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Studies on the effects of light on human neuroendocrine physiology and cognition

Submission date
19/04/2023

Recruitment status
No longer recruiting

Registration date
01/05/2023

Overall study status
Completed

Last Edited
11/12/2023

Condition category
Other

[ ] Prospectively registered
[ ] Protocol
[ ] Statistical analysis plan
[ ] Results
[ ] Individual participant data
[ ] Record updated in last year

Plain English summary of protocol

Background and study aims
The human brain has a central clock that controls our daily biological rhythms, including our sleep-wake cycle. This central clock receives direct input from light-sensitive cells in the eye, which allows it to stay synchronized with the day and night cycle. The purpose of this study is to examine how our eyes and brain process light to keep our central clock synchronized, and how light exposure in the evening affects our biological rhythms. In particular, this study tries to understand how light information from both eyes is combined in the brain to inform our central clock. The research team have developed an experiment to understand how the effects of light exposure in the evening differ when light is presented in one eye versus presented in both eyes at the same time. The team are also interested in understanding how fast changes in the light in our environment affect this response, so we use flickering lights (turning on and off repeatedly) to examine these mechanisms.

Who can participate?
Healthy people aged between 18 and 40 years old that have normal vision and colour perception

What does the study involve?
The study will last for a total of at least 3 weeks. During this time, volunteers will be asked to avoid travelling across time zones and to maintain a regular bedtime and wake-up time, which will be chosen by them in the initial visit. Throughout the study, they will wear an actigraphy wristwatch that tracks their daily movement and activity, complete a brief sleep diary questionnaire every morning, and log the times of their meals during the day. Participants will be required to abstain from caffeine, nicotine and alcohol for the entire duration of the study. Starting from the second week of the study, participants will visit the laboratory on four evenings, each one at least two days apart. Each visit will last 6 hours, starting 5 hours before their usual bedtime and ending 1 hour after their usual bedtime. During these six hours in the laboratory, they will: Remain seated in dim light for 3 hours, while being allowed to read printed materials or listen to audiobooks or podcasts. After this, they will view a light stimulus using a Virtual Reality headset for two hours (with 10-minute breaks every 20 minutes). During this time, their gaze and pupil size will be recorded. Afterwards, they will return to the dim light for 1 hour. Every 30 minutes, they will provide a saliva sample, do an auditory reaction time test, and complete a brief questionnaire about their sleepiness, perception and mood. Their body

temperature will be measured throughout the evening by means of an ingestible temperature capsule. Participants will have access to a toilet and water but will be asked to avoid other drinks or food.

What are the possible benefits and risks of participating?
Participants will have no immediate advantage or benefit from participation in the study, but their data will be used for research purposes with the aim of improving our understanding of the effect of light on daily biological rhythms and the processing of light on the brain. The study is not expected to have any negative impact on the physical health or mental well-being of participants. On the days of visiting the lab, participants will go to bed up to one hour later than usual, which is not associated with any long-term impacts. During the study, volunteers will be subjected to flickering light, which may seem uncomfortable, but is not expected to have any negative effects on their vision or perception. Wearing virtual reality glasses may cause some short-term discomfort after prolonged use, which will be counteracted with frequent breaks.

Where is the study run from?
The Max Planck Institute for Biological Cybernetics, in Tübingen (Germany)

When is the study starting and how long is it expected to run for?
April 2022 to June 2025

Who is funding the study?
Max Planck Society (Germany)

Who is the main contact?
Dr Maydel Fernandez-Alonso, maydel.fernandez.alonso@tuebingen.mpg.de (Germany)
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Additional identifiers

Study information

Scientific Title
Within-subjects comparison of the effect of evening light exposure of different spatial and temporal properties on melatonin production in healthy adults

Study objectives
Spatial (monocular versus binocular) and temporal (constant light versus different temporal frequencies) properties of evening light exposure affect human melatonin production

Ethics approval required
Old ethics approval format

Ethics approval(s)
Approved 19/04/2023, Ethics Committee of Technical University of Munich (Ethikkommission der Technischen Universität München; Ismaninger Straße 22, 81675 München, Germany; +49 (0) 89 4140-4199; ethikkommission@mri.tum.de), ref: 2022-439_1-S-SR

Primary study design
Interventional

Study design
Interventional randomized controlled study

Study type(s)
Other

Health condition(s) or problem(s) studied
Characterisation of non-visual function in healthy participants

Interventions
The participants will attend four in-laboratory sessions over a total study period of 3 weeks, including an initial circadian stabilisation period of 1 week. Participants will spend a total of 6 hours in the laboratory during which they will repeatedly give saliva samples for later melatonin assays, complete reaction time and other rating tests. Their pupil size, core body temperature, and other physiological parameters will be monitored throughout each session. In the 2 hours preceding their habitual bedtime, participants will be exposed to one of multiple possible stimuli. The same participant will be exposed to four different stimuli: (A) dim light, (B) constant light, and two active stimulus conditions (C & D). The temporal frequency and spatial properties of the stimulus, and the extent to which stimuli are presented between the two eyes will vary between different participants.

Method of randomization
All possible sequences of the light stimuli conditions and their combination with the different flicker frequencies possible were added to a list and pseudo-randomized via code in Python. Upon enrollment, each participant is assigned a numerical ID according to the order of enrollment. The experimental code assigns the sequence of the light stimuli and the frequency of flicker that will be delivered via the Virtual Reality headset to each participant, according to their numerical ID. The list containing this information is kept in a file that can only be read via code. The experimenters cannot see the light stimuli during the intervention, and participants are instructed to avoid making comments about the stimuli they see. For each category of intervention provider (e.g. psychologist, nursing assistant), describe their expertise, background and any specific training given.

