Assessment of Cognitive Function using P3 Components of Eye fixation Related Potentials

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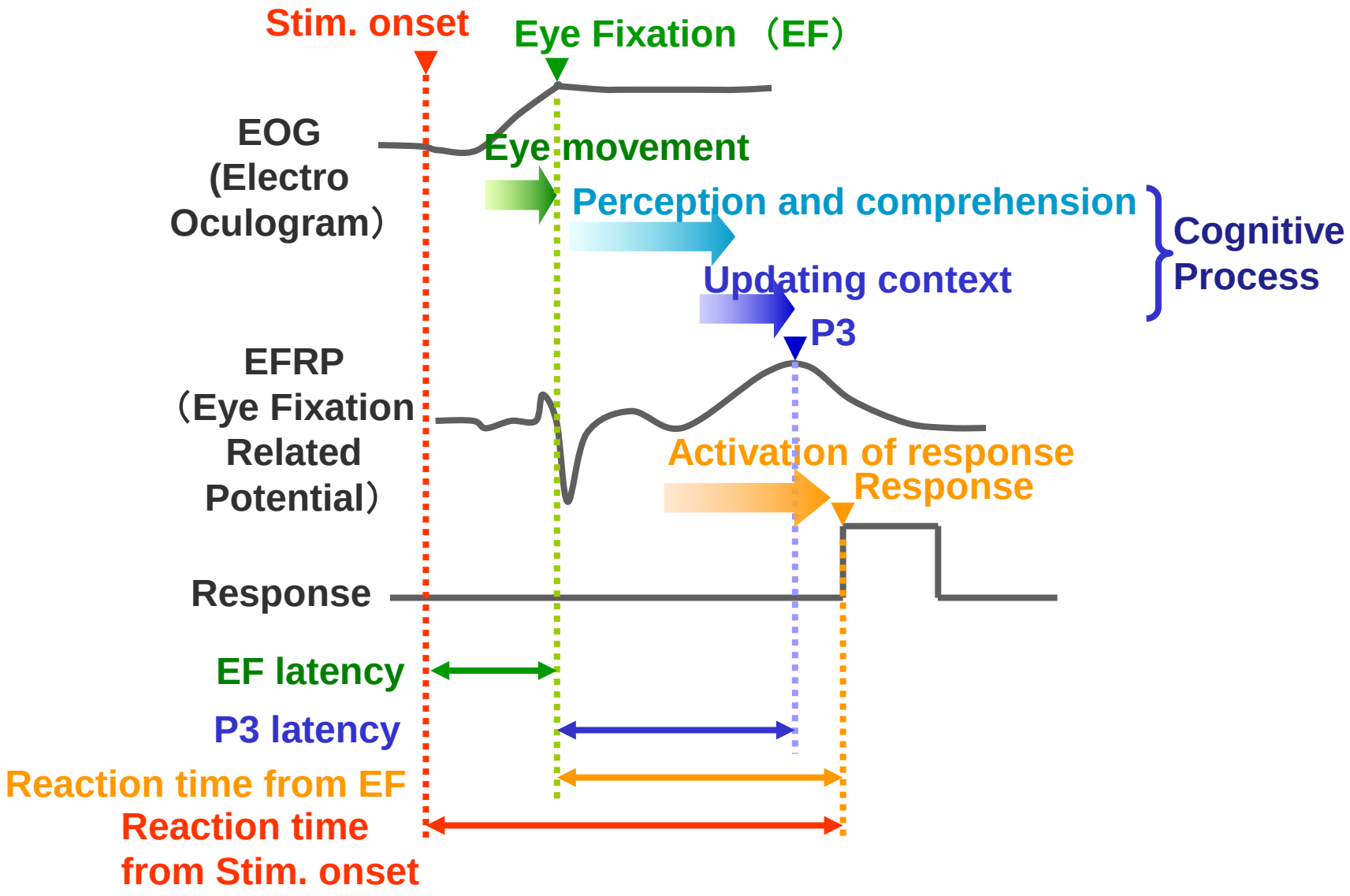
Introduction

- ✓ The ultimate goal of our work is to provide elderly drivers with training methods or driver assistant systems appropriate for their individual levels of cognitive ability.
- ✓ The assessment method is necessary to access the three phases of the cognitive process; recognition, judgment, and operation.
- ✓ In this study, we propose that the response latency between stimulus presentation and eye fixation—with specific focus on the P3 component of eye-fixation related potentials (EFRP)—can be used to develop one such method of assessment.

