Decoding the spectral diet of humans: Development of new analysis methods for spectral light exposure timeseries data

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Project Type: Master Thesis

Context

Light enables visual perception of the world and has a fundamental role in regulating biological rhythms as well as acute physiological and behavioural functions.[1] The patterns of light we are exposed to on a daily basis are highly complex signals resulting from the interaction between the light provided in our immediate environment and our behaviour within this environment. Not only the amount of light but also the spectral composition of light arriving at the eye fluctuates over time, depending on the light sources and reflecting materials in the environment.[2] Measuring the spectral diet of individuals or groups of people may help to identify potential for lighting interventions, to validate design decisions, and to understand how building features shape personal light exposure, which is critical in understanding how modern living can be better aligned with human biology.[3]

At the Laboratory for Integrated Performance in Design (LIPID) we recently developed a novel wearable spectral sensor (Spectrace), which records spectral irradiance in 14 wavelength bands across the visible range (380-780nm).[4] This sensor will be used in field studies to measure personal light exposure patterns in diverse groups of people. We are looking to develop new analysis methods for this spectral light exposure timeseries data through a Master's project, focusing on unsupervised methods for clustering and classification.

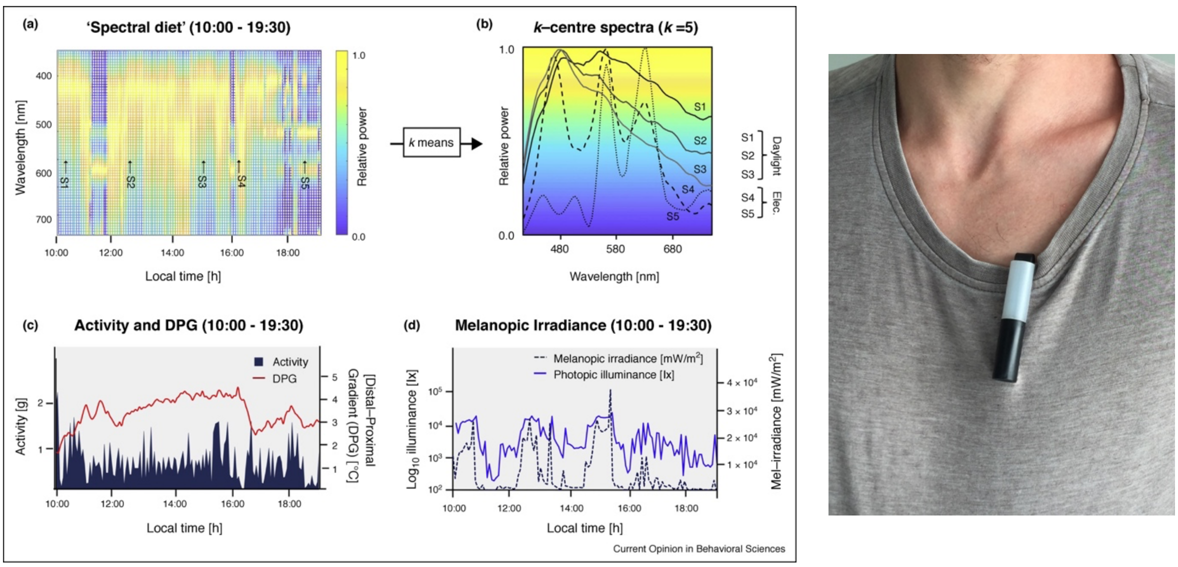

Figure 1. Left: example of measured spectral timeseries data and clustering approach[2]; **right:** Spectrace sensor with which the data will be measured.

Objectives

The objective of this project is to develop new analysis methods for the data gathered with the Spectrace sensors. The focus is on developing/testing/comparing and implementing methods for:

- unsupervised clustering of measured spectra
- classification of spectral types
- decomposing spectra into different source spectra

All methods should be developed for efficient analysis of large sets of data and validated in a systematic research and development process. The final project outcome should be a working implementation of the developed methods (ideally in R, possibly in Python or MATLAB), together with a written report documenting the research and development process.

Deliverables

The student will present their development progress and research through:

- A midterm presentation (10 min)
- A final presentation (20 min)
- A written report (accounting for 2/3 of the final grade)

The report and presentations must be in English.

Requirements

The project involves the development and implementation of analytical methods for timeseries data. Therefore, the student should have a strong background in data science, computer science and/or machine learning, and should be proficient in R and Python (or MATLAB). Familiarity with the topic of lighting would be useful but is not mandatory.

References

1. Fisk AS, Tam SKE, Brown LA, Vyazovskiy VV, Bannerman DM, Peirson SN. Light and Cognition: Roles for Circadian Rhythms, Sleep, and Arousal. *Frontiers in Neurology*; 0. Epub ahead of print 2018.

2. Webler FS, Spitschan M, Foster RG, Andersen M, Peirson SN. What is the ‘spectral diet’ of humans? *Current Opinion in Behavioral Sciences* 2019; 30: 80–86.

3. Münch M, Wirz-Justice A, Brown SA, Kantermann T, Martiny K, Stefani O, Vetter C, Wright KP, Wulff K, Skene DJ. The Role of Daylight for Humans: Gaps in Current Knowledge. *Clocks & Sleep* 2020; 2: 61–85.

4. Webler FS, Chinazzo G, Andersen M. Towards a wearable sensor for spectrally-resolved personal light monitoring. *Journal of Physics: Conference Series* 2021; 2042: 012120.