

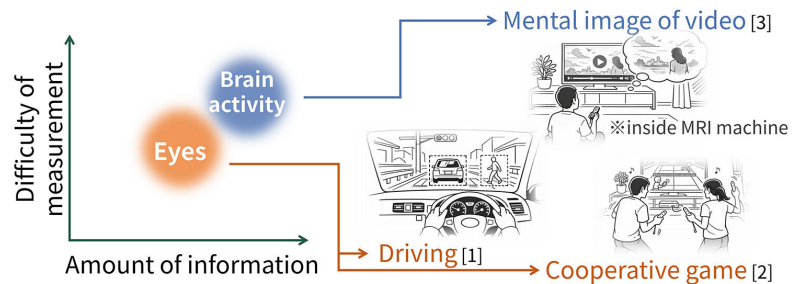
Abstract

Humans act in rich and complex everyday environments, but it is still difficult to understand how the brain works in such situations and whether a person's mental state can be estimated from natural behavior. This exhibit introduces a series of studies that **extend mind reading beyond the laboratory by using eye and brain signals measured during daily activities such as driving, cooperative gameplay, and video viewing**. Based on knowledge from controlled laboratory experiments, we show that it is **possible to estimate higher-level mental information in more realistic settings**. Examples include detecting attentional state and concentration during natural driving, finding cooperative states from eye-related signals during team play, and decoding perceived or imagined video content from brain activity. In the future, this approach may support **better communication and adaptive assistance by adjusting information presentation and interaction to each person's state**. In driving, for example, it may help driver monitoring systems detect inattentive states.

Mind Reading in the wild

Building on methods from conventional laboratory experiments

- Can we read good and bad states from the **eyes**, which are relatively easy to measure?
- Can we also decode nonverbal cognitive content by measuring **brain activity**?



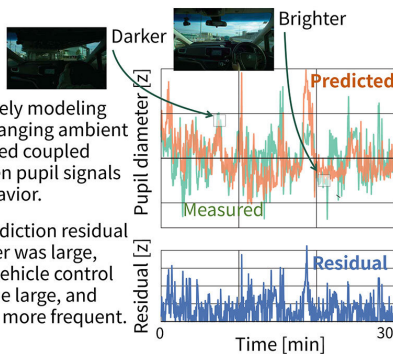
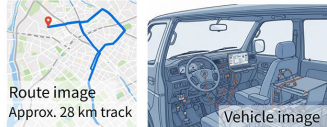
Reading unsafe driving states from the eyes [1]

Coupled patterns in pupil signals and driving behavior

Joint study with DENSO COROPRATION

- We identified pupil-based markers linked with unstable operation in natural driving.

Vehicle-operation data and pupil diameter during natural driving under safe conditions



→ When the prediction residual of pupil diameter was large, fluctuations in vehicle control also tended to be large, and gaze shifts were more frequent.

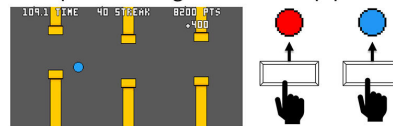
- Useful for improving safety, for example by detecting inattentive driving states

Reading cooperative states from the eyes [2]

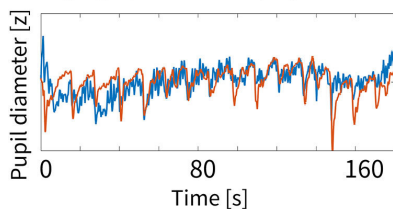
Team performance and synchronization of the eyes

- Pupil diameters of two players in a game requiring cooperation are more strongly synchronized when the team performed better.

Measured pupil diameter while two players took turns controlling a ball in an experimental game to avoid pipes.



Example of strong pupil synchronization during high-performance play



Reading mental content from brain activity [3]

Mind Captioning

- Generating texts that explain contents of viewed/recalled video from brain activity

Viewed/recalled video



Generated text from brain activity during viewing

Two young men and woman are dancing in unison and joking around.

Generated text from brain activity during recall

Four young men are standing together, laughing and doing hand motions.

- Showcased the feasibility of non-verbal thought-based brain-to-text communication, potentially aiding individuals with difficulties in language expression such as aphasia

References

- [1] J. Yamashita, Y. Suzuki, F. Nakanishi, M. Yamataka, H. Terashima, K. Maruya, "Finding Workload in the Wild: Recovering Latent Cognitive Dynamics Jointly from Eye Metrics and Driving Telemetry," in Proc. *The 2026 ACM Symposium on Eye Tracking Research & Applications (ETRA2026)*, accepted.
- [2] H.-I. Liao, M. Montemayor, K. Haly, M. Kashino, S. Shimojo, "Interpersonal pupil synchronization during high-engagement team plays," in Proc. *The 47th European Conference on Visual Perception (EVP2025)*, 2025.
- [3] T. Horikawa, "Mind captioning: evolving descriptive text of mental content from human brain activity," *Science Advances*, Vol. 11, No. 45, eadw1464, 2025.

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