Unseen light that enhances cognitive task performance

Abstract

"Mind reading" based on eye-metric features has advanced to the point where psychological states can be estimated. This study explores a method that employs specific lighting to intervene in psychological states, all without altering the user's perceptual experience. We utilized "stealth light" that modulates the activation of intrinsically photosensitive retinal ganglion cells (ipRGCs) without producing noticeable changes in visual perception. Participants exposed to this lighting condition showed improved performance on cognitive tasks and reduced subjective sleepiness and fatigue. These findings suggest that light can serve as a subconscious intervention tool to guide users toward optimal psychological states. Moreover, by dynamically adjusting lighting in response to the user's condition, we aim to regulate the autonomic nervous system and promote overall well-being. This approach offers new possibilities for personalized, non-invasive interventions by integrating physiological sensing with light-based modulation.

Mind reading

By analyzing eye metrics, we aim to read the mind and establish optimal intervention techniques tailored to the user's state.

Understanding brain mechanisms for cognitive processes via eye-metrics

Pupil changes depending on preferences for music and facial expressions [1]

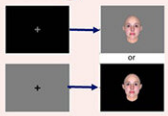
Pupil changes in bistable perception [2]

Pupillary light reflex toward auditory attention direction [3]

Reading

Leading

Changing pupil size through luminance affects facial preferences [1]

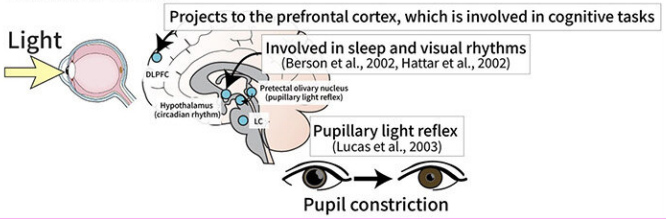


Light-based intervention in perception and cognition

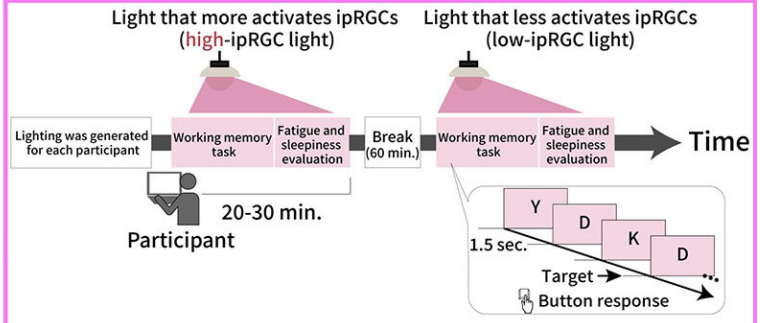
We aim to develop techniques that modulate perception and cognition through ipRGC activation, without altering the user's visual experience.

What is "ipRGCs"?

Intrinsically photosensitive retinal ganglion cells (ipRGCs) represent a third class of photoreceptors in addition to rods and cones.

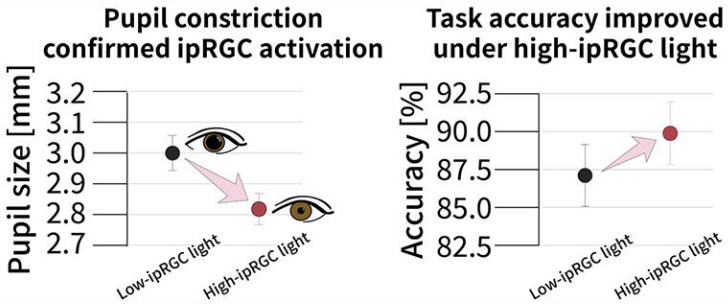


Cognitive tasks under ipRGC-activating light

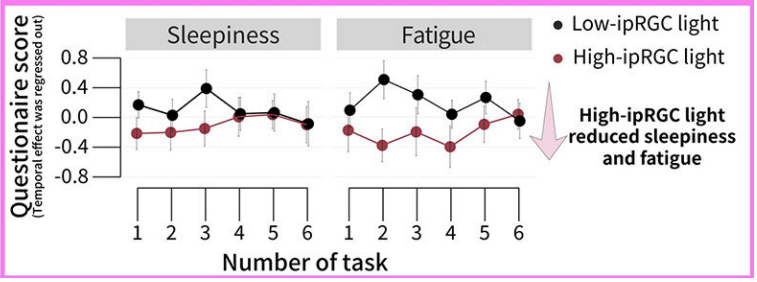


- Participants performed an N-back task (pressing a button when the current letter matched the one presented N trials earlier) under lighting conditions that either strongly or minimally activated ipRGCs.
- Participants rated sleepiness and fatigue levels using a 10-point scale.

Finding 1: Improved task accuracy under high-ipRGC light



Finding 2: Reduced sleepiness and fatigue through ipRGC activation



References

[1] H.Liao, M. Kashino, S. Shimojo, "Attractiveness in the eyes: A possibility of positive loop between transient pupil constriction and facial attraction," *Journal of Cognitive Neuroscience,* Vol. 33, pp. 315–340, 2021.

[2] Y. Suzuki, H.Liao, S. Furukawa, "Temporal dynamics of auditory bistable perception correlated with fluctuation of baseline pupil size," *Psychophysiology*, e14028, 2022.

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