



# White Light Exposures and Mood: A Systematic Review and Meta-Analysis

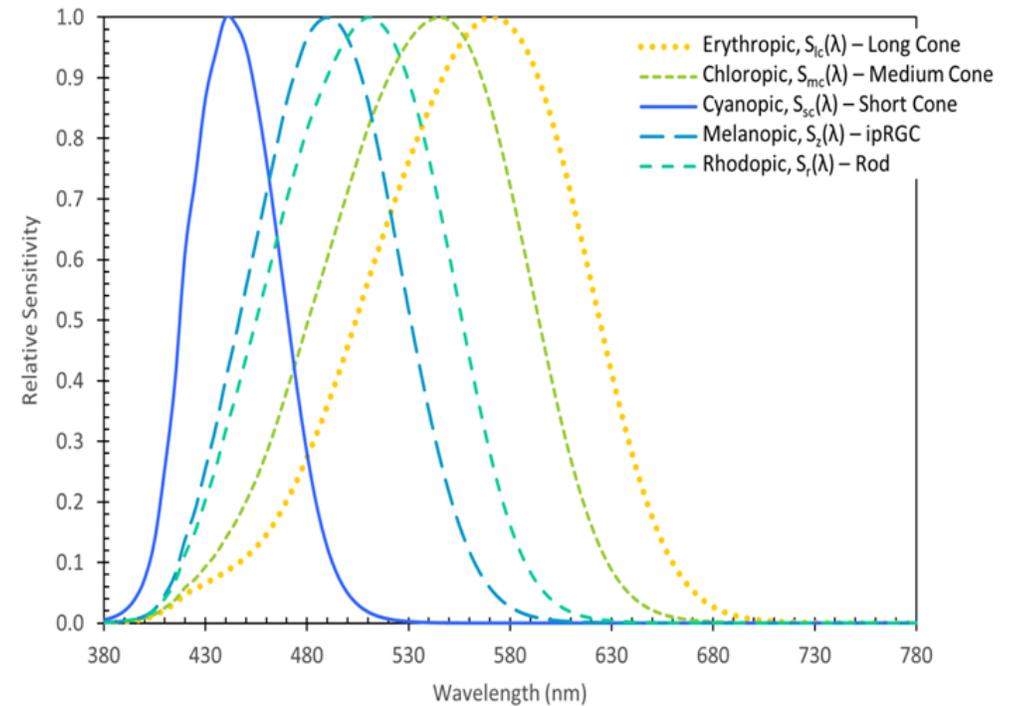
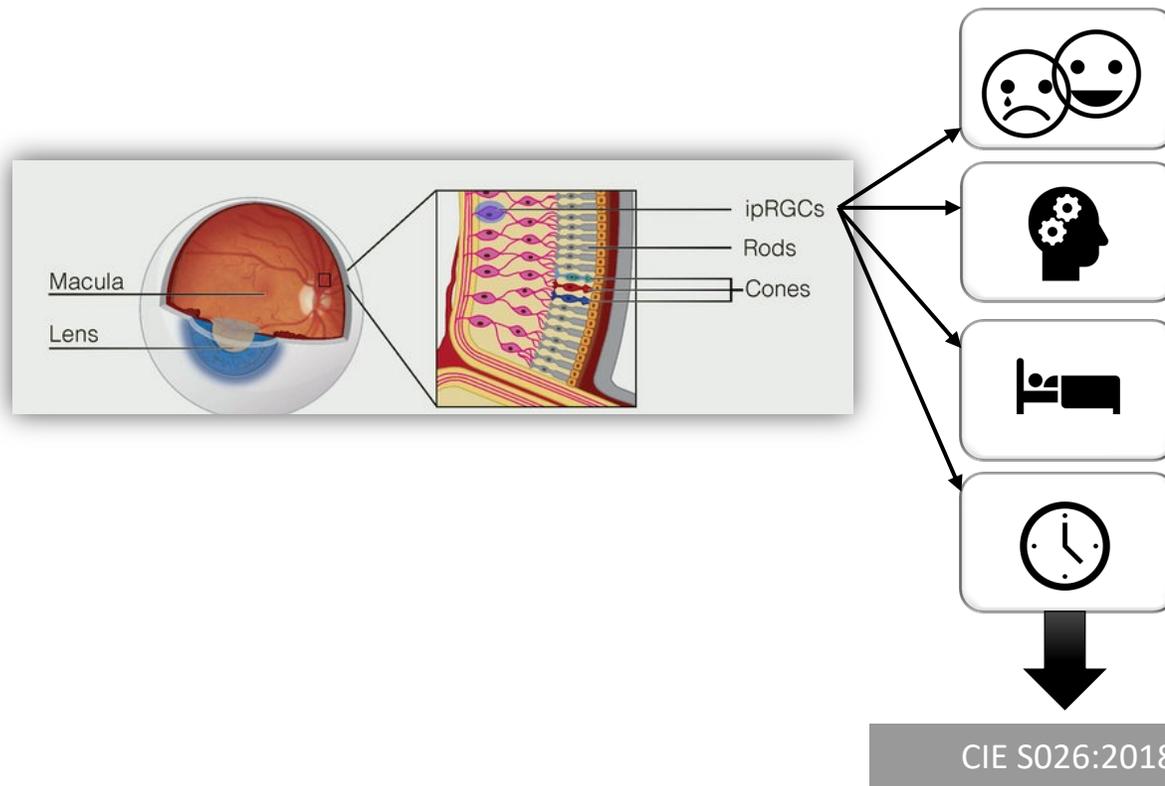
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uOttawa

