

Abstract

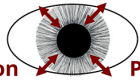
Eyes are windows to the soul. In addition to eye movements such as saccades, **the eyes have various tiny and unaware activities, including pupil responses and microsaccades.** These eye activities reflect our internal states and brain activities, which are known to be in charge of functions related to attention and alertness. Based on this knowledge, **we aim to use these eye movement characteristics to infer people's mental states.** Here we introduce two studies demonstrating how these unaware eye movements reflect auditory attention and facial attractiveness judgment. With the advance of eye movement recording technology, we may apply our findings to daily life scenarios to infer people's cognitive functions.

What is Eye-metrics?

Eye-metrics: Eye movements measures

Pupillary responses

Pupil light response (PLR), Balance of the autonomic nervous systems, etc.



Pupil dilation

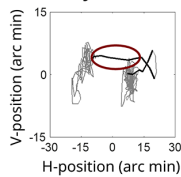
PLR: darkness
Sympathetic nervous system activation

Pupil constriction

PLR: brightness
Parasympathetic nervous system activation

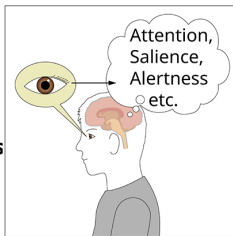
Microsaccades (MS)

Transient fixational eye movements



Eye-metrics' merits

- Non-invasive measurements
- Time-series output (real-time)
- Reflecting brainstem, autonomic nervous systems' "unconscious" processing
- Inversive manipulation by visual stimuli



Can mind-reading be achieved by eye-metrics?

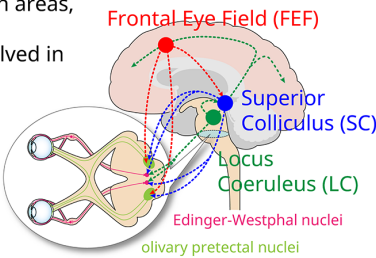
Mind-reading: To sense people's mental states

Mind-reading's merits

- To provide specific information for individuals
- Self-regulation of the mental and physical conditions

Can mind-reading be achieved by eye-metrics?

- Pupillary responses and microsaccades reflect neural activities in broad brain areas, including FEF, SC, and LC.
- These brain activities are involved in various mental states



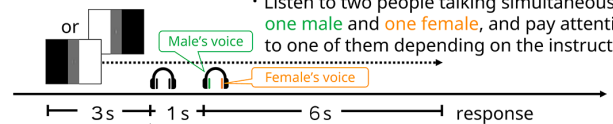
We introduce two studies of mind-reading by eye-metrics:

- Cognition (Study1)
- Emotion (Study2)

Study1: Auditory attention [1]

Experiment

- Task
- Fixate the display with luminance disparities
 - Listen to two people talking simultaneously, one male and one female, and pay attention to one of them depending on the instruction

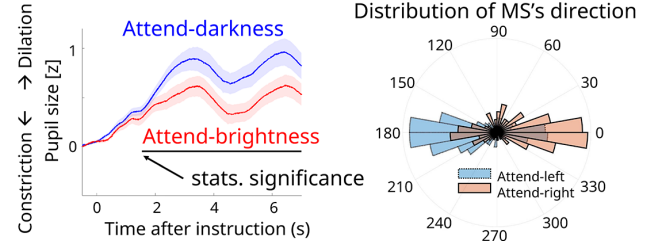


Relationship between the background and the attended voice's direction:

e.g., [display] + [audio] attend to the male voice → left side → darkness

Results

Pupils and microsaccades during fixation behaved as if the eyes went towards the attended direction.



While listening to multiple sound sources simultaneously, PLR and MS reflect the attended voice's direction.

Study2: Attractiveness evaluation [2]

Experiment

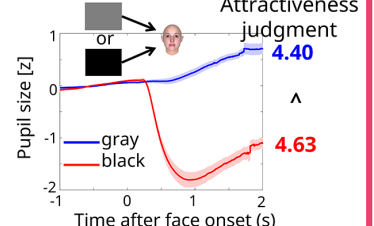
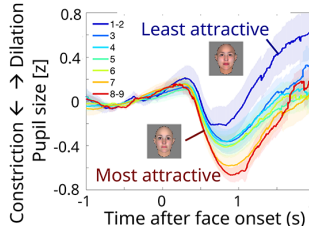
Facial attractiveness rating: 1-9

Manipulate pupil constriction via pre-face luminance

Results

Pupil constriction reflects facial attractiveness.

Pupil constriction affects facial attractiveness.



A positive loop between transient pupil constriction and facial attractiveness

References

- [1] H.-I. Liao, H. Fujihira, S. Yamagishi, Y.-H. Yang, S. Furukawa, "Seeing an auditory object: Pupillary light response reflects covert attention to auditory space and object," *Journal of Cognitive Neuroscience*, Vol. 35, No. 2, pp. 276-290, 2023.
- [2] H.-I. 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, No. 2, pp. 315-340, 2021.

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