

# 24

## Tiny eye movements reflect cognitive states

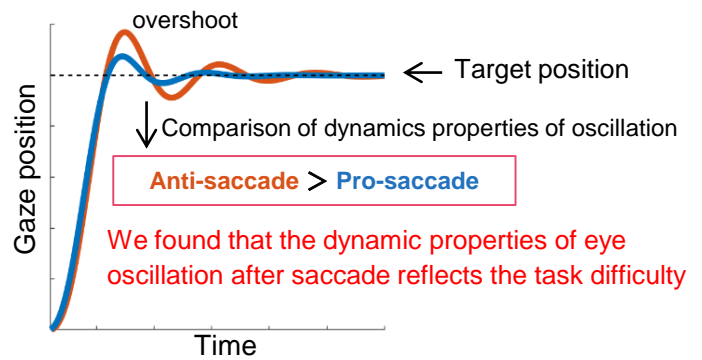
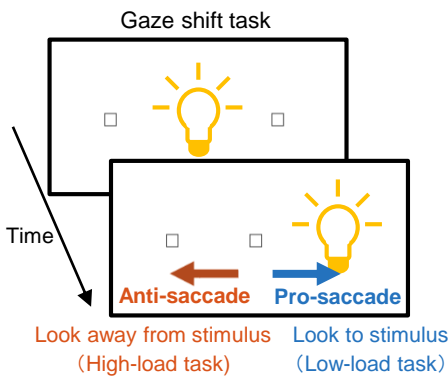
### Relation of eye-movement dynamics with cognition and pupil

#### Abstract

Recent studies have shown that the characteristics of the eye movements reflect the cognitive state varying moment by moment. In this study, we investigated the relationship between cognitive states and the detailed dynamics of eye movements which have been regarded as mere mechanical oscillation. We found that the **dynamic properties of eye oscillation after saccade reflect the task difficulty** in gaze shift task. In addition, we showed that the **oscillation dynamics was greater for pupil-centric motion than motion of entire eyeball**. The correlation between the pupil-centric oscillation and pupil size indicates that it reflects the instantaneous states of eye tissue inside iris (e.g., stiffness of muscles controlling pupil size). **There is a potential that the measurement of the tiny eye movements can be applied to a tool for monitoring the time-varying cognitive state** (for example, monitoring the worker who engages in task requiring attention or cognitive load).

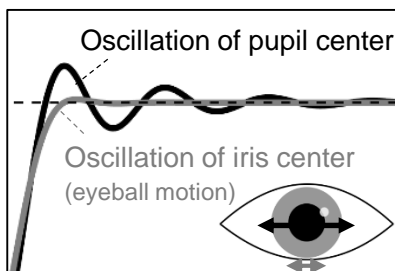
#### Relation between dynamics of saccadic eye movement and cognitive task

- The gaze position after a saccade does not stop exactly at the target position but oscillate around it (overshoot)
- We tested the relationship between overshoot, which has been regarded as mere mechanical vibration, and cognition



#### Eye-movement dynamics reflects the physical properties of eye tissue

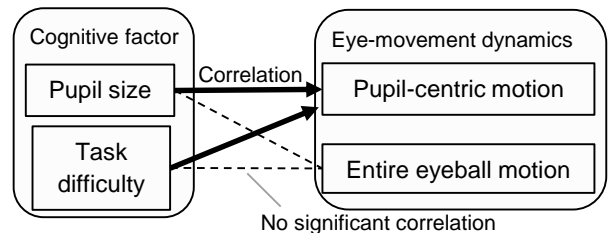
- Extracts the pupil-centric and iris-centric motions



Viscoelasticity of the pupil-centric oscillation is greater than iris-centric one (entire eyeball)

#### Correlation between pupil size and dynamics of pupil-centric motion

- Calculates the correlation coefficient between eye-movement dynamics and pupil size or task difficulty



Dynamics correlate with pupil size as well as task difficulty

➡ Reflects state of muscles controlling pupil size

#### References

- [1] S. Yamagishi, M. Yoneya, S. Furukawa, "Relationship of postsaccadic oscillation with the state of the pupil inside the iris and with cognitive processing," *J Neurophysiol*, 2020.

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