**NRC · CMRC**

# Ocular Photoreception



Normalized photoreceptor sensitivity curves: Graphics by PNNL, data from CIE TN003:2015

# CIE Position Statement (2019)

- Metrology for ipRGC-influenced light (IIL) should follow CIE S026:2018 quantities and units
  - Melanopic equivalent daylight illuminance (EDI), expressed in units of lx, is a reasonable way to specify exposures
- Proper light at a proper time – exact quantities remain unclear:
  - A high melanopic EDI during the day is usually supportive for alertness, circadian rhythms and a good night's sleep
  - A low melanopic EDI in the evening and at night facilitates sleep initiation and consolidation

# The Application Question

- How much light do we need?
- Past literature can't be compared easily because  $V(\lambda)$  is the wrong spectral sensitivity function for ipRGC-influenced effects
- Need to put results all on one scale, using the appropriate quantities

# Overall Project Goals

To examine light characteristics that support optimal **well-being**, **cognition**, and **physiological** function in humans (>18 years old)

- Negative & positive affect
  - What does it mean?
  - COVID19 – an example

Ammar et al., 2020



# Objective/Hypotheses

**Objective:** Predict optimal light exposure parameters for well-being

Hypotheses:

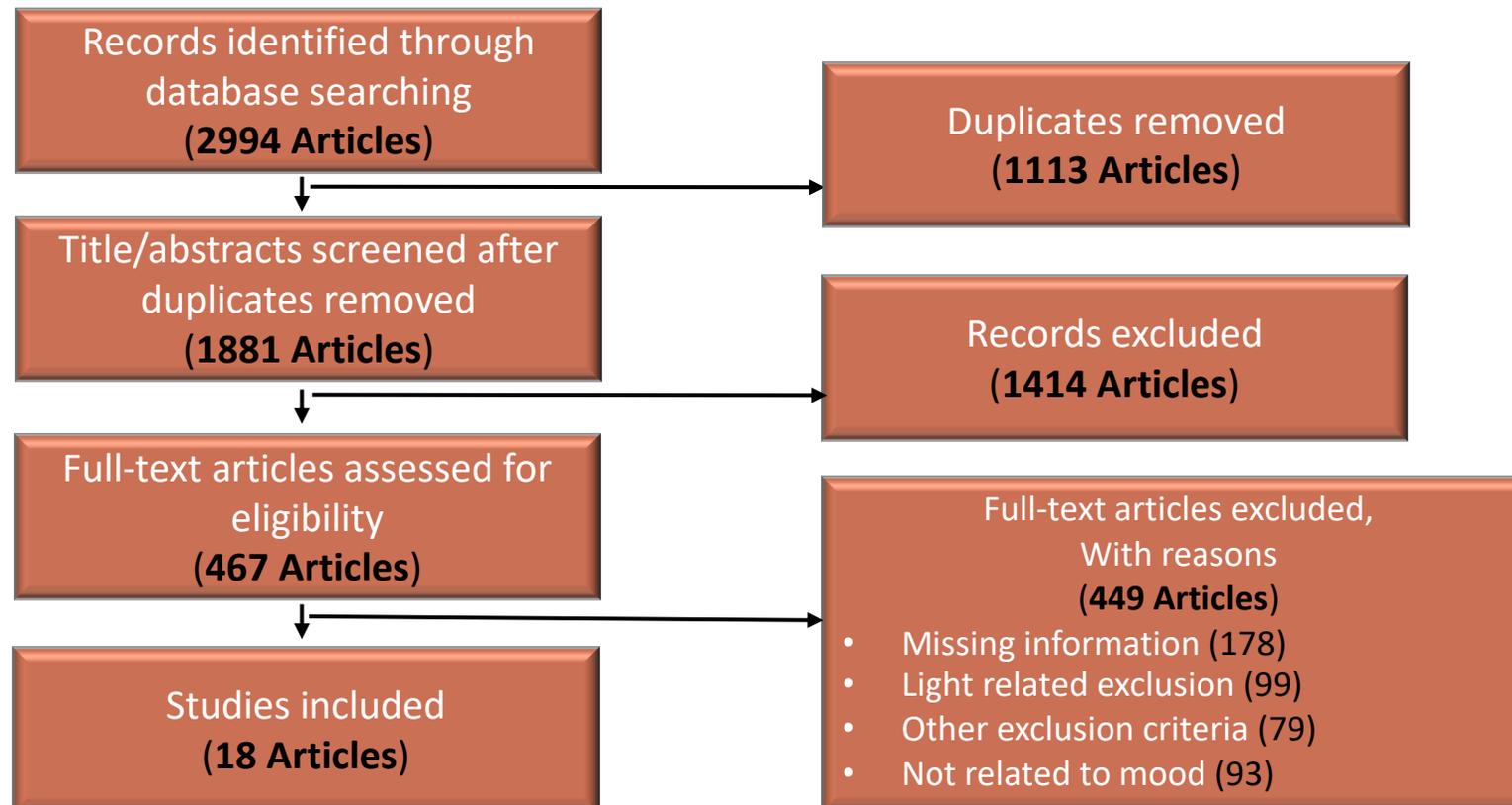
- Melanopic EDI will be the best predictor of mood outcomes (i.e., these effects will be primarily mediated by ipRGCs)
- Length (hrs) and time (AM/PM) of exposure will also contribute to the predictive model

# Review Criteria

Inclusion:	Exclusion:
Publications: 1990-2020	Only hormonal outcomes (cortisol/melatonin) or genetic
Healthy adults (18+ years)	Total sleep deprivation
Polychromatic light (white)	Shift workers (real or simulated)
Ocular light (eyes open)	Insufficient light information for the CIE toolbox
New empirical data	
Light exposures reported in S026 or CIE TN 003 OR light measurement	

# PRISMA

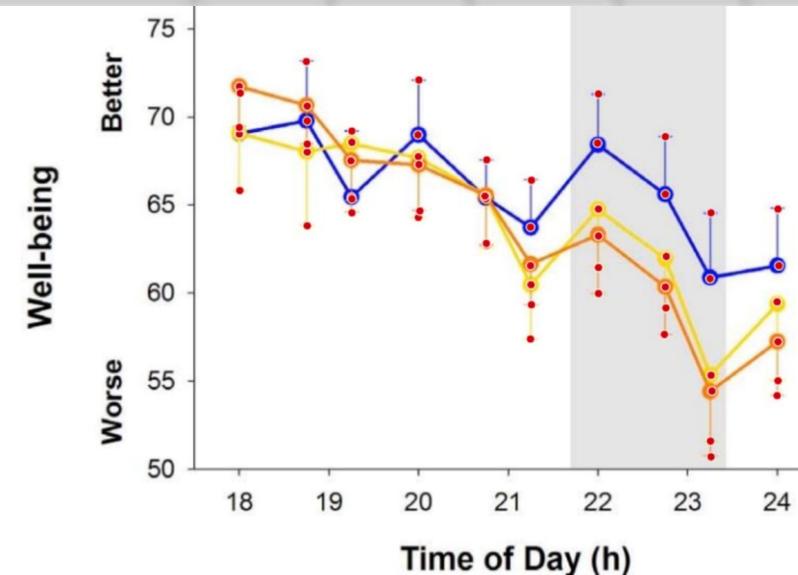
(Preferred Reporting Items for Systematic Reviews and Meta-Analyses)



