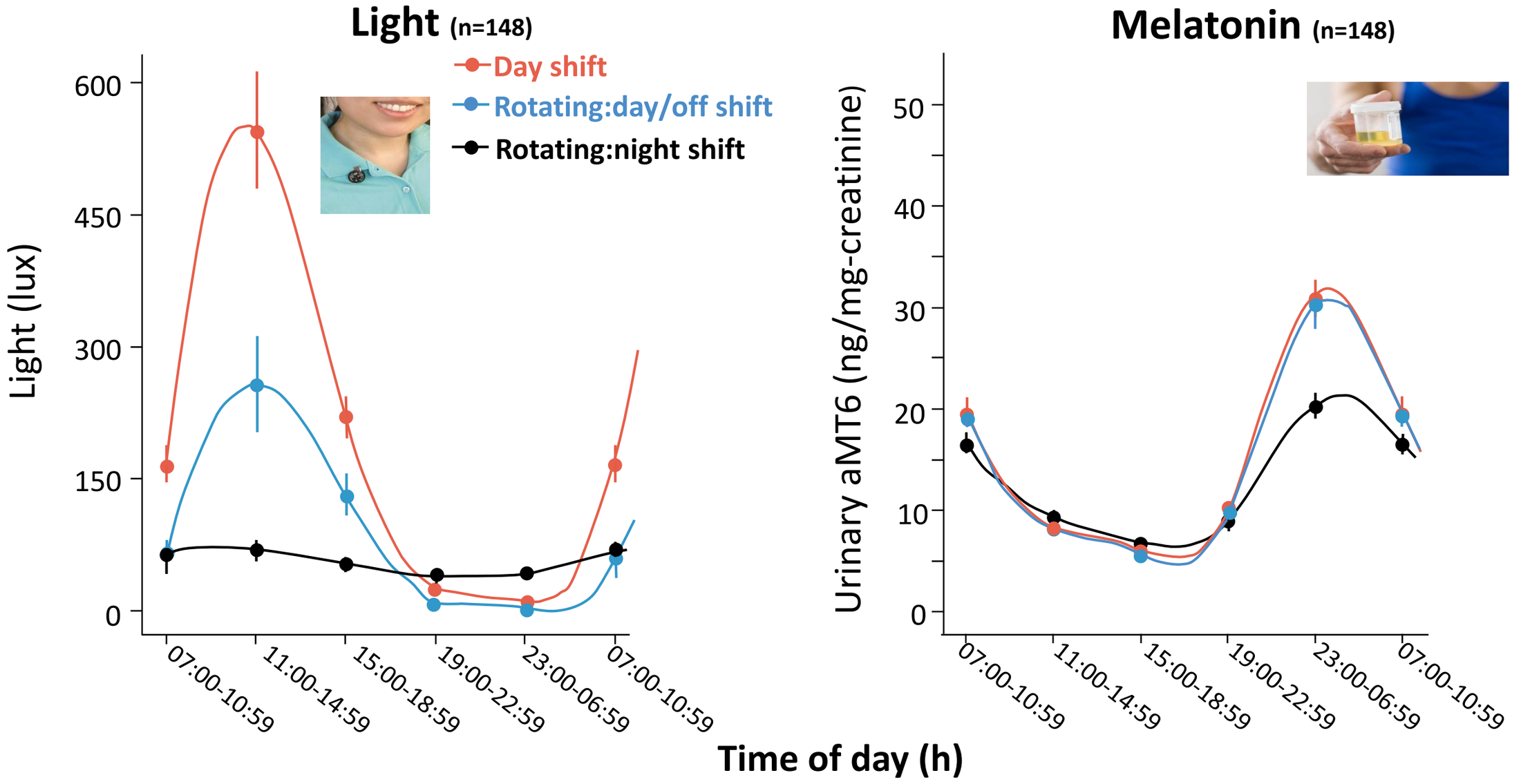
Künstliches Aussenlicht während der Nacht korreliert mit verändertem Schlafverhalten in der Amerikanischen Bevölkerung (n=19’136)

Verteilung der nächtlichen Beleuchtungsstärke



Ohayon and Miles, Sleep, 2016

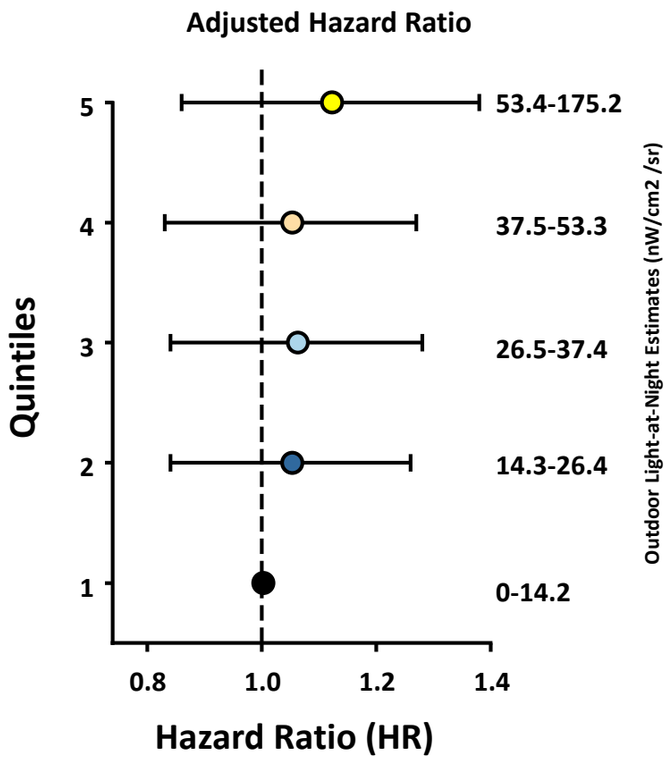
Light exposure and urinary melatonin levels across shift work schedules



Razavi et al. Cancer Epidemiol Biomarkers Prev 2019

Light at Night and Cancer

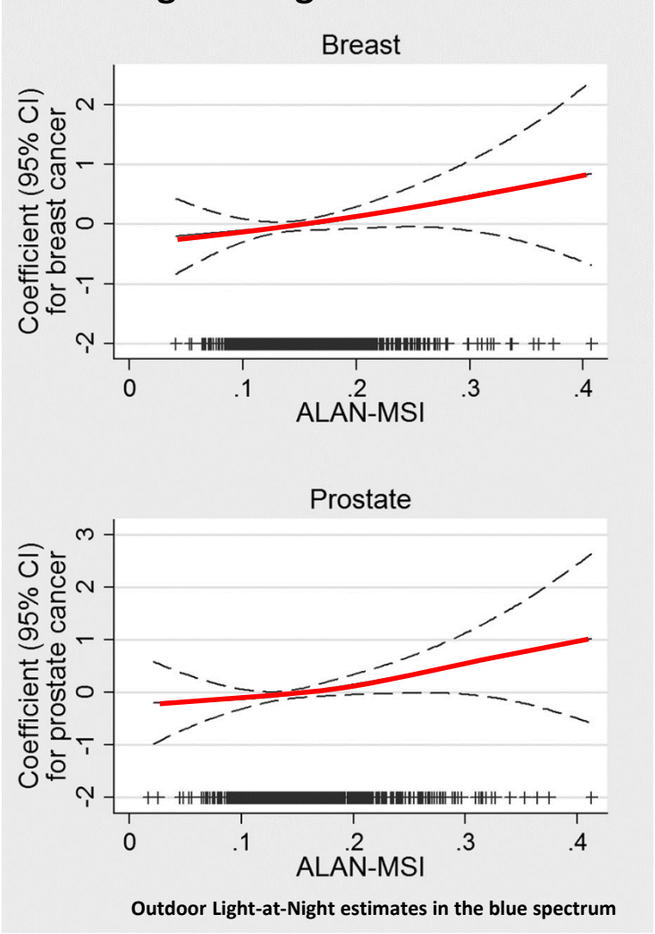
Women living in areas with high levels of ambient light at night may be at an increased risk of breast cancer