EFRP: Eye-Fixation Related Potentials



Method

✓Participants

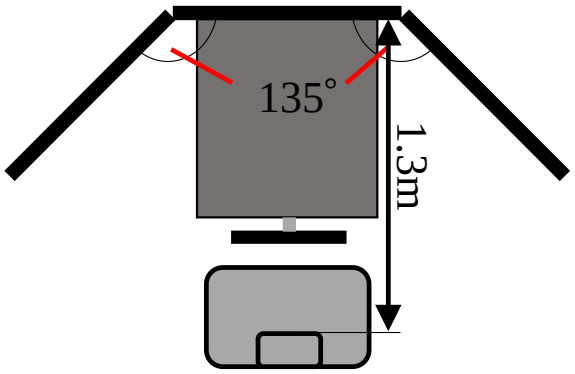
- 33 elderly aged 66 – 81 (28 males and 5 females)
- 6 young male adults aged 21- 23

The experiments were executed with permission of the president of Osaka Institute of Technology in accordance with the report of the Ethics Committee on Life Sciences of Osaka Institute of Technology (approval number 2015-4-1).

Method

✓Experimental settings

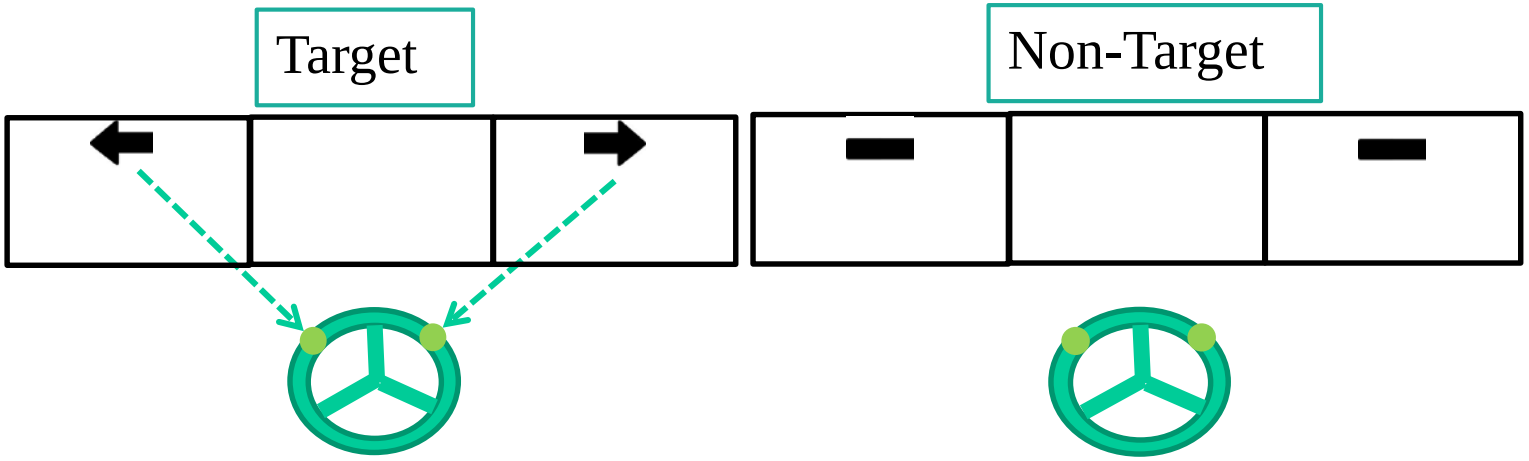
- A simulated driving environment consisted of three 42-inch LCDs, a car seat, a steering wheel, an accelerator pedal and a brake pedal



Method

✓Odd ball Task

- Target : Non-Target = 2 : 8
- 200 stimuli for a session
- duration 0.5 s, intervals 1.8s



