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Driving Behavior and Characteristics of Eye Movements during Inattentive Driving

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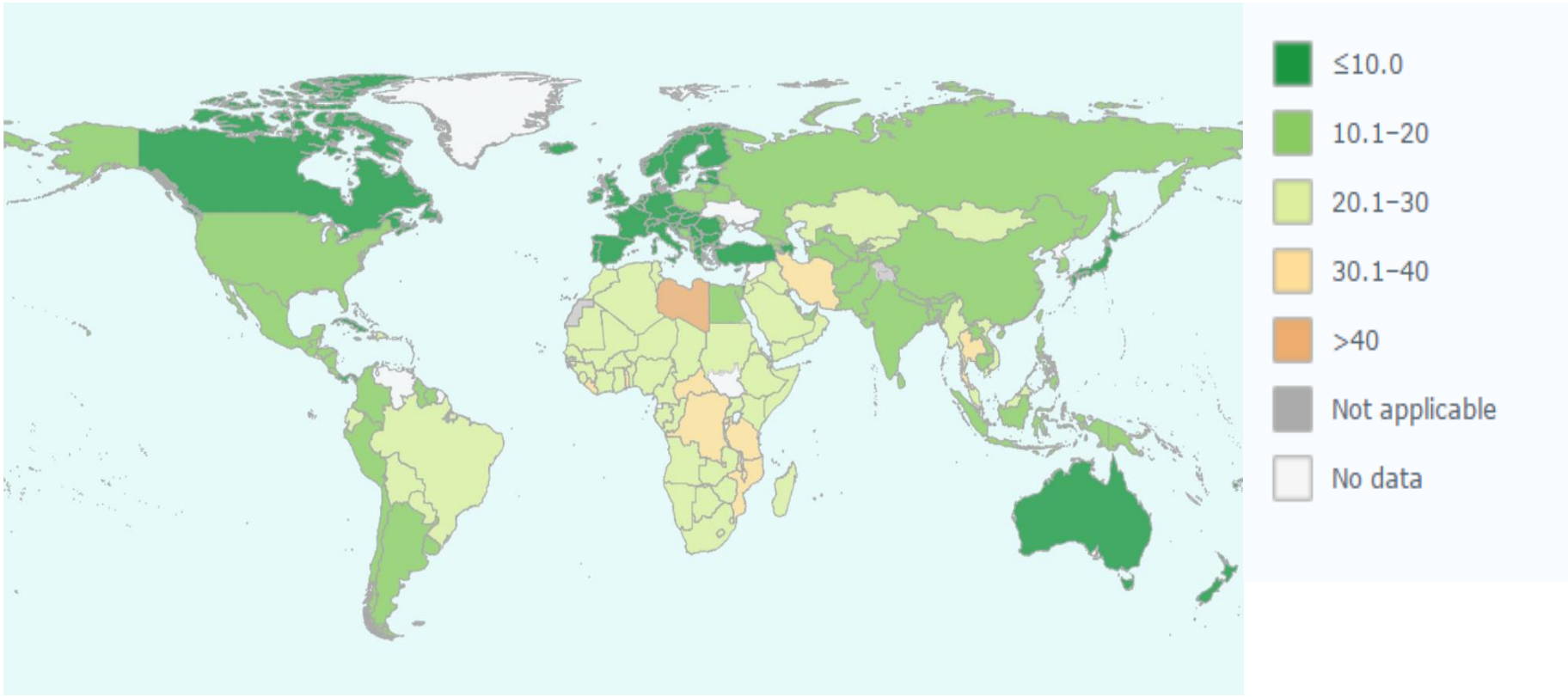
Contents