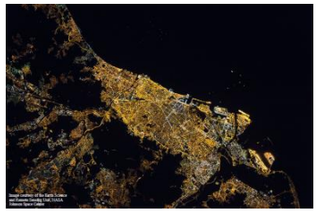


Risk of Invasive Breast Cancer Associated with Outdoor Estimates of Light at Night Among **106,731 Study Participants**: Adjusted HRs and 95% CIs Estimated from Cox Proportional Hazard Models

Hurley et al., Epidemiology, 2014

Both prostate and breast cancer were associated with high estimated exposure to outdoor light at night in the blue-enriched light spectrum



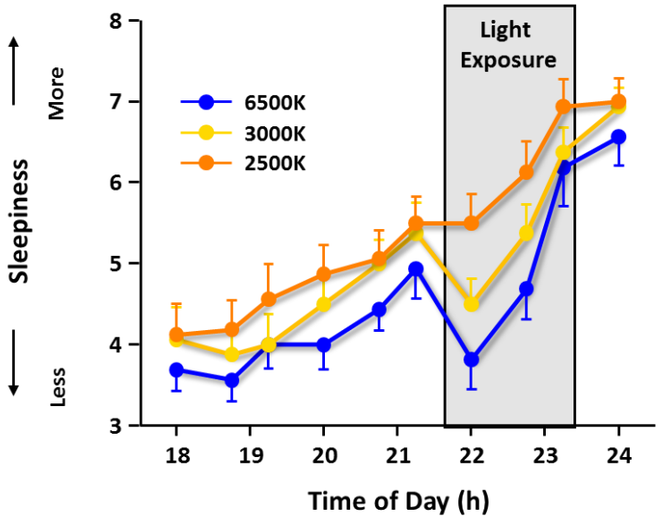


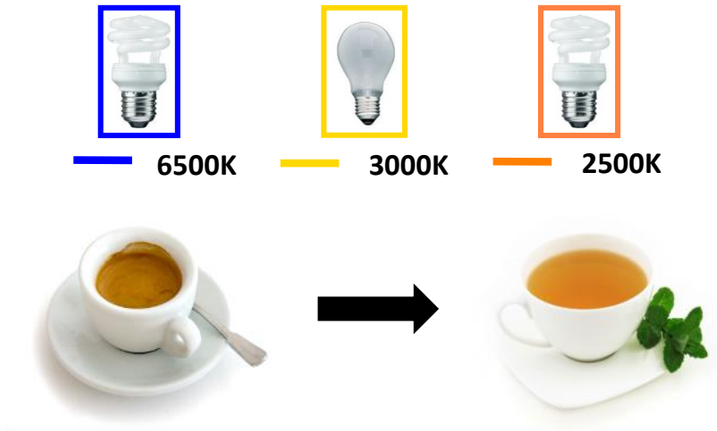
Garcia-Saenz et al., Env Health Persp, 2018

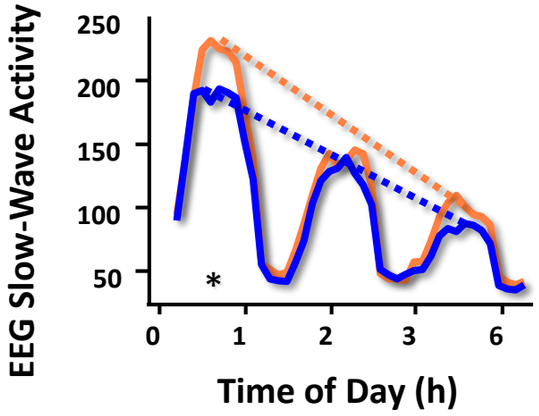
Beispiel: hohe Blauanteile am Abend

Lichtwirkung auf den Menschen | **Spektrum: Müdigkeit und Schlaf**

Einfluss bereits geringer Helligkeiten am Abend jeweils nur 40 Lux!





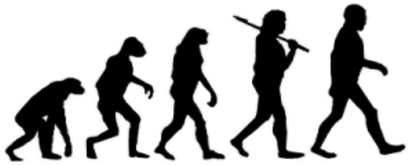


Kaltes Licht (6500 K) am Abend beeinflusst unseren Non-REM-Schlaf negativ
Warmes Licht (2500 K und 3000 K) hat keinen Einfluss

Chellappa et al., PlosOne, 2011

Evolutionäre Anpassung an natürliches Licht

22.25 Stunden pro Tag in Gebäuden [1]



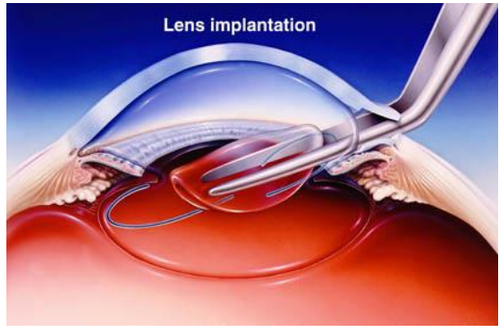
200.000

150 Jahre

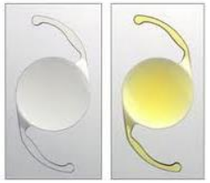
Graphik Dr. Oliver Stefani

[1] Schweizer et al. 2007

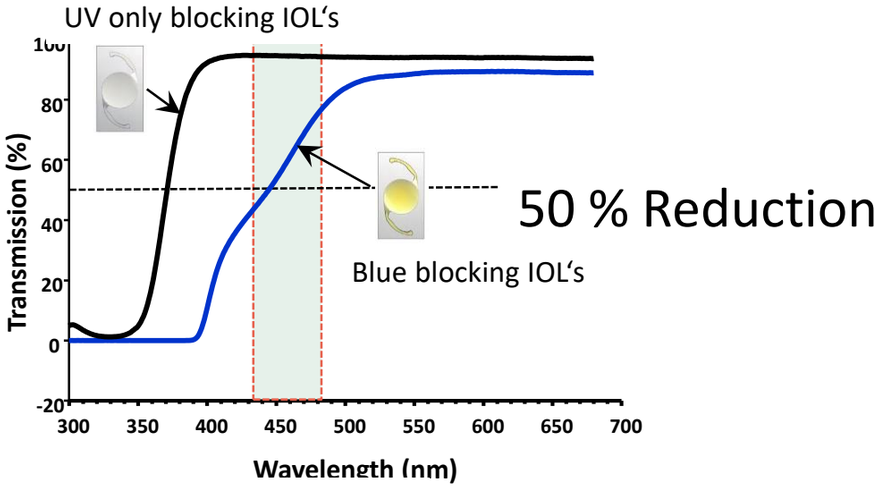
Intraocular cataract lens replacement improves circadian rhythms, cognitive function and sleep in older adults