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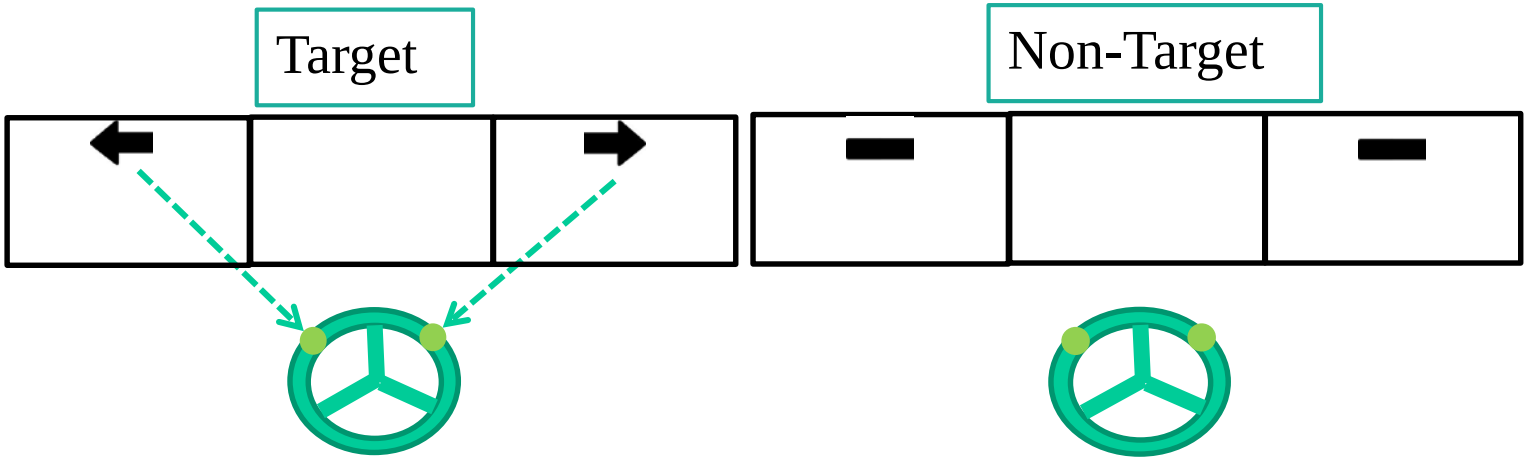


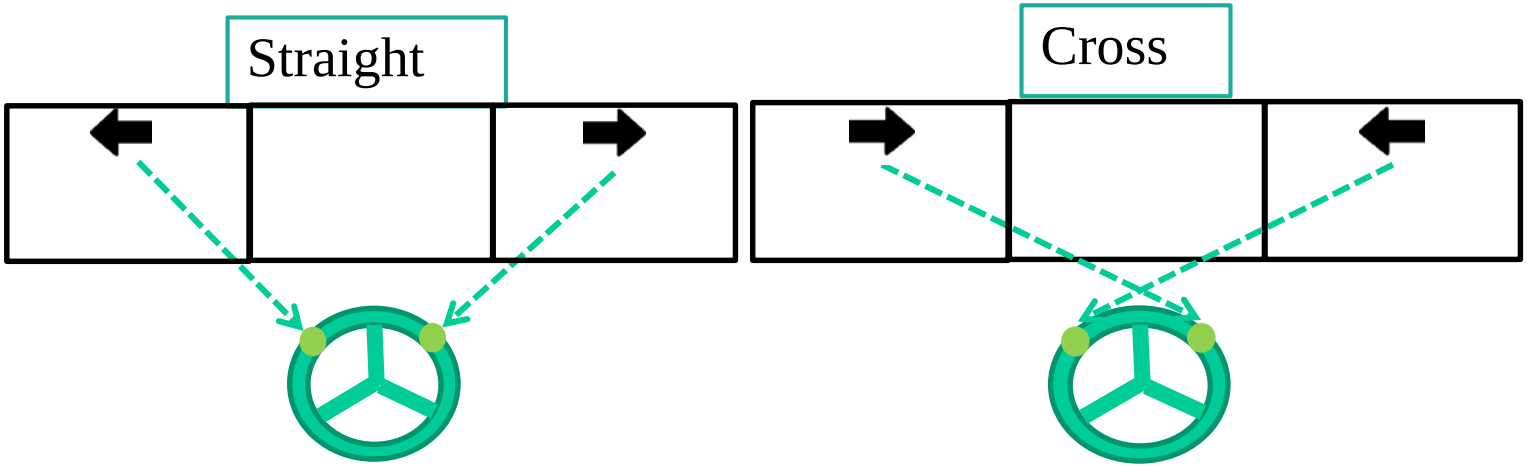
Method

✓2 levels of response load based on “Simon effect”

Hypothesis:

response loads and reaction times; “cross” > “straight”

cognitive loads and EFRP latencies; “cross” = “straight”



Method

✓Measurement

- 19 ch electroencephalogram (EEG) data based on the international 10-20 system

  using an electrode cap (Electro-cap Co.) and

  a multi-purpose biological amplifier (Polymate)

