

CHAPTER III

METHODS

Participants

Thirty-four healthy participants, aged 22-40 years, were recruited for the study.

Inclusion criteria:

- Owning a driver license
- Has at least 1 year of driving experience
- Has normal or correct to normal vision
- Owning a cellular phone

Exclusion criteria

- Hearing, cognitive, and communication impairment
- Chronic smoker
- Has alcohol or caffeine intake at least 2 hours before testing
- Use of medication that may cause drowsiness at least 4 hours before testing

Equipments

1. Subject's data collection form
2. Computer with CPU and monitor
3. LCD projector (SONY VPL-CX75 LCD Projector)
4. Car driving accessories (steering wheel, accelerator pedal, brake pedal)
5. Car simulator software (AMS-CMU 2006)
6. Cellular phone with hand free phone
7. Holter monitor (Philips Zymed DigiTrak-Plus Holter) with EKG electrodes
8. Mini logger data (Mini logger series 2000)
9. Digital blood pressure meter (Terumo electronic sphygmomanometer)

Independent and dependent variables

The independent variables were three phone conversation conditions; 1) no phone conversation condition, 2) simple phone conversation condition, and 3) working memory conversation condition. The dependent variables were driving performance (brake reaction time, number of lane crosses, and number of object crashes) and physiological changes (heart rate, skin temperature, and HRV)

AMS-CMU 2006 Driving simulation software program

The program was designed to mimic a daily driving situation where there were both light and heavy traffic, simple and demanding road situation. The driving simulation program was designed for a 15 minute-driving duration. The development processes were as followed:

November 10, 2005: Contacted a programmer, gave a detailed description of the driving simulation program.

January 13, 2006: Received simulation V.1. The program was tested and the following limitations were identified:

- The environment sound was not surrounding.
- Numbers of buildings in the urban section were not enough.
- Road surface between the urban and country area was too similar.
- Driving time was too long (20 instead of 15 minutes).
- Raw data could not be exported to an excel file.
- Objects movement in the scene (human and dog) were not smooth.

February 12, 2006: Received program V.2, in which the above limitations were solved. The program was tested and the following limitations were identified:

- The driving time was still too long (16.30 minutes).

- Road surface in the country area caused strong vibration on joy stick.
- Data for lane crosses did not separate left lane from right lane.

May 1, 2006: Received program V.3, in which the above limitations were solved. In this version, a feature of not counting lane cross that was resulted from object avoidance was added to the program. The simulation program V.3 was completed and ready for use in the study. Table 4 shows the AMS-CMU 2006's driving description detail.

Table 4 AMS-CMU 2006's driving description detail

Driving time (minute)	0-4	5-11	12-15
Road width (meter)	3.7	3.3	3.7
Road surface type	Smooth	Rough	Smooth
Number of sharp curve	7	10	7
Left	4	5	4
Right	3	5	3
Number of easy curve	2	4	2
Left	1	2	1
Right	1	2	1
Number of oncoming car/15 sec	1	2	1
Number of objects appeared on the display	7	7	6

Experimental setup

Testing took place in a quiet testing room. Participants were asked to sit in a chair that was fixed. The height of the chair, the position of the steering wheel, brake and accelerator pedal was adjusted to fit with each participant. A hand free cellular

phone was used in this study. Prior to data collection, the speaker volume was adjusted until the participants can hear clearly.

Procedures

Participants who met the inclusion criteria and agreed to participate signed an informed consent. Each participant answered the questions in the information sheet. The researcher explained the procedure of the testing. Participants were instructed in how to use the steering wheel, accelerator pedal, and break pedal. All participants had a 10-minute driving practice with a different driving situation from the testing situation in order to be familiar with the equipment. There were a total of 3 testing conditions, driving while engaging: 1) simple phone conversation, 2) working memory phone conversation, and 3) no phone conversation. To eliminate learning effect, each condition was tested one week apart and the order of the phone conversation condition was random. Mini logger data was attached to the participant's forehead in order to monitor skin temperature. The heart rate monitor band and 5 EKG electrodes were attached on the participant's chest in order to monitor heart rate and collect heart rate variability data. During data collection, participants were instructed to:

- 1) Keep the driving speed at 65 ± 5 kilometers per hour
- 2) Maintain the car within the driving lane
- 3) Avoid an accident caused by any object that may appear on the road
- 4) Press the brake pedal in response to the red light sign as quickly as possible
- 5) Answer the phone when it rings
- 6) Talk to the person on the phone

- 7) Hang up the phone when finishing the conversation

Data Analysis

All variables representing driving performance (brake reaction time, number of lane crosses, numbers of object crashes) were measured through the computer simulation program. Brake reaction time was defined as the time from the appearance of the red light to the depression of the brake pedal. Lane maintenance was the number when the right and left wheels were on or outside the lane line (lane crosses). For the physiological variables, skin temperature was collected every minute through the Minilogger data. Heart rate and heart rate variabilities (both time domain and frequency domain) were collected by Holter monitor.

Statistical Analysis

Repeated measures analysis of variance (ANOVA) was used to compare the difference of each dependent variable among the three testing conditions.

A post hoc analysis was conducted to determine the location of the difference between the testing conditions. SPSS software program (version 10.0) was used for statistical analysis. The significant level in all tests was set at $p\text{-value} < 0.05$.