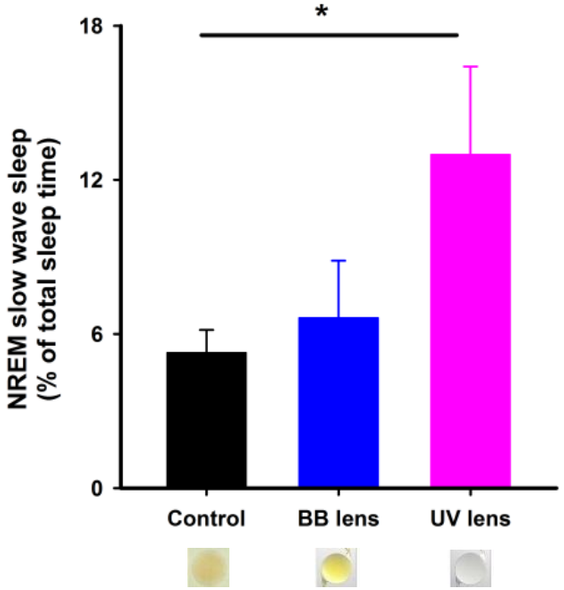


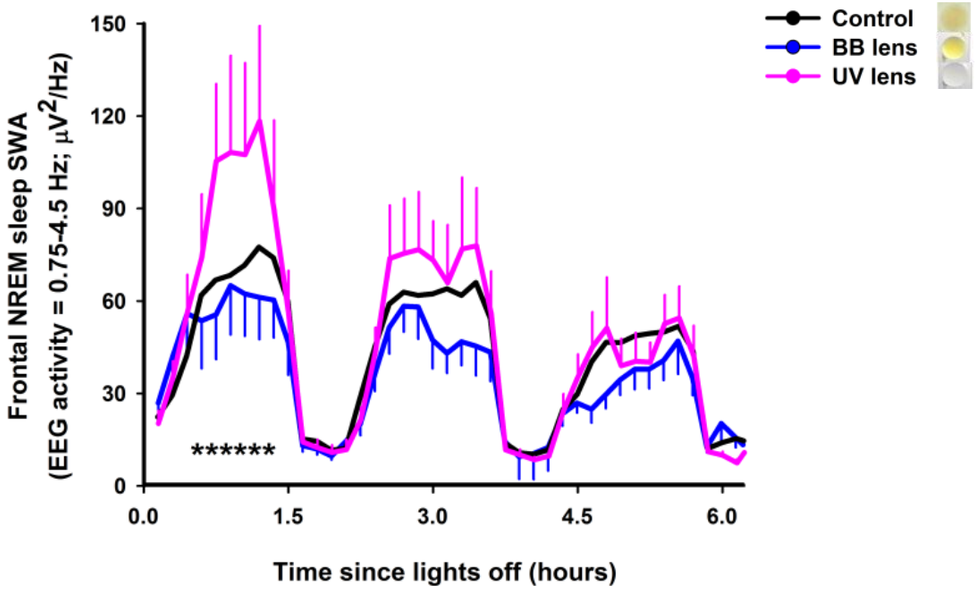
Two frequently implanted IOLs



Clear Lenses (UV block only) BlueBlockers





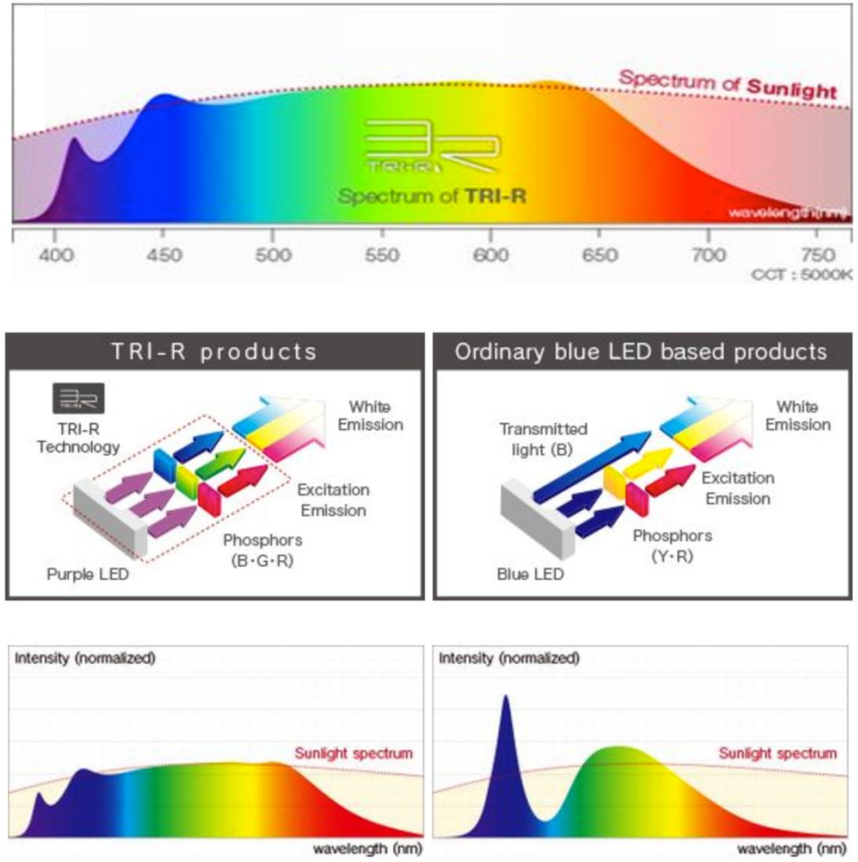


Chellappa et al., Jama Ophthalmology, 2019

Tageslicht-LED vs. konventionelle LED

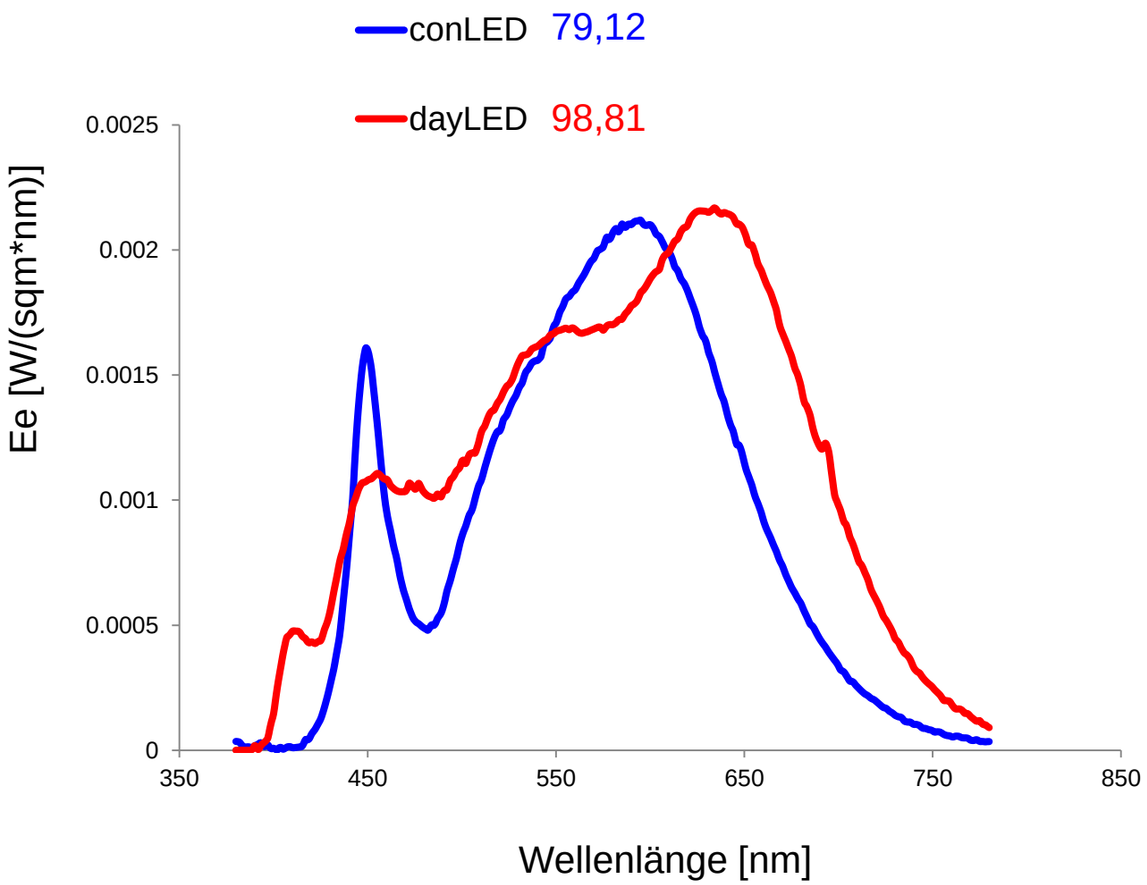
Beleuchtungsstärke und Farbtemperatur jeweils gleich | **100 Lux, 3700 Kelvin**