- Vertical and horizontal electrooculography (EOG)

  using small Ag-AgCl electrodes and

  the same amplifier

Method

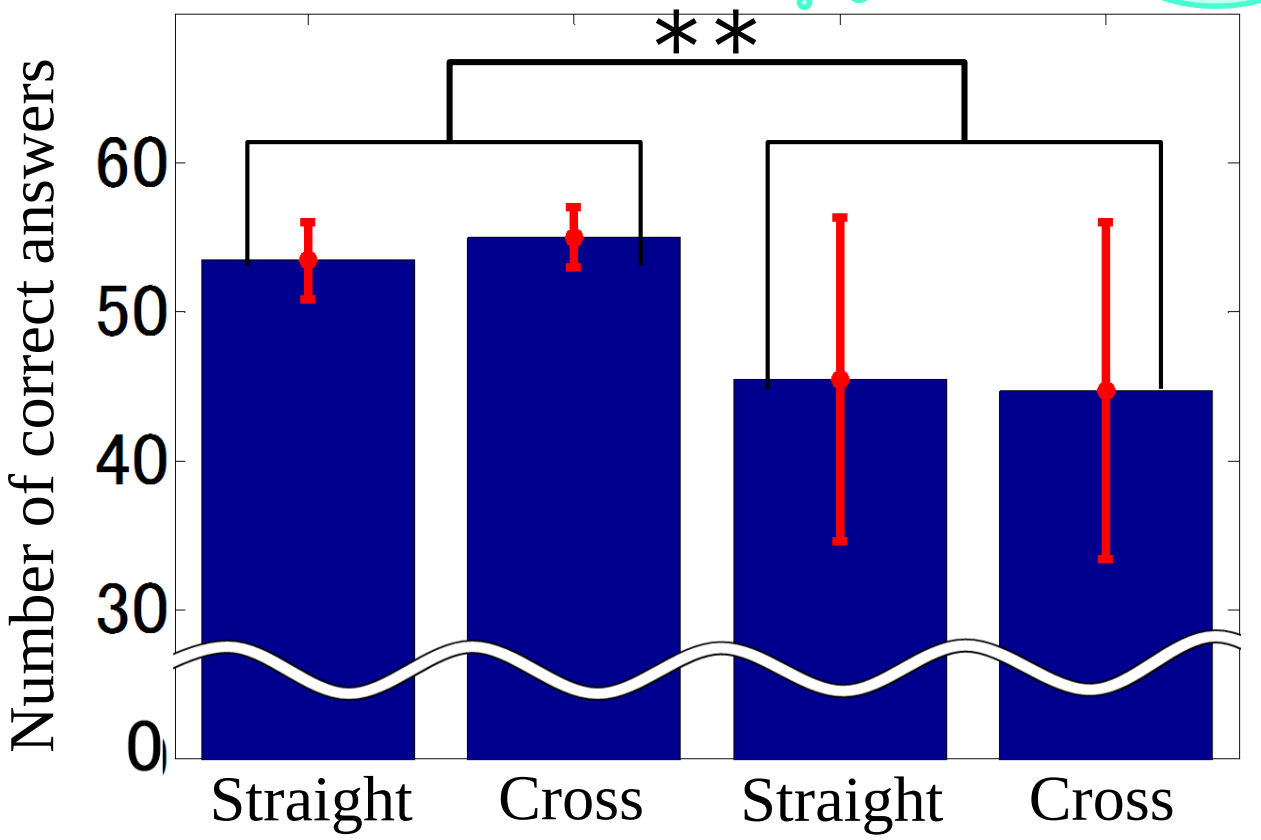
✓ Analysis for obtaining EFRP

- EEG data were analyzed with respect to linked-ear reference data
- Eye movement-related artifacts were removed using ICA
- Eye fixation points were determined by the norm of both EOG waveforms and used as triggers
- EEG data between 300 ms before and 1000 ms after the trigger were extracted and baseline correction was executed
- EFRP were obtained by averaging the extracted EEG data from trials with correct responses
- A low-pass filter with a cut-off frequency of 8 Hz was applied for smoothing