Introduction

Introduction

- Estimated road traffic death rate (per 100 000 population), 2013

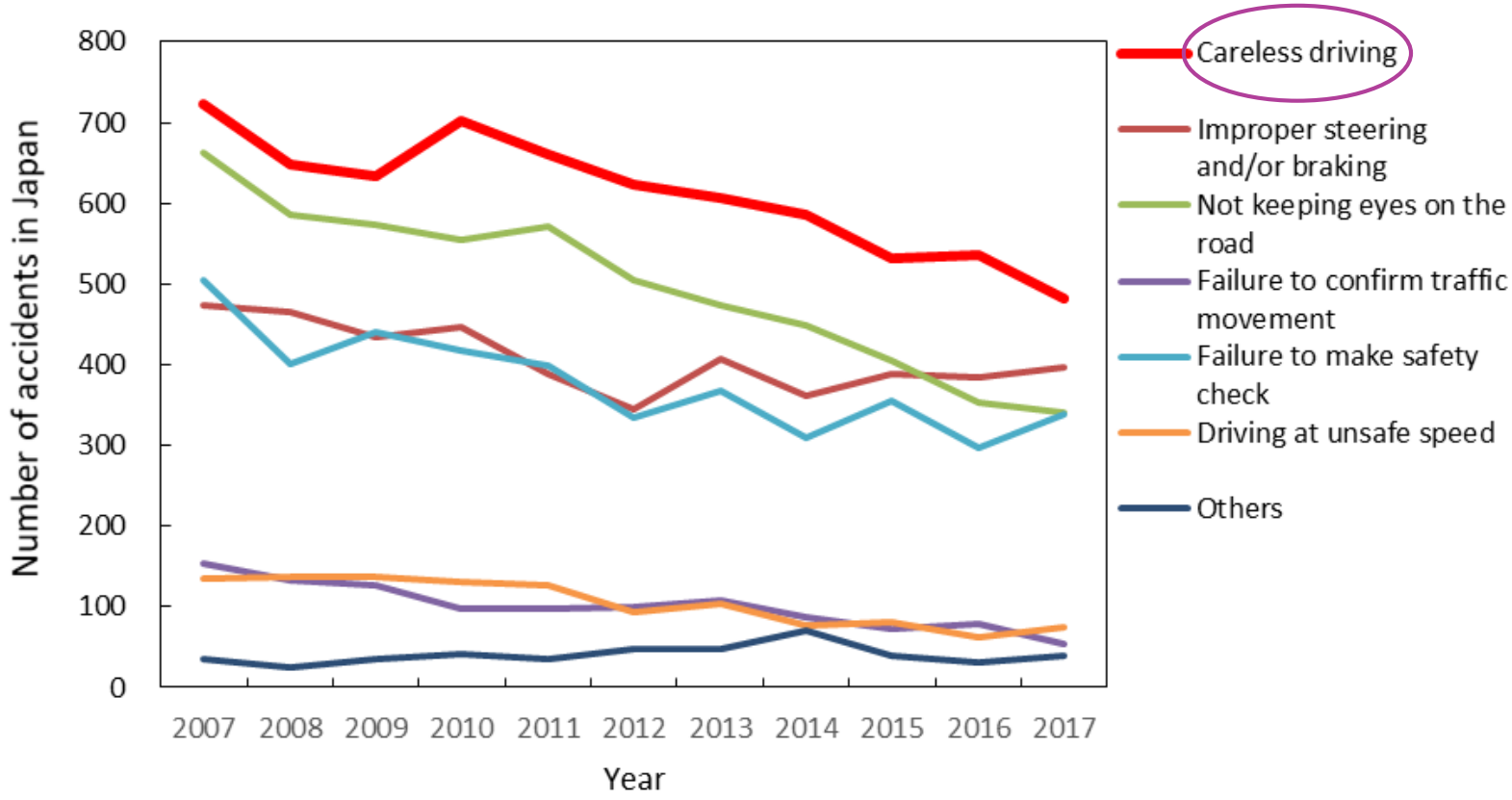


http://gamapserver.who.int/gho/interactive_charts/road_safety/road_traffic_deaths2/atlas.html

Introduction

- Annual fatal accidents by types of violation involving primary parties

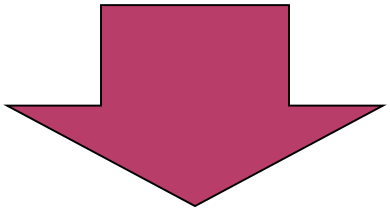
  (by the end of November every year)



Inattentive driving:
think about something or be dazed in the process of driving.

Introduction

To reduce and to resolve all kinds of traffic problems, Intelligent Transport Systems (ITS) has become a mainstream of study field, especially to reduce the traffic accidents, which caused by inattentive driving (careless driving).



The following experiment assesses the influence of mental arithmetic and map recall on driver behavior when either a vehicle or a pedestrian suddenly appears in front of the vehicle.

For safety we used a driving simulator.

Experiment 1(with mental arithmetic)

- Purpose
- Method
- Results
- Conclusions

Purpose

In order to study the effects of inattentive driving, drivers were asked to do a mental calculation subtask during driving.

Then we measured:

Driving behaviors

- Reaction time of braking
- Frequency of rotating the steering wheel

Eye movements

- Fixation time frequency distribution[s]
- Traveling speed frequency distribution[deg/s]
- Traveling direction frequent distribution[deg]

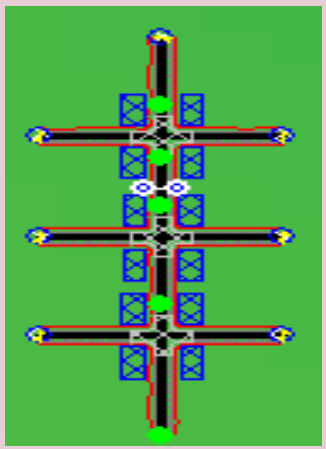
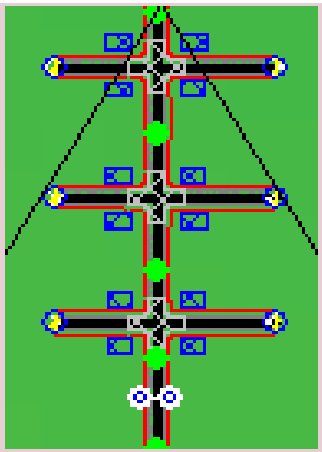
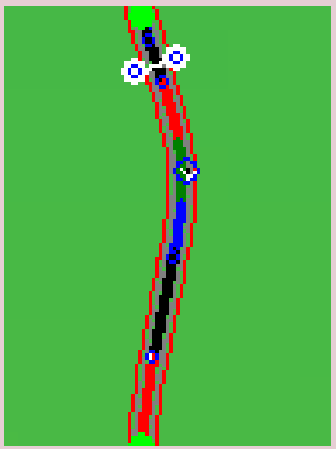
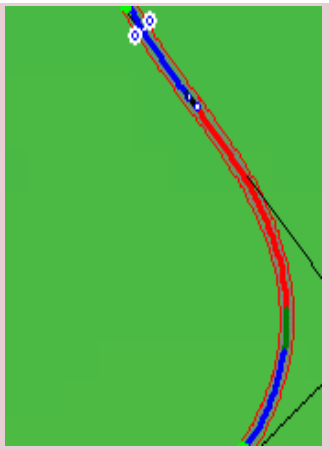
Method

Participants

14 participants (10men, 4 women. 22-29 years old)