# Examples of mood measures

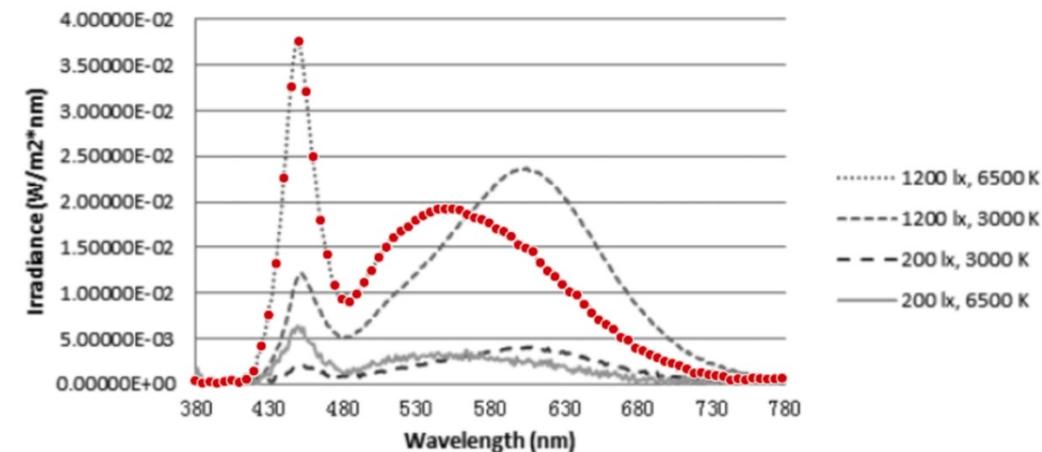
- Mood outcomes were identified and then filtered for affect specific outcomes
  - EX: P<sub>ositive</sub> A<sub>nd</sub> N<sub>egative</sub> A<sub>ffect</sub> S<sub>cale</sub>
- Analyses also required means and associated indicators of variability (standard deviation or standard error)
  - Digitized from published figures if not presented in table or text

PANAS	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Interested	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Distressed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Excited	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Upset	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Strong	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Guilty	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Scared	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hostile	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Enthusiastic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Proud	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



# Refinement the reporting process

- Outcome measures
- Study details:
  - Setting
  - Location of light measurements (eye/desk level)
  - Length of exposure and time of day
- CIE S026:2018 toolbox requires a light source spectral power distribution (SPD) for input and illuminance to scale
  - Digitized from published figures if necessary, or obtained from study authors



# Calculating the $\alpha$ -opic exposures

## CIE S 026 $\alpha$ -opic Toolbox - v1.049 - 2020/03

**Inputs sheet**      Inputs = blue

1324 - 1200lx 6500

1. Select source of spectral data  
Spectrum      User

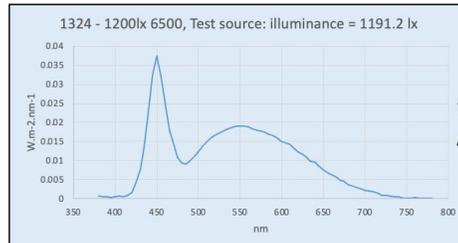
2. Select measurement details  
Spectral quantity, Q      Irradiance  
Main SI prefix  
Area prefix

3. Skip this step  
Clear this input

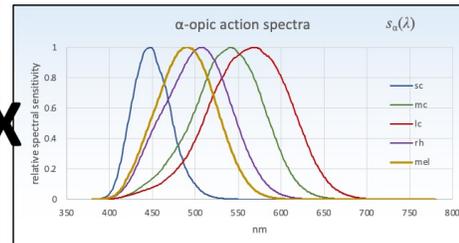
4. Select wavelength step  
Step size, nm      5

5. Enter spectral irradiance data

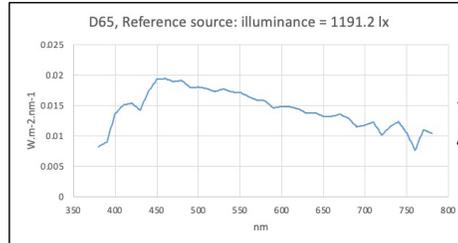
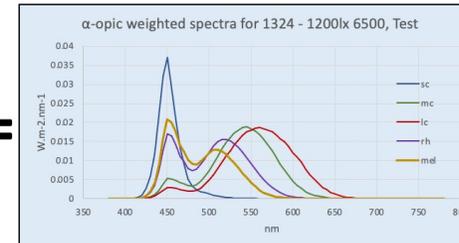
nm	W.m-2.nm-1
380	0.000675497
385	0.000411153
390	0.000546981
395	0.000376939
400	0.000552824
405	0.000677562
410	0.000443362
415	0.000758324
420	0.001646056
425	0.004363317
430	0.007724164
435	0.013319757
440	0.022610047