Results

✓Number of correct answers

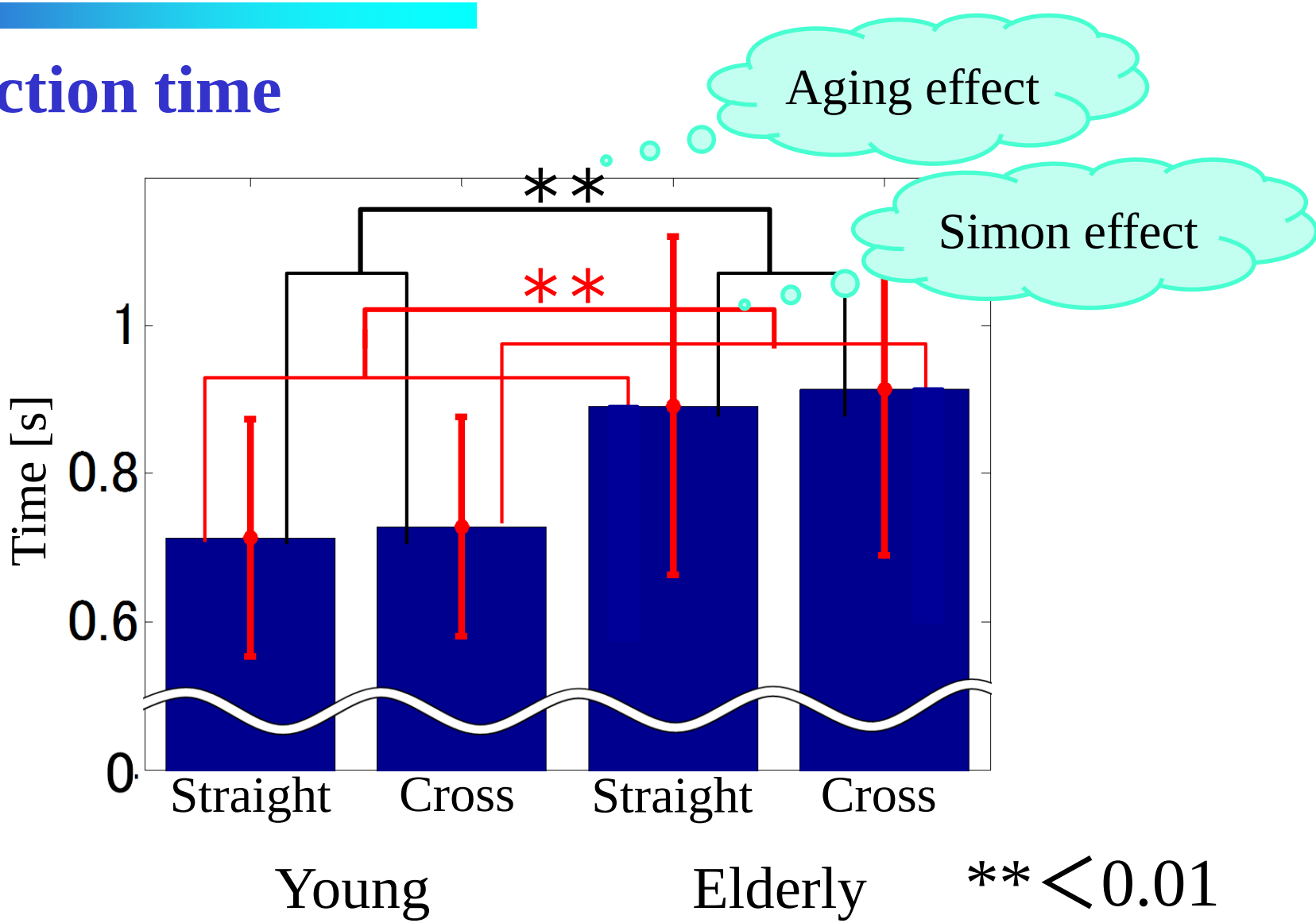
Aging effect



**＜0.01

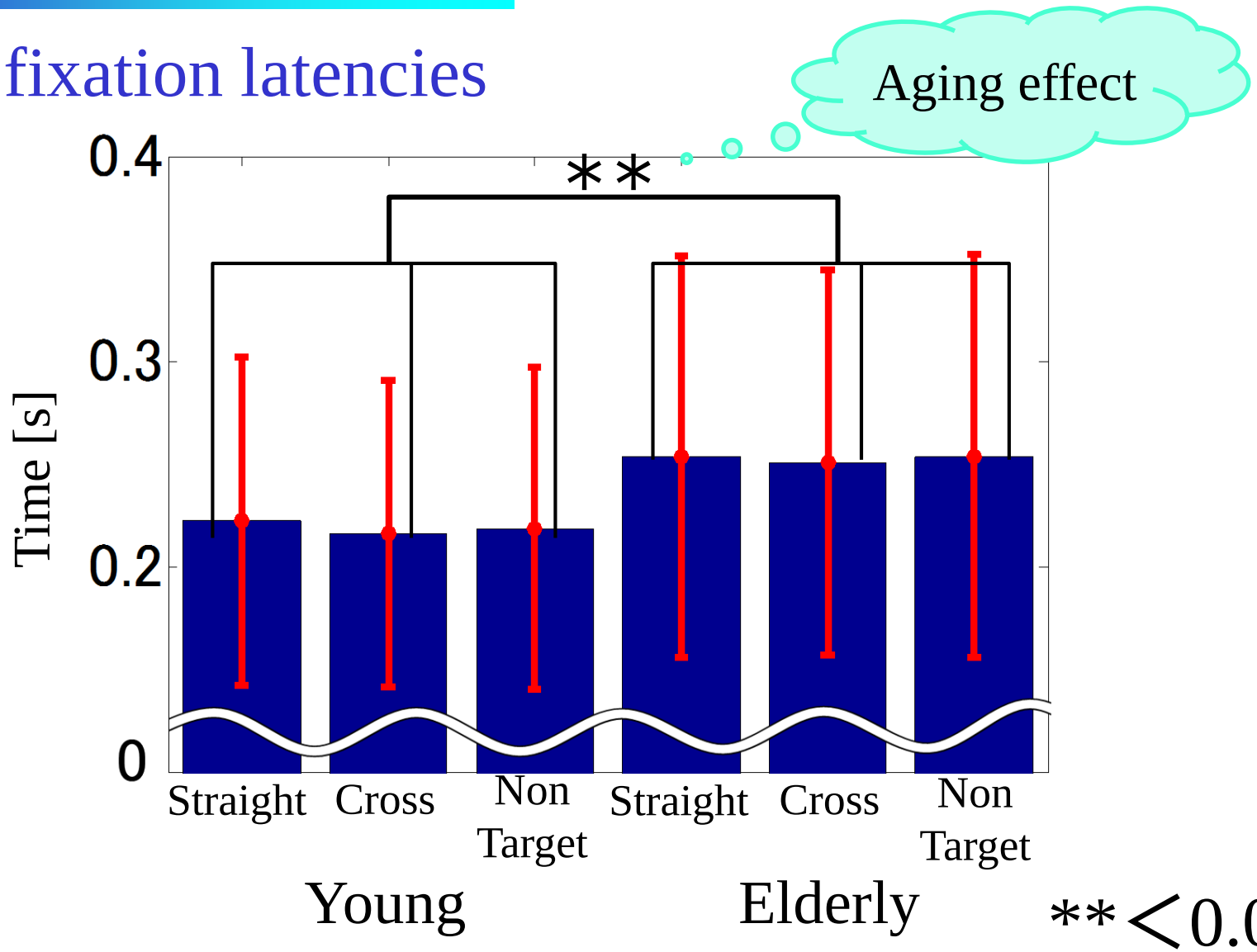
Results

✓Reaction time



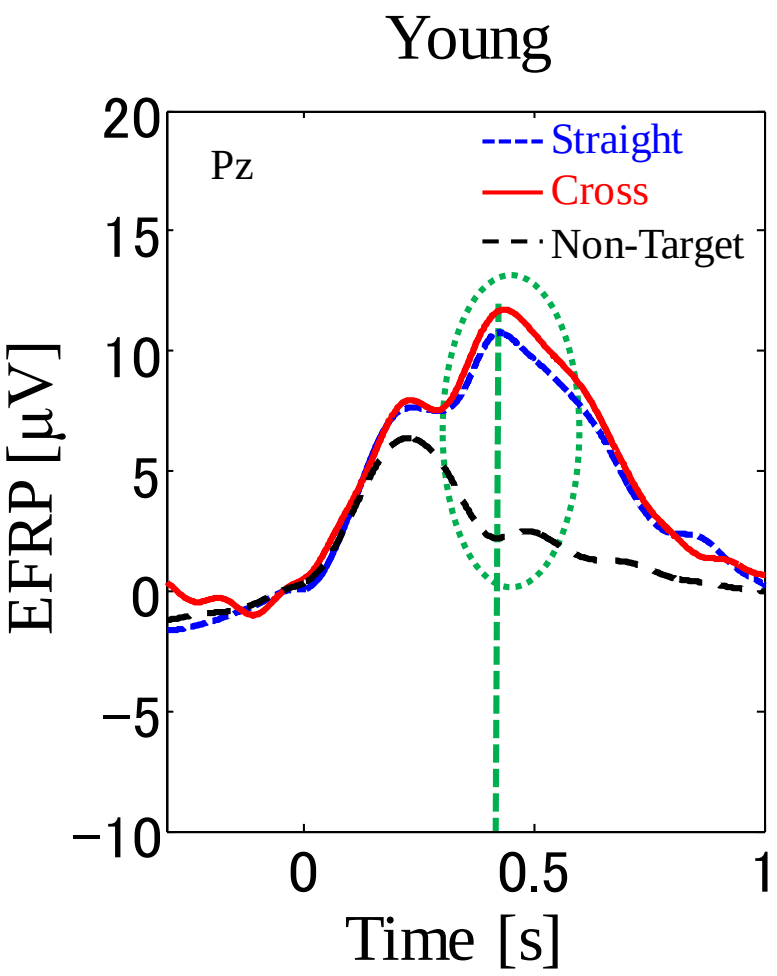
Results