Each participant held a valid driver's license

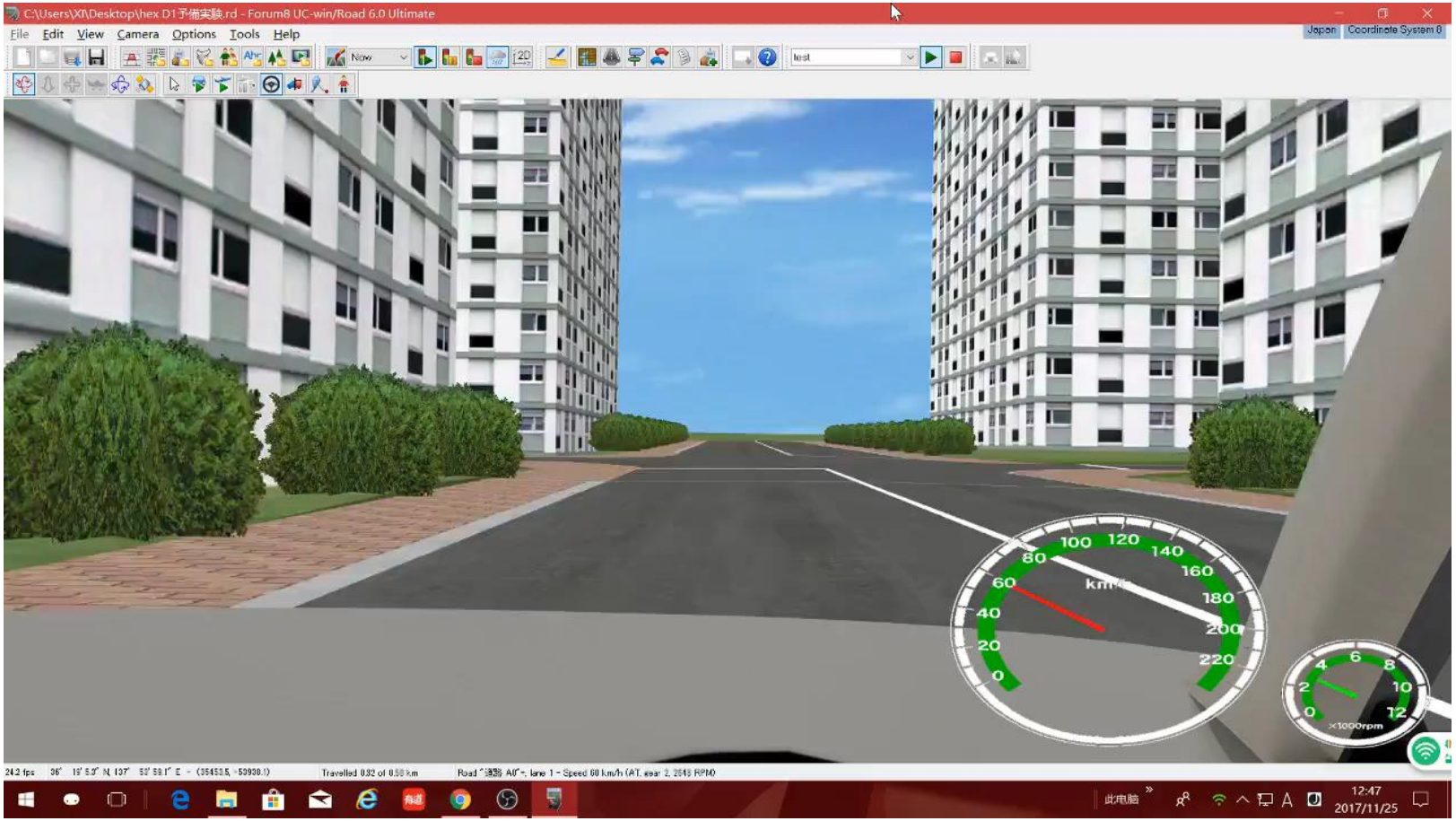
Design

Road	A	D	B	C
Image				
Length	500m	500m	500m	1,000m
Event	Car Pedestrian	Car	Pedestrian	Pedestrian