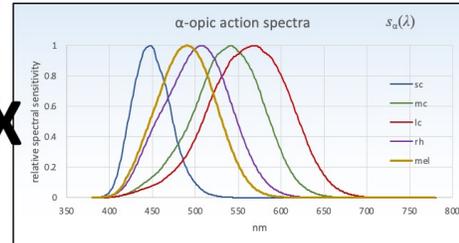
X



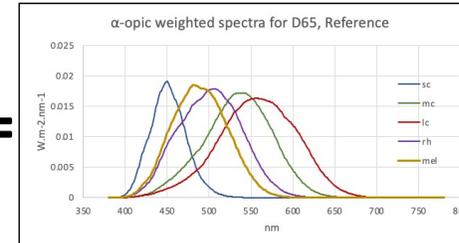
=



X



=



Selected spectral quantity is permitted.

Selected prefixes are permitted.

Results based on spectral data provided.

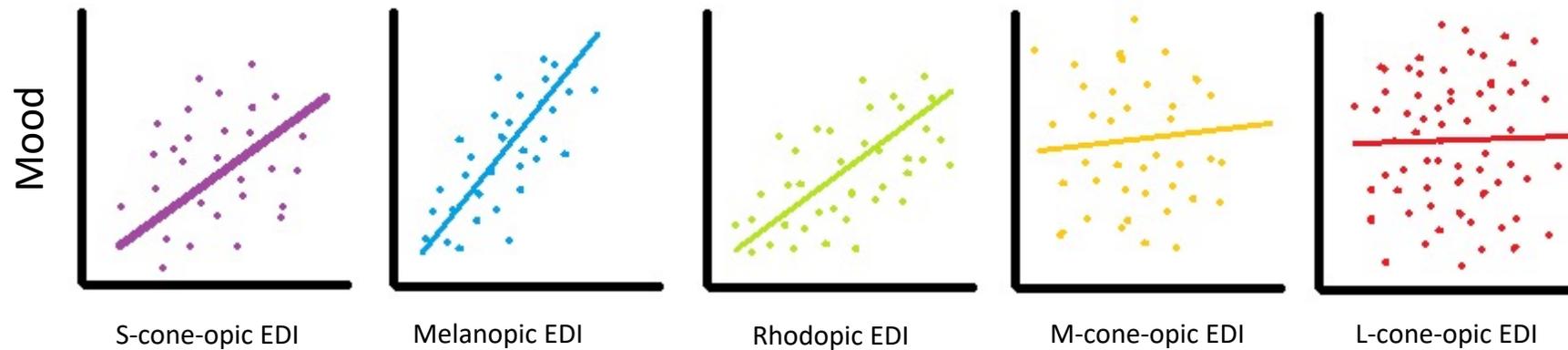
Details of built in spectra (CIE 015:2018)

A: Range 380 nm to 780 nm, step 1 nm  
 D65: Range 380 nm to 780 nm, step 1 nm  
 E: Range 380 nm to 780 nm, step 1 nm

- $\alpha$ -opic Equivalent Daylight Illuminance (EDI) scales to the equivalent CIE D65 exposure in lx for the same  $\alpha$ -opic irradiance of the given light source

# Data analysis plan

- Statistical analysis plan relating the mood outcome measures to the light exposures, shown conceptually here



# Conclusion

- Clinical implications for depression
- Continued investigation

# Status and next steps

- Present:
  - **Well-being** – Finalizing analyses & report
  - **Sleep** – Finalizing data extraction
  - **Cognition** – Starting data extraction
- Next Steps:
  - **Well-being** – To be reviewed by scientific advisory board & submit to journal
  - **Sleep, Cognition & Physiology** - Complete

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- We thank study authors who have shared with us details about light sources, SPDs, and outcome statistics to permit the meta-analysis.

# References

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- CIE position statement on non-visual effects of light: recommending proper light at the proper time. October 3<sup>rd</sup> 2019
- CIE TN003: 2015
- CIE S026: 2018

Thank you

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