Intensity [normalized]



http://www.toshiba-tmat.co.jp/eng/case_tri_r/index.htm

Farbwiedergabe, R_a unterschiedlich:

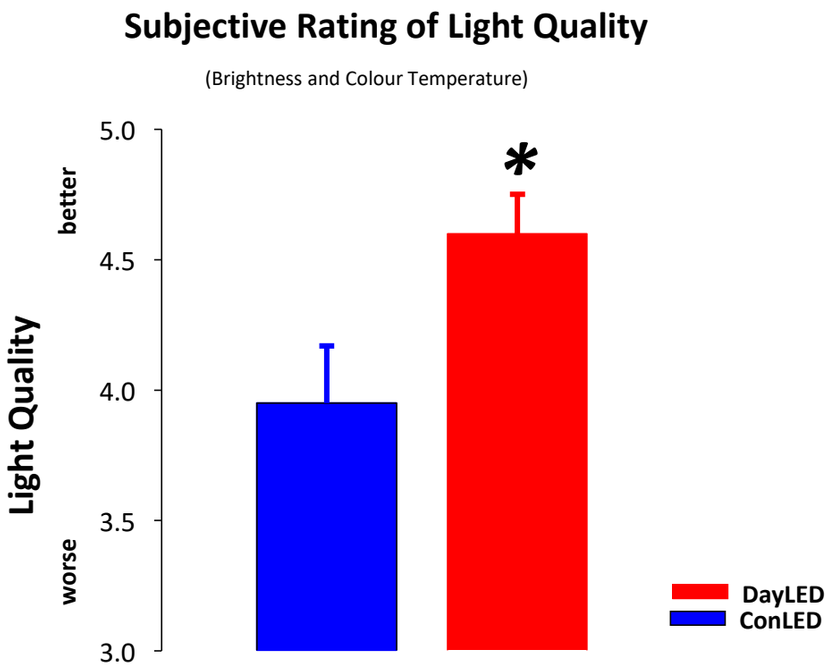


Farbtemperatur von 3700K = sonniger Tag kurz nach Sonnenaufgang während "goldener Stunde" gemessen in der Sonne

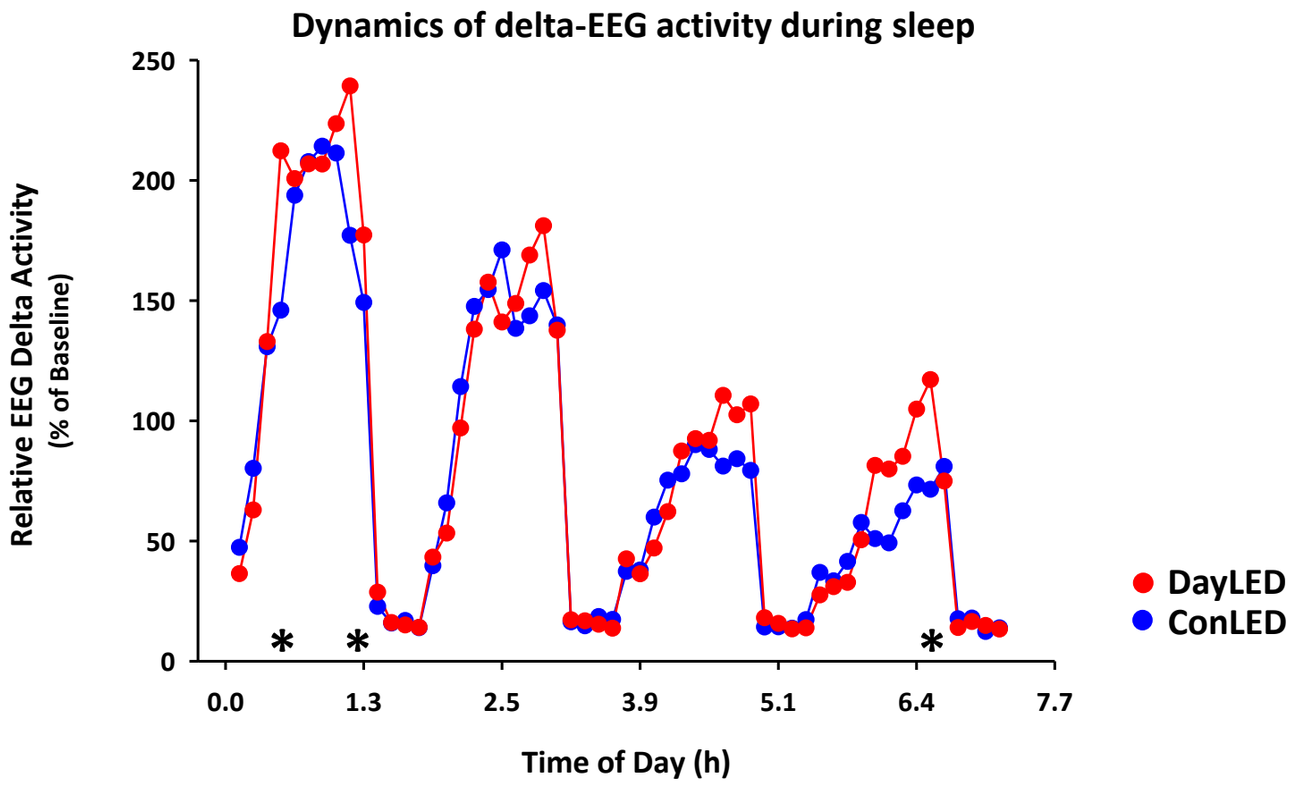
https://www.nrel.gov/ grid/solar-resource/smarts.html