Method

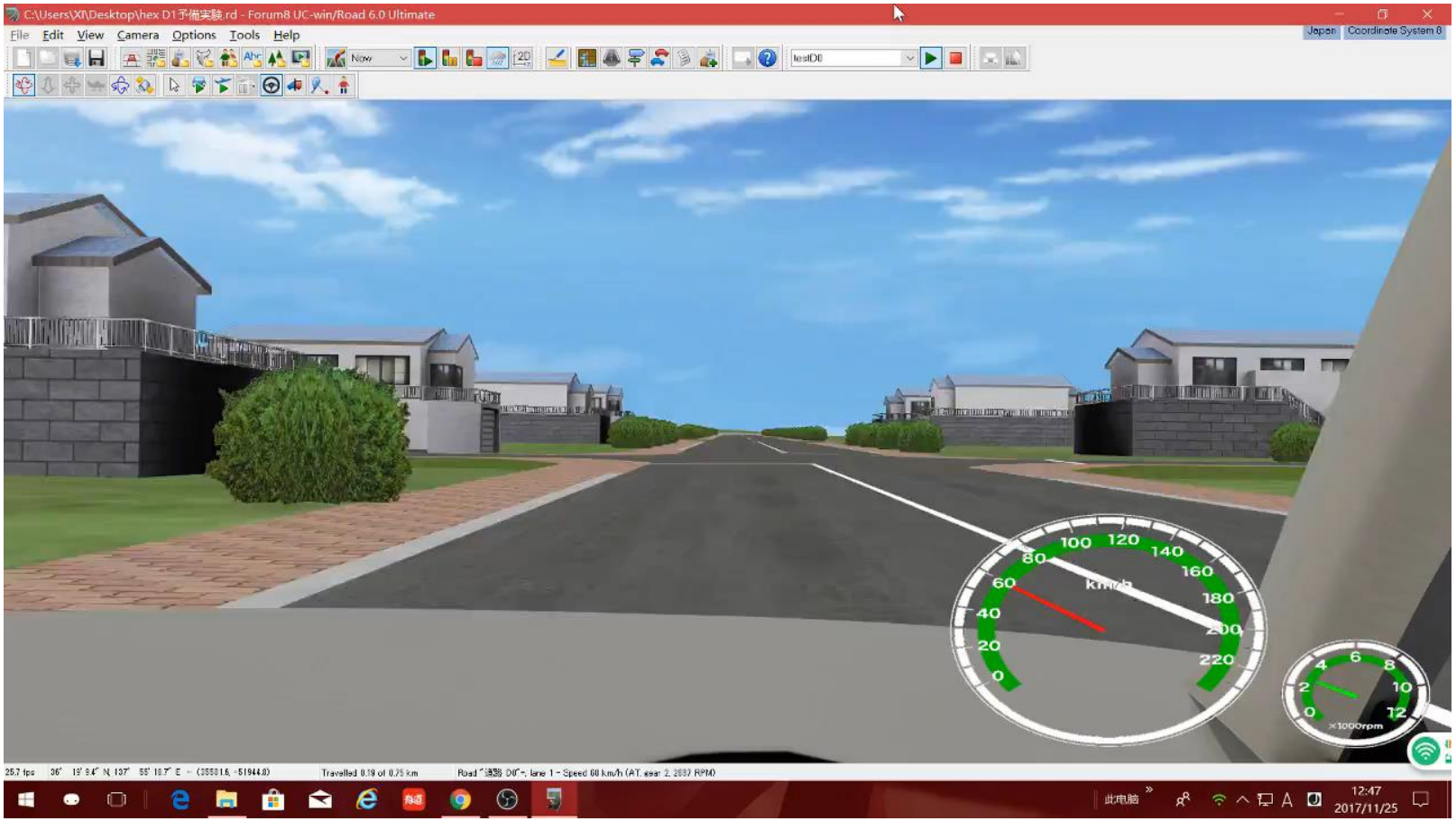
- Videos

  Sudden car appearance at road A



Method

Sudden car appearance at road D



Method

Sudden appearance of pedestrian at road A

Method

Procedure

Instructions → Apply EMR → Practice

1. A→B→C	With subtask
2. B→D→A→D	Without…
3. C→A→B	With…
4. D→C→A	Without…
5. A→D→B→D	With…
6. B→A→B→D	Without…

7. A→B→C	Without subtask
8. B→D→A→D	With…
9. C→A→B	Without…
10. D→C→A	With…
