The Measurement of biomedical reaction of the VR motion sickness in elderly subjects

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***Abstract*—We evaluated effects on the biomedical reactions relating to VR motion sickness using VR (virtual reality) scene of amusement ride for the elderly subjects. By applying psychomotor vigilance test (PVT) before and after use of VR material, score of PVT were improved after the use of VR. By this result, elderly subjects may have weaker VR motion sickness. And concentration might be improved by activation of sympathetic nerve.**

***Contribution*—This research examined biomedical reactions of elderly subjects for VR(virtual reality) motion sickness under VR gaming of amusement park ride.**

Keywords— virtual reality; VR motion sickness; psychomotor vigilance test(PVT), pedal selective PVT(PS-PVT)

I. INTRODUCTION

VR (Virtual Reality) is rapidly increase popularity in the entertainment especially for the young generation. The use in training tool for the elderly patients and their helpers is also increasing[1,2]. While the motion sickness is actively investigated[3,4], it is mainly for the younger or middle age subjects and very few for the elder subjects. In this report, we will report on the investigation of biomedical reaction of the VR motion sickness in elderly subjects.

II. EXPERIMENTAL METHOD

A. Subjects for experiment

Subjects are 8 elder people age 75±7 including four females. Bare eyes sights are Right: 0.6±0.3, Left: 0.4±0.2. We informed purpose and objective to subjects of and confirmed their agreement. This research is also verified by ethical verification by Graduate School of Design and Architecture, Nagoya City University(No.31-6).

B. Evaluation method

We measured electrocardiogram and ear drum temperature. We used the measurement tool named “Kiritsu Meijin” by Crosswell corporation in Japan. For measurement of eardrum temperature, eardrum temperature meter (BL100, Techno Next Co., Ltd) was used. Probe (2.5mm) was inserted to the ear canal and eardrum temperature was measured.

C. VR content for the stimulation

The authors consider that strong visual stimulus is required to occur VR sickness in the elderly. For the stimulation, VR amusement rides, gaming software for the PlayStation4 gaming console, “Roller coaster drams, Binbou Software)” was used. Three different content, Roller coaster, swing ride and rotating cart were used.

D. Experimental protocol

Prior to the measurement session, to evaluate behavioral awakens, we requested subjects to work on psychomotor vigilance test (PVT)[5] and pedal selective PVT (PS-PVT)[6]. Finger reaction time is measured by PVT and leg reaction time is measured by PS-PVT. In PVT, the subject clicks the mouse at the moment when the number suddenly appears on the screen. The elapsed time of mouse click is displayed on the screen of PVT. In PS-PVT, when the screen displays red, press the right pedal, and when blue is displayed, press the left pedal(Figure 1). The test time for PVT and PS-PVT are 5 minutes and 6 minutes. Then subjects are requested to ware PlayStation VR headsets, rested three minutes, then were asked to run on through same virtual amusement rides (stimulus) three times which is 3 minutes and 30 seconds. During VR amusement rides, subject was instructed to close eyes when they was unable to tolerate a strong sickness. After another three minutes of resting, requested to answer simulator sickness questionnaire (SSQ). At the end, subjects were

requested to PVT and PS-PVT and this is completion of the one round of test.

After least 30 minutes washout period, second round of test with PVT, PS-PVT virtual amusement rides can start. The orders of rides (stimuluses) were chosen to counterbalance among the subjects. And stimuluses were given without audio. Subjects performed these experiments in a sitting position. Table 1 shows the experimental protocol.