Conventional LED vs. daylight LED

Visual comfort ratings

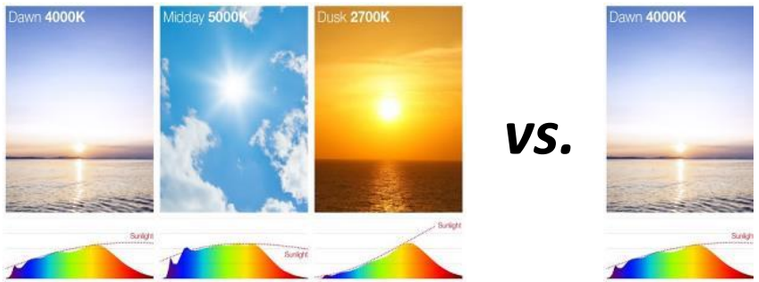


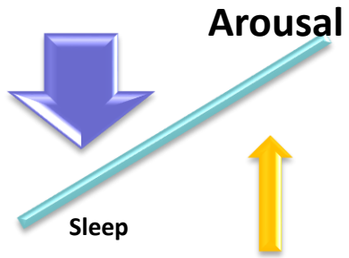
Sleep

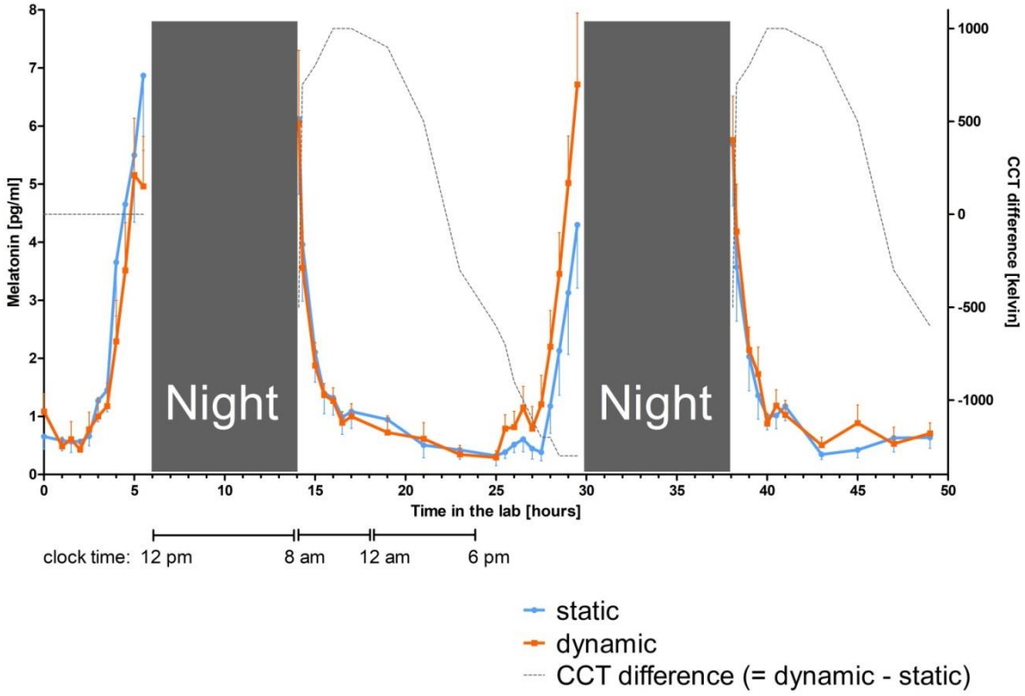


Cajochen et al. Lighting Res. Technol., 2019

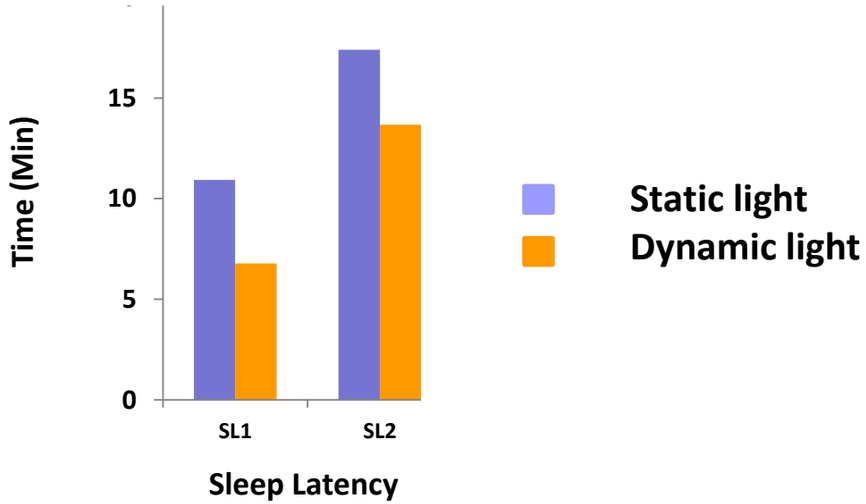
Dynamic “Daylight” LED impacts on melatonin secretion and sleep







Dynamic light: 38% reduction in latency to sleep stage 1



Stefani et al., J Pineal Research, 2021

Ausgangssituation und Zielsetzung (Beispiel Skyguide)

Verbesserung der Beleuchtung in Dübendorf

Unterstützung von Wohlbefinden und der circadianen Rhythmik

Hohe vertikale Beleuchtungsstärken am Auge sind wichtig, um eine biologische Wirkung zu erreichen

Gestaltung eines optimalen Lichtverlaufs (Lichtfarbe, Lichtverteilung und Beleuchtungsstärke)

Die streng geometrische und stark kontrastierende Deckenbeleuchtung soll aufgelockert und gleichmässiger ausgeleuchtet werden

SOMMERLATTE & SOMMERLATTE AG Inge Sommerlatte

Chronolight Dr. Oliver Stefani

Beleuchtungskonzepte

zur menschorientierten Beleuchtung

Nacht:
Melatoninsuppression während der Nacht reduzieren.