11. A→D→B→D	Without…
12. B→A→B→D	With…

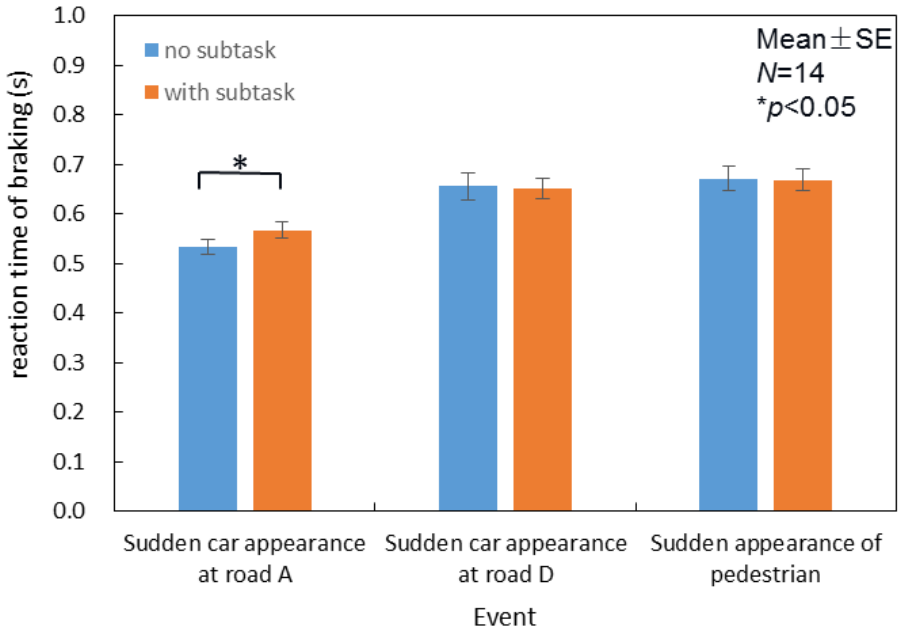
End

Main task: drive at up 60km/h and run all road combinations

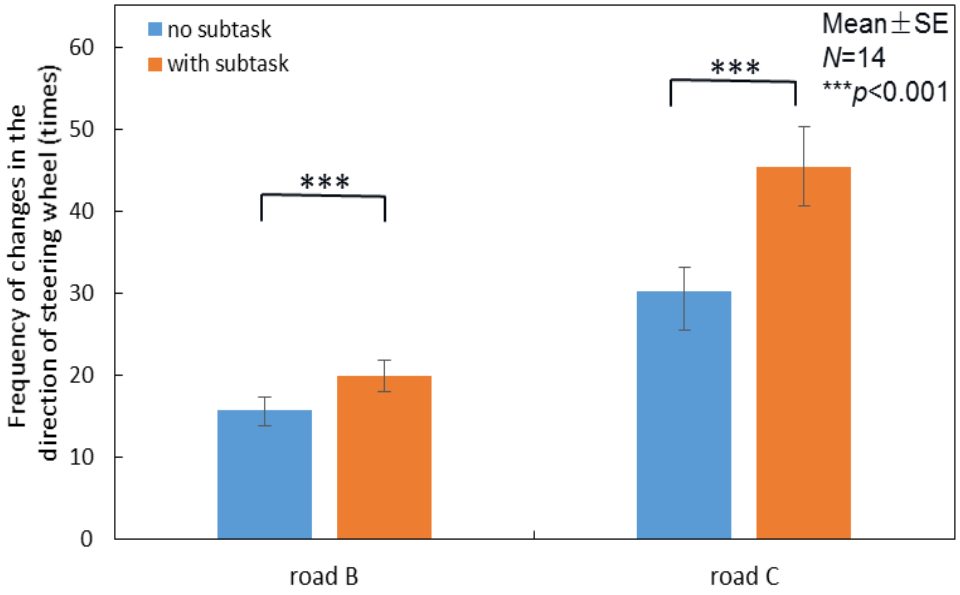
Subtask: mental arithmetic

Results (Driving behavior)

Reaction time of braking

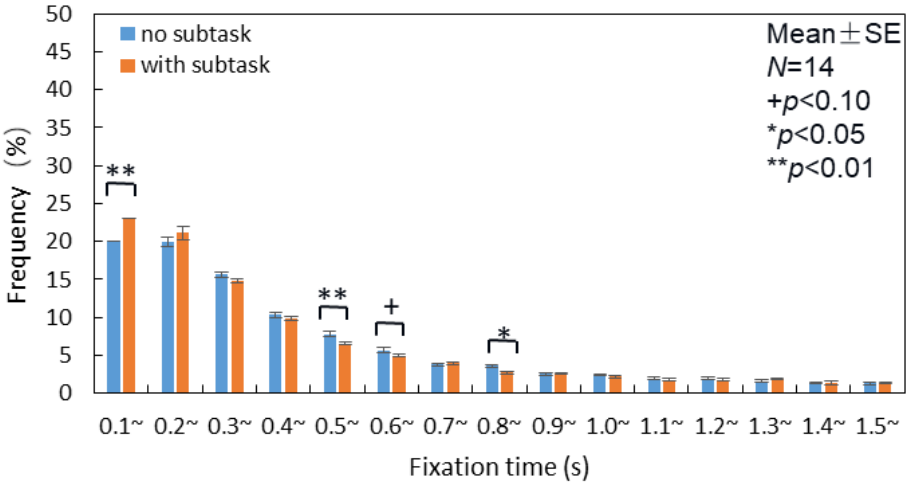


Frequency of rotating the steering wheel

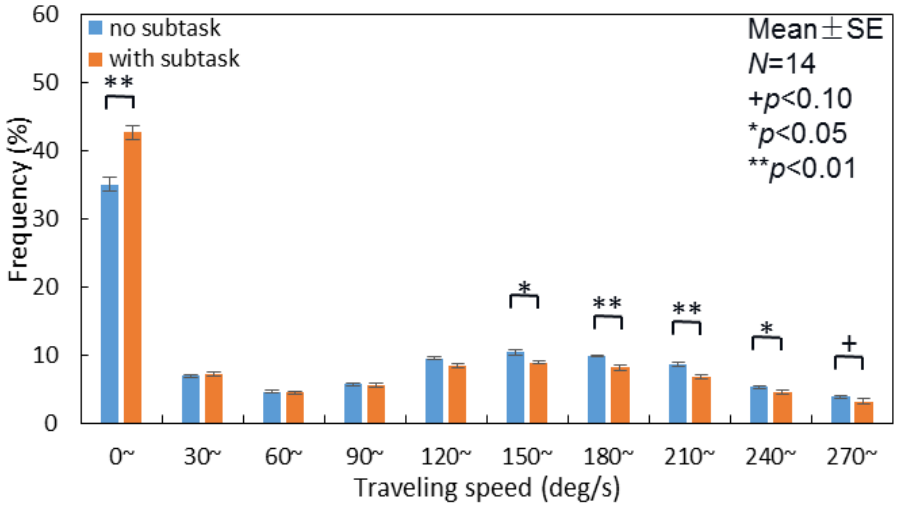


Results (Eye movements)