Lead experimenter: Postdoctoral scientist with a background in Psychology and Neuroscience and expertise in human behavioral research. They received training in collecting, processing and storing saliva samples and performing screening tests.
Research assistants: Postgraduate and undergraduate students with a background in Psychology and Biology. They received training in collecting, processing and storing saliva samples, as well as in conducting the experiment, giving instructions to participants and assisting with the different screening tests.
Modes of delivery: The intervention is delivered in person at the laboratory. The light stimuli are delivered individually for each participant. In each laboratory visit, there might be up to three participants at once. Their privacy is protected via individual booths, where each participant remains throughout the experiment. Describe the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features

The intervention is delivered in the laboratory of the Max Planck Institute for Biological Cybernetics. The space counts with the necessary infrastructure to conduct the experiment. The room where the intervention is delivered has individual booths for each participant. Comfortable

seating and an area for personal belongings are provided. Participants have access to a toilet, and all rooms and hallways are kept adequately illuminated. The saliva samples are processed on-site in a separate room that has the centrifuge and freezer for storage.

Intervention Type
Other

Primary outcome(s)
Salivary melatonin concentrations measured using a melatonin hormone testing kit at half-hour intervals during a 5-hour evening protocol

Key secondary outcome(s)
The following secondary outcome measures are measured at half-hour intervals during a 5-hour evening protocol:
1. Vigilance measured using the Psychomotor Vigilance Test (PVT)
2. Sleepiness measured using the Karolinska Sleepiness Scale (KSS)
3. Visual comfort measured using a self-report questionnaire

Completion date
30/06/2025

Eligibility

Key inclusion criteria
Current participant inclusion criteria as of 12/07/2023:
1. Age, ≥18, ≤40 years of age, Self-report
2. Physical health, Good physical health, Self-report
3. Mental health, Good mental health, Self-report
4. Ocular health, Good ocular health (self-report)
5. Binocular vision, Titmus Fly Test
6. Visual acuity, Normal or corrected-to-normal visual acuity, Landolt C (20/30 or better)
7. Colour vision, Normal colour vision, Cambridge Colour Test, anomaloscope

Previous participant inclusion criteria:
1. Age, ≥18, ≤40 years of age, Self-report
2. Physical health, Good physical health, Self-report
3. Mental health, Good mental health, Self-report
4. Ocular health, Good ocular health, Ophthalmological examination by ophthalmologist
5. Binocular vision, , Titmus Fly Test
6. Visual acuity, Normal or corrected-to-normal visual acuity, Landolt C
7. Colour vision, Normal colour vision, Cambridge Colour Test, anomaloscope

Participant type(s)
Healthy volunteer

Healthy volunteers allowed
No

Age group
Adult

Lower age limit
18 Years

Upper age limit
40 Years

Sex
All

Key exclusion criteria
Current participant inclusion criteria as of 12/07/2023:
1. BMI, <18 or >30, Calculation from self-reported and/or measured height and weight
2. Medication use, Any use of medications, Self-report
3. Smoking, Habitual smoking, Self-report
4. Epilepsy, Diagnosis of epilepsy in self or close relatives with epilepsy (parents, siblings, children), Self-report
5. Substance abuse, Excessive alcohol use, AUDIT > 7
6. Sleep, Poor sleep quality, PSQI >5
7. Chronotype, Extreme chronotype, MCTQ
8. Shift work, No shift work in the past 3 months, Self-report
9. Time zone travel, No inter-time zone travel with more than 1-hour difference in the past 3 months, Self-report
10. Excessive daytime sleepiness, ESS > 12
11. Exogenous hormone intake, including hormonal contraceptives, Self-report
12. Pregnant or breastfeeding, Self-report
13. Hormonal disorders, Self-report
14. Frequent severe physical symptoms related to the menstrual cycle (headache, fever, nausea, vomiting, severe pain), Self-report

Previous participant inclusion criteria:
1. BMI, <18 or >30, Calculation from measured height and weight
2. Medication use, Any use of medications, Self-report
3. Smoking, Habitual smoking, Self-report
4. Epilepsy, Diagnosis of epilepsy, Self-report
5. Substance abuse, Excessive alcohol use, AUDIT
6. Sleep, Poor sleep quality, PSQI >5
7. Chronotype, Extreme chronotype, MEQ
9. Shift work, No shift work in the past 3 months, Self-report
10. Time zone travel, No inter-time zone travel in the past 3 months, Self-report

Date of first enrolment
19/04/2023

Date of final enrolment
31/12/2024

Locations

Countries of recruitment
Germany

Study participating centre
Max Planck Institute for Biological Cybernetics
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Sponsor information

Organisation
Max Planck Institute for Biological Cybernetics

ROR
https://ror.org/026nmvv73

Funder(s)

Funder type
Research organisation

Funder Name
Max-Planck-Gesellschaft

Alternative Name(s)
Die Max-Planck-Gesellschaft, Max Planck Society for the Advancement of Science, Max-Planck-Gesellschaft zur Förderung der Wissenschaften, Max Planck Society, MPG

Funding Body Type
Government organisation

Funding Body Subtype
Research institutes and centers

Location
Germany

Results and Publications

Individual participant data (IPD) sharing plan

The datasets generated during and/or analysed during the current study will be stored in a publicly available repository (FigShare and GitHub). Raw, individual-level data with appropriate metadata will be made available via FigShare.org at the time of submission of the peer-reviewed article or preprint. No restrictions are placed on the data. Data will be fully anonymised, and participants are informed of this in the Informed Consent form.

IPD sharing plan summary

Stored in publicly available repository

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Participant information sheet	version 1.02	27/03/2023	01/05/2023	No	Yes
Participant information sheet	version 1.02	27/03/2023	01/05/2023	No	Yes