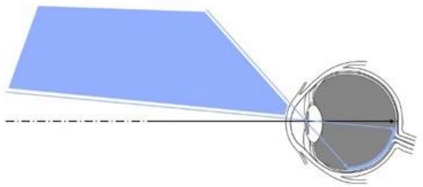
Tag:
Höhere Lichtwerte am Auge (vertikale Beleuchtungsstärken)
Hoher Anteil an melEDI am Tag am Auge durch:

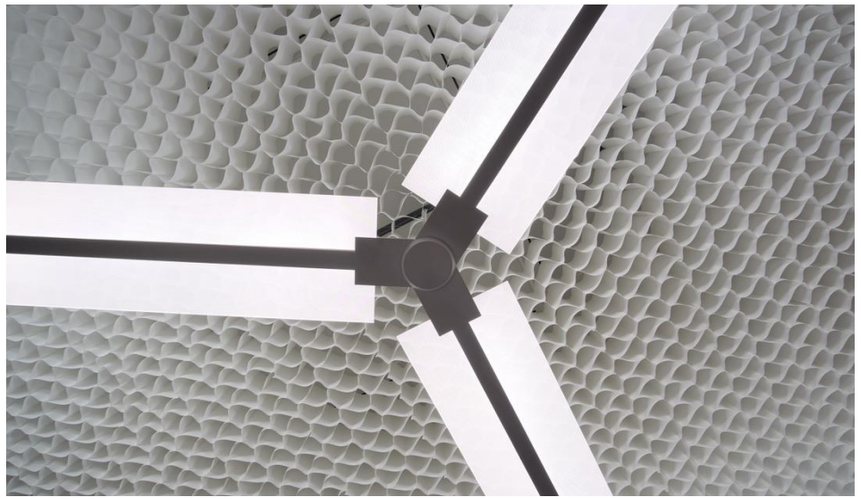
- **Optimierung des Spektrums**
  - Verwendung von Lichtquellen mit hohen melEDI (und einem hohen CRI)
- **Optimierung der vertikalen Beleuchtungsstärken**
  - Optimierung der Lichtverteilung
  - Stehleuchten, die das Licht auf die Decke richten und "wall washing"-Leuchten an den Wänden
  - Zusätzliche weiße Vertikalelemente können die vertikalen Beleuchtungsstärken erhöhen
- **ipRGCs über große Fläche der Netzhaut verteilt**
  - NV Wirkung vermutlich am grössten von grossflächiger Quelle
  - Wird nur ein kleiner Bereich der Netzhaut beleuchtet („Propeller“), wird eine schwächere nicht-visuelle Wirkung angenommen.