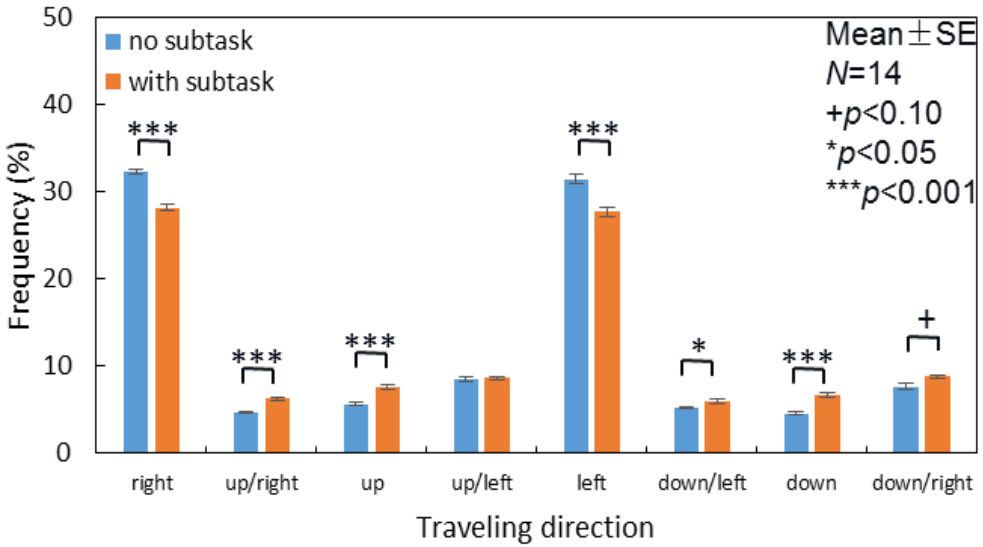
Fixation time frequency distribution



Traveling speed frequency distribution



Traveling direction frequency distribution



Conclusions

- Driving behavior
  - longer reaction time of braking (road A)
  - more steering wheel rotations on curved roads
- Characteristics of eye movement
  - shorter fixation time
  - slower angular speed of the eyeballs
  - lower frequency of the focal point in left and right directions
  - higher frequency of the focal point in up and down directions

Experiment 2（with map memorization）

- Purpose
- Method
- Results
- Conclusions

Purpose

Drivers will often recall something when doing inattentive driving. During recall, an image might appear in a person's mind. To ascertain the manner by which and the degree to which this process affects drivers, designed an experiment of map memorization to simulate a recall process during driving.

Then we measured:

Driving behaviors

- Reaction time of braking
- Frequency of rotating the steering wheel

Eye movements

- Fixation time frequency distribution[s]
- Traveling speed frequency distribution[deg/s]
- Traveling direction frequent distribution[deg]

Method

- Participants

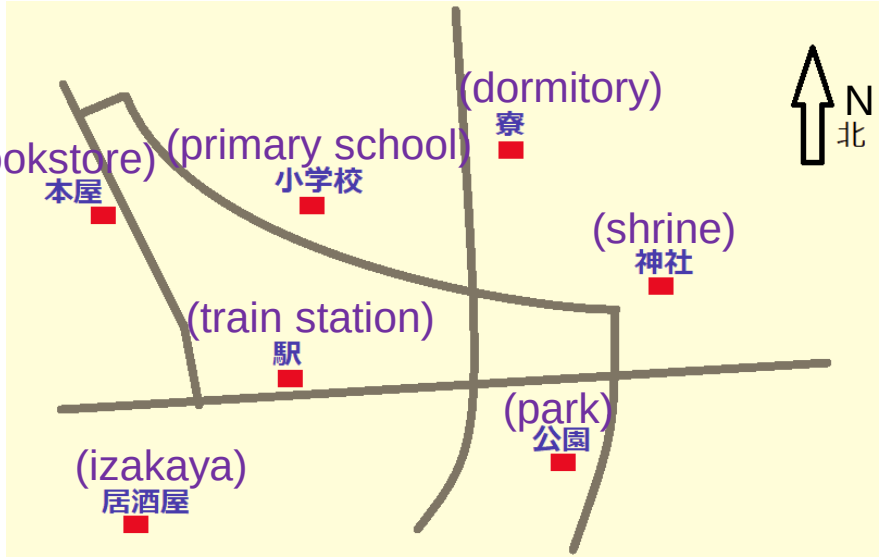
  14 participants(10men, 4 women. 22-29 years old)

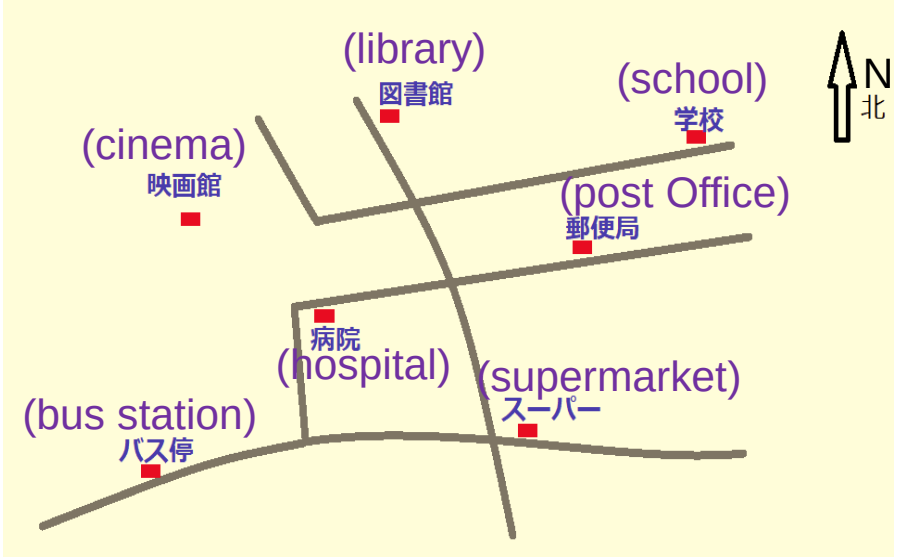
  Each participant held a valid driver's license