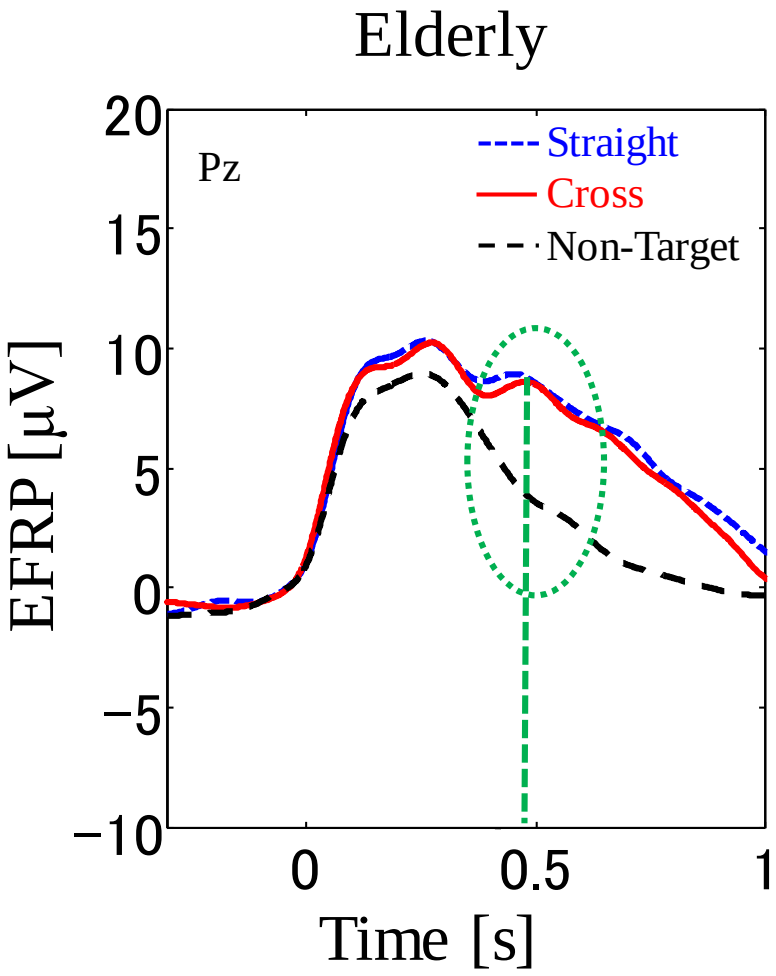
✓Eye fixation latencies



Results

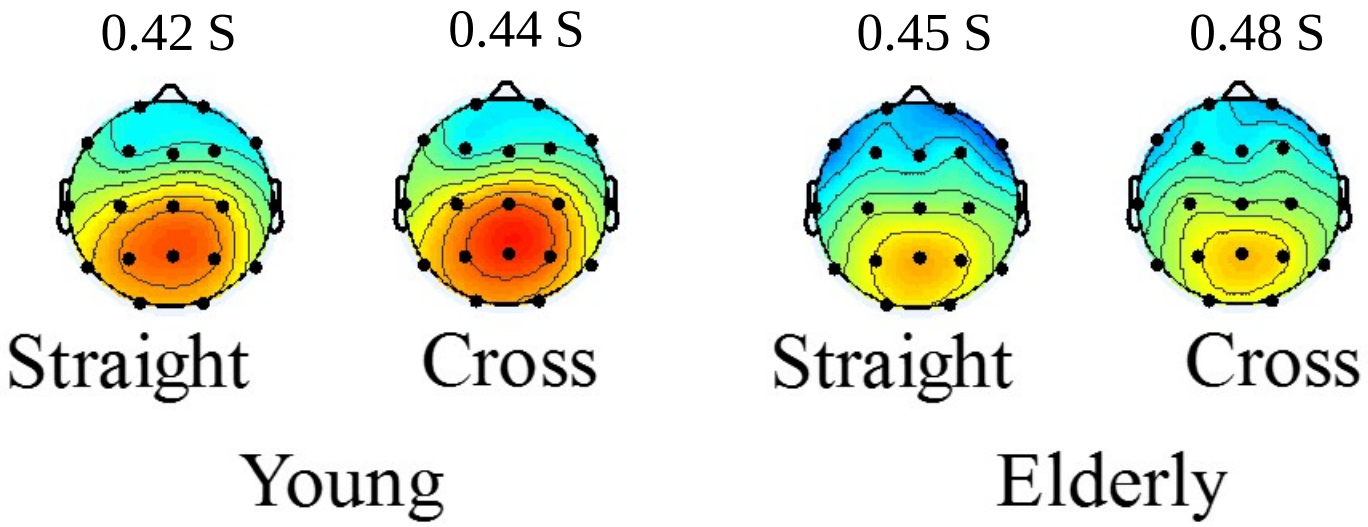
✓EFRP: grand mean





Results

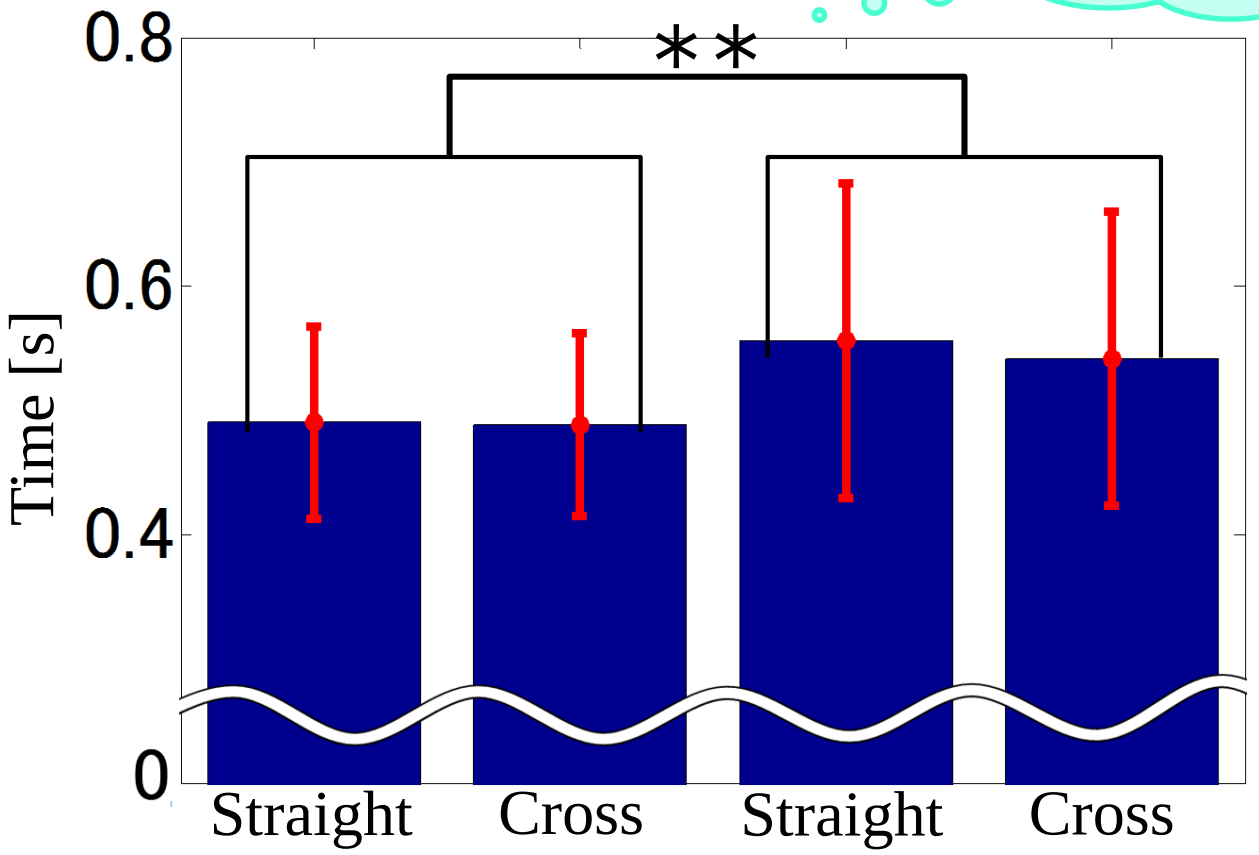
✓EFRP: scarp distribution



Results

✓EFRP latencies

Aging effect



Young Elderly **＜0.01

Conclusions

- ✓ Aging effects were confirmed in
  - eye fixation latencies
  - P3 latencies of EFRP
  - reaction times
- ✓ Large individual differenced were found in these indices
- ✓ Cognitive process may be assessed divided into three phases;
  - detection
  - judgement
  - operation
- ✓ The assessment method for individual person should be studied in the future work

Acknowledgements

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