Beleuchtungskonzepte

Umsetzung und Validierung

Tag

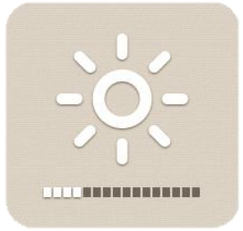


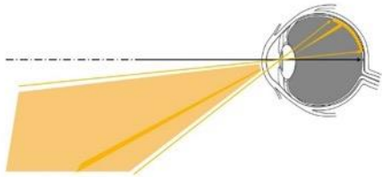


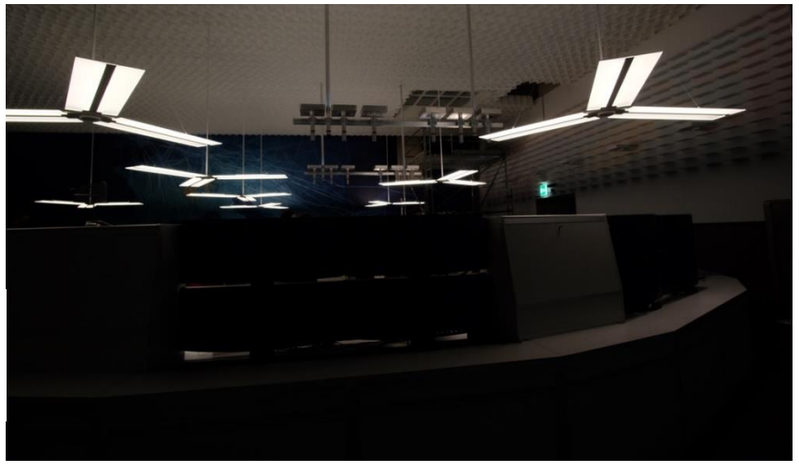
Beleuchtungskonzepte

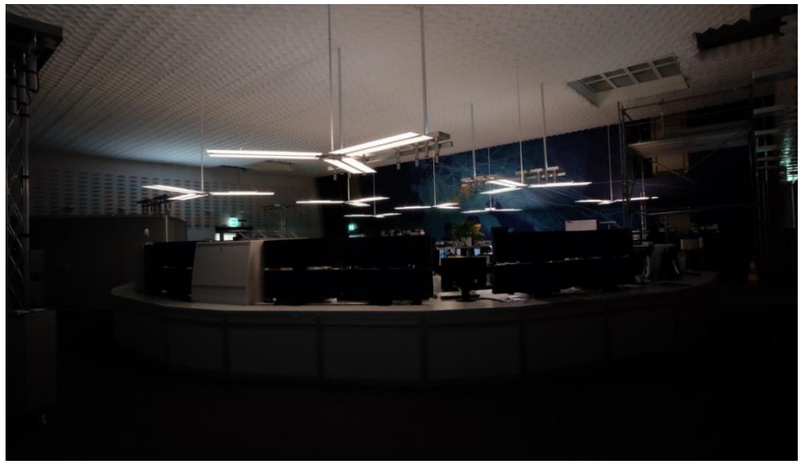
Umsetzung und Validierung

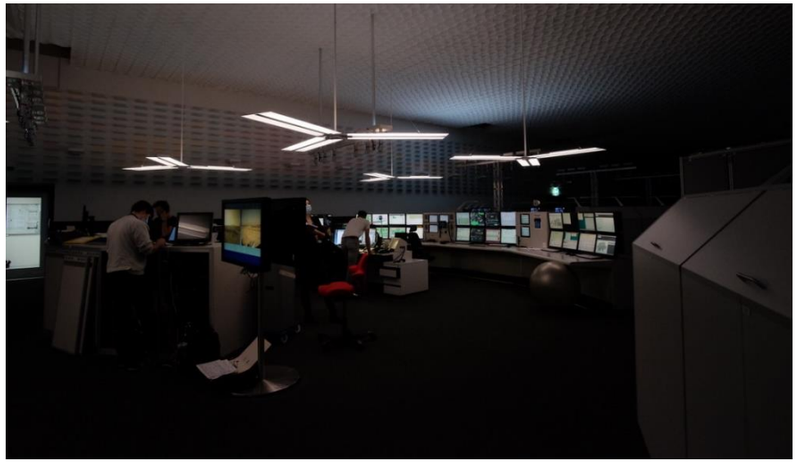
Nacht

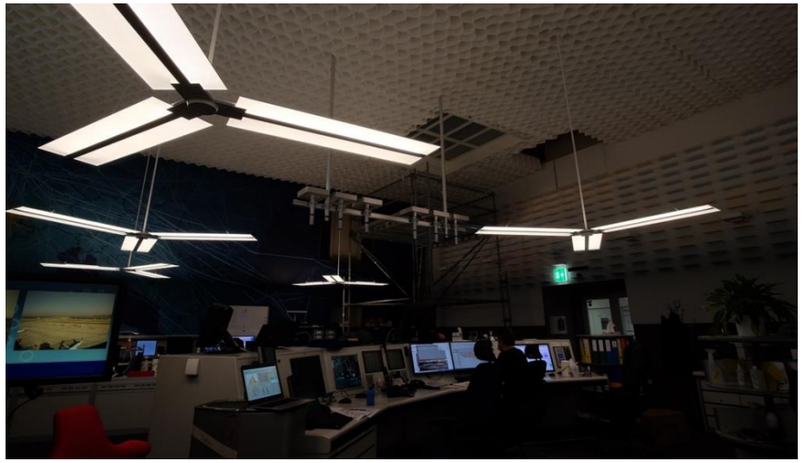






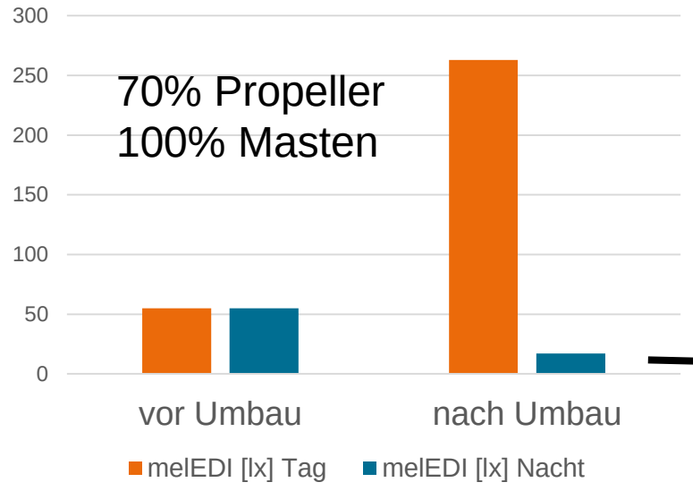


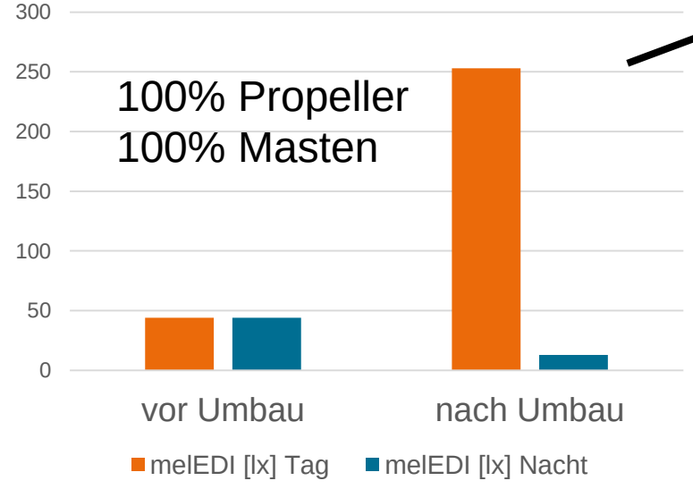


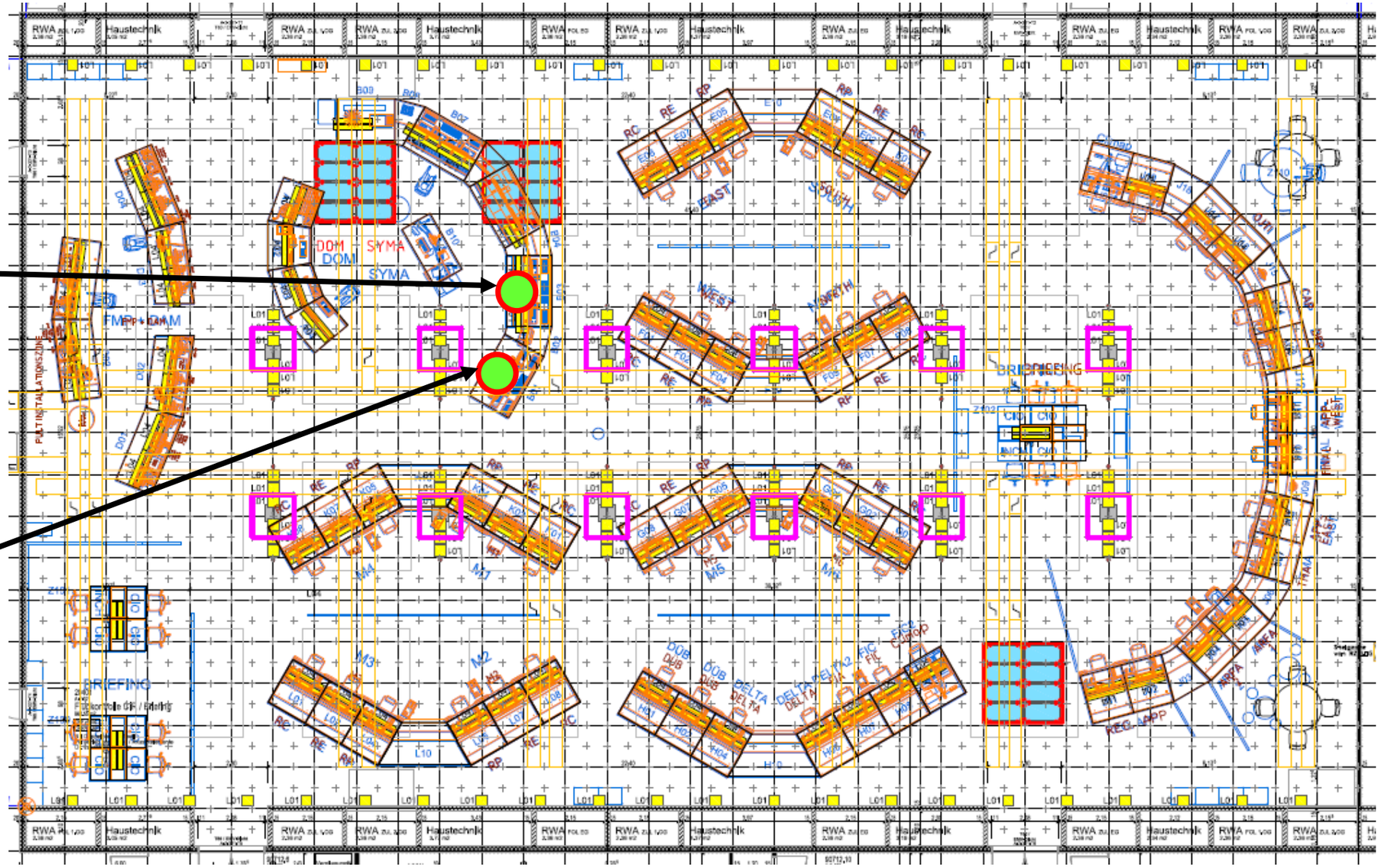


Beleuchtungskonzepte

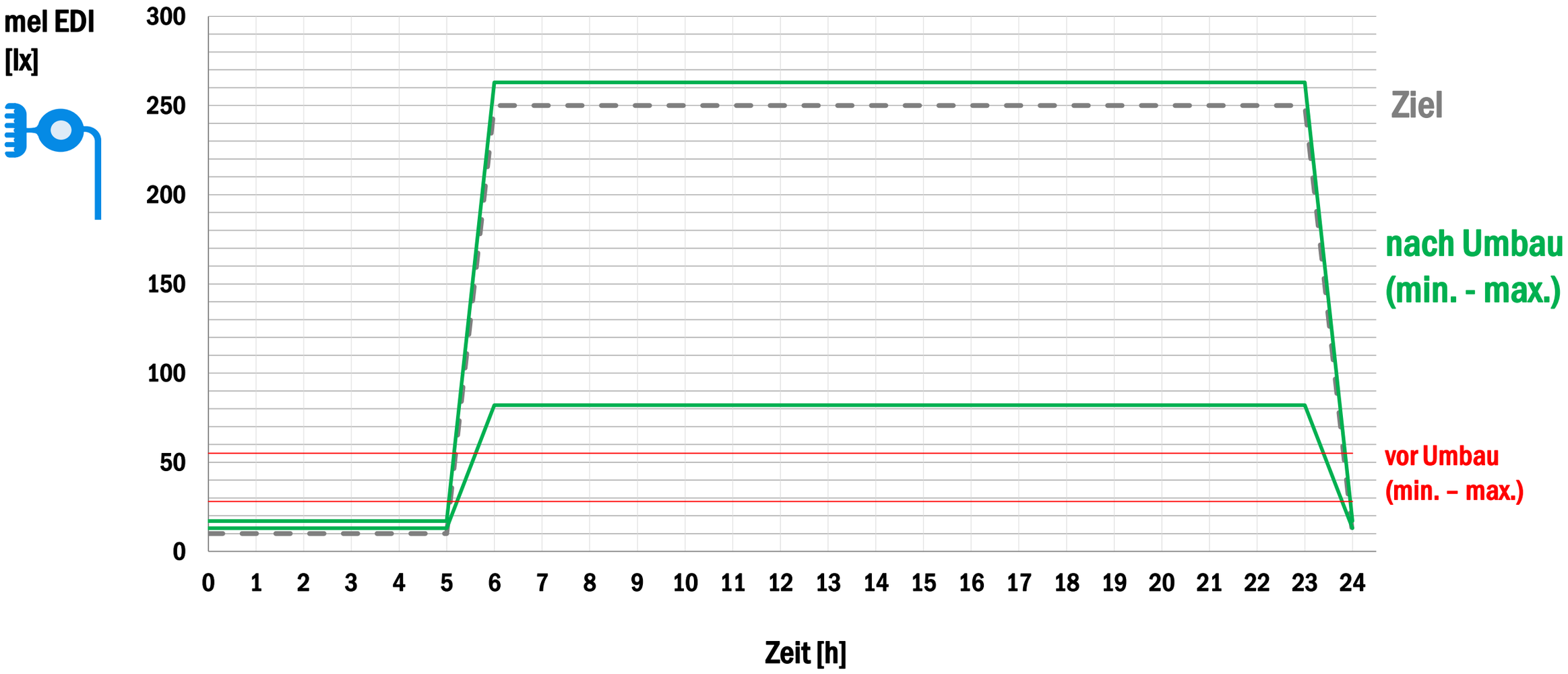
Umsetzung und Validierung | **MelEDI [lx] am Auge**







Lichtverlauf



Empfehlungen

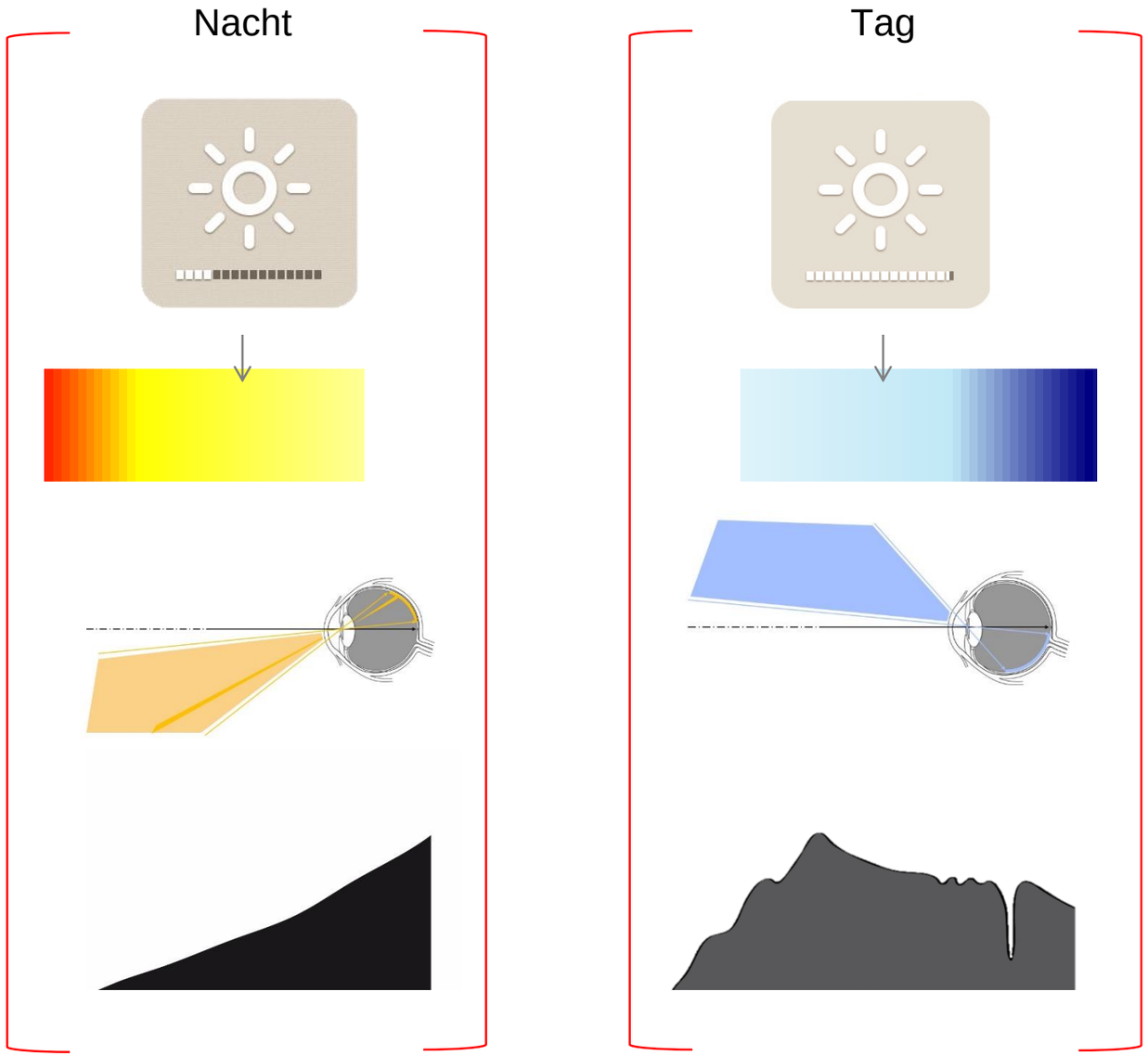
zur menschorientierten Beleuchtung

Helligkeit variabel

Farbtemperatur variabel

Lichtverteilung variabel

Hohe spektrale Qualität (Farbwiedergabe)



Antidepressiva

Schlafstörungen mindern & innere Uhr in den Takt bringen

Aufmerksamkeit und Kognition verbessern

Krebsrisiko minimieren

Wohlbefinden verbessern

Graphik Dr. Oliver Stefani

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Transfaculty Research Platform Molecular and Cognitive Neurosciences (MCN)

UNI BASEL

UPK Universitäre Psychiatrische Kliniken Basel

Centre for Chronobiology

www.chronobiology.ch

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AXA Research Fund Through Research, Protection

W CLOCK R K Daimler-Benz Foundation

EUC LOCK EU IP

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
BAFU und BASPO

VELUX STIFTUNG

PHILIPS TOSHIBA Materials

Vielen Dank für Ihre Aufmerksamkeit

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