- Design

  Subtask: map memorization

  For example





Method

Procedure

Instructions → Apply EMR → Practice

1. A→B→C	With subtask
2. B→D→A→D	Without…
3. C→A→B	With…
4. D→C→A	Without…
5. A→D→B→D	With…
6. B→A→B→D	Without…

7. A→B→C	Without subtask
8. B→D→A→D	With…
9. C→A→B	Without…
10. D→C→A	With…
11. A→D→B→D	Without…
12. B→A→B→D	With…

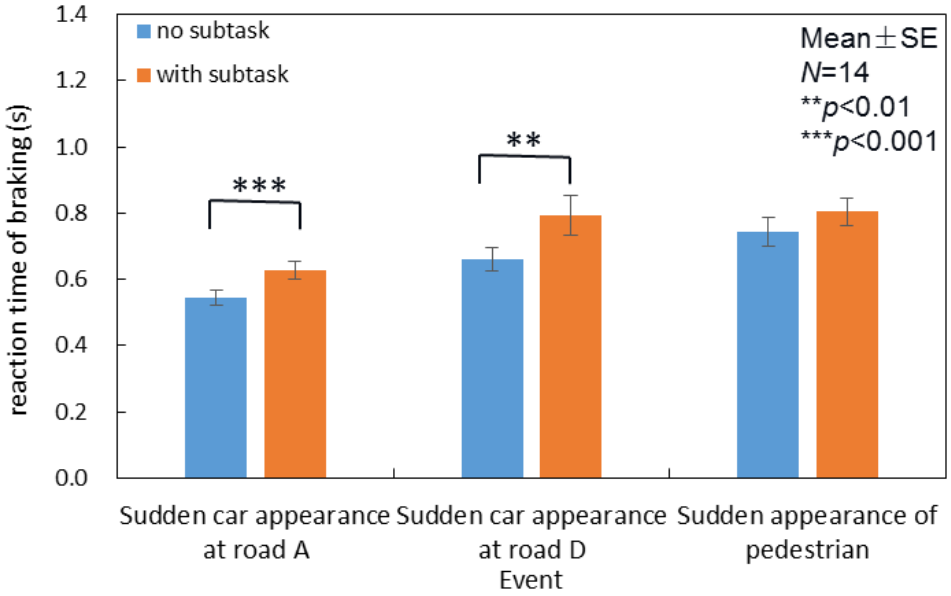
End

Main task: drive at up 60km/h and run all road combinations

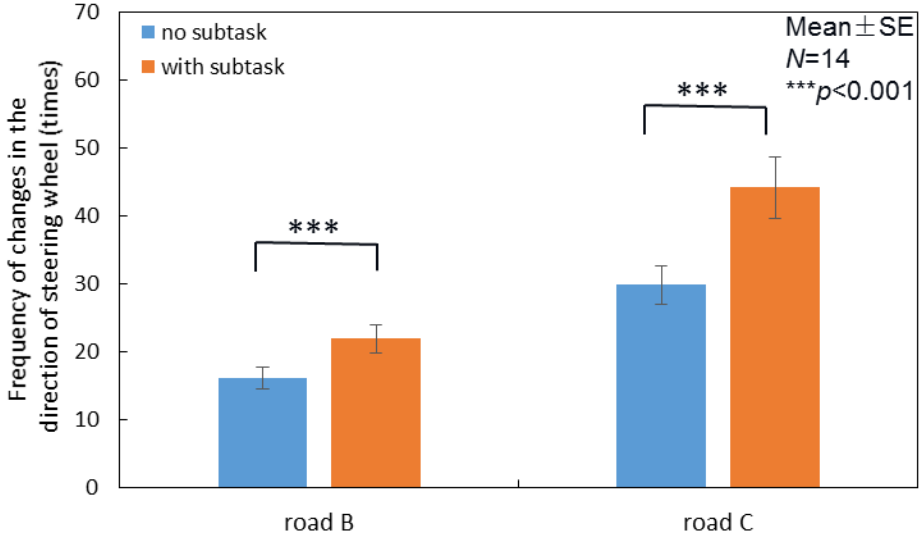
Subtask: map memorization

Results (Driving behavior)

Reaction time of braking

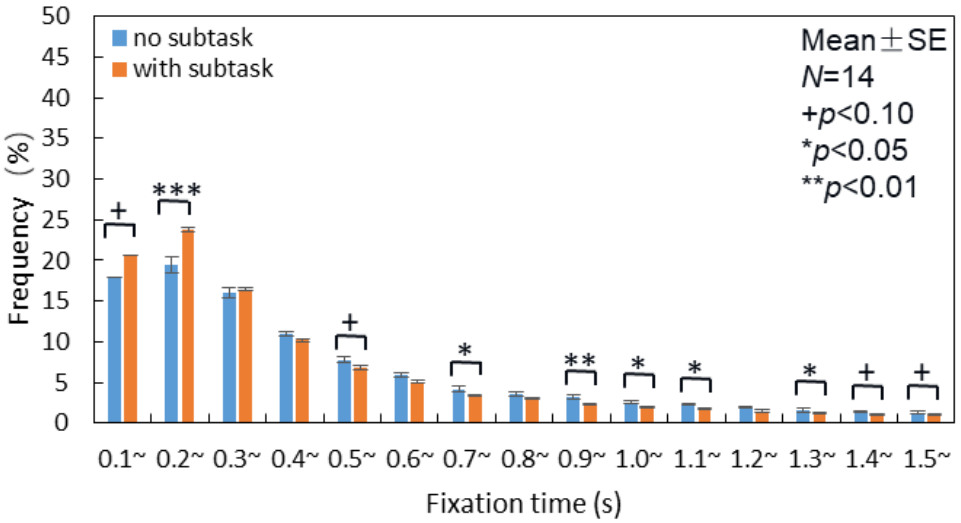


Frequency of rotating the steering wheel

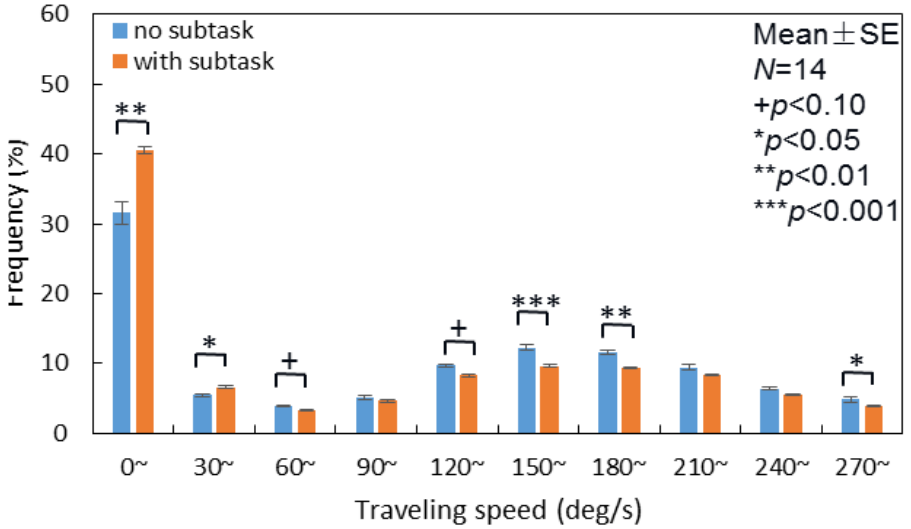


Results (Eye movements)

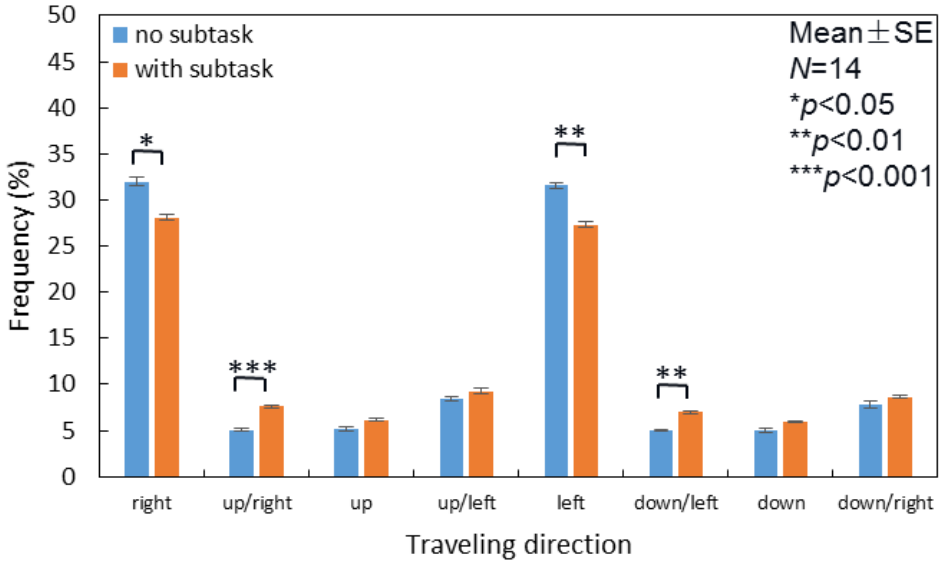
Fixation time frequency distribution



Traveling speed frequency distribution



Traveling direction frequency distribution



Conclusions

- Driving behavior

  longer reaction time of braking

  more steering wheel rotations on curved roads

- Characteristics of eye movement

  shorter fixation time

  slower angular speed of the eyeballs

  lower frequency of the focal point in left and right directions

  higher frequency of the focal point in up and down directions

General discussion

General discussion

- Driving behavior

Reaction time of braking

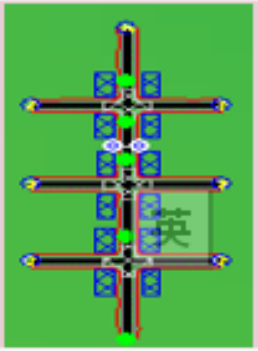
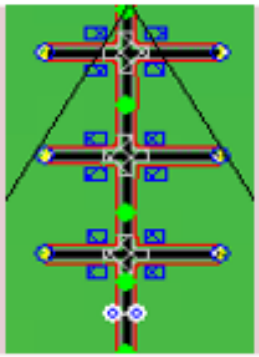
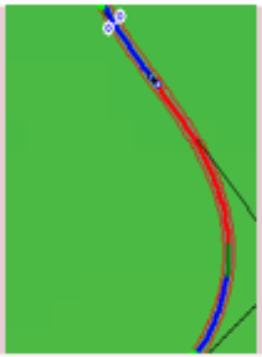
Sudden car appearance at road A: longer (Mental arithmetic and Map memorization)

Sudden car appearance at road D: longer (only Map memorization)

Sudden appearance of pedestrian: no difference

Frequency of rotating the steering wheel

At road B and C: more (Mental arithmetic and Map memorization)

Road	A	D	B	C
Image				

The effect of map memorization is stronger than mental arithmetic.

Different kinds of subtask will influent driving behavior with different extent.

General discussion

- Characteristics of eye movement

Fixation time: shorter (Mental arithmetic and Map memorization)

Traveling speed: slower (Mental arithmetic and Map memorization)

Traveling direction

In the left and right direction: lower frequency

(Mental arithmetic and Map memorization ）

In the up and down direction: higher frequency

(Mental arithmetic and Map memorization)

The shorter fixation time indicates more mental stress.

The less horizontal eye movements and slower eye movement speed will increase the danger of driving.

General discussion

This study investigated the influence of mental arithmetic and map recall on driving performance and eye movements.

Find evaluation indicators

Test evaluation indicators

Detect inattentive driving

Thank for your kind attention!

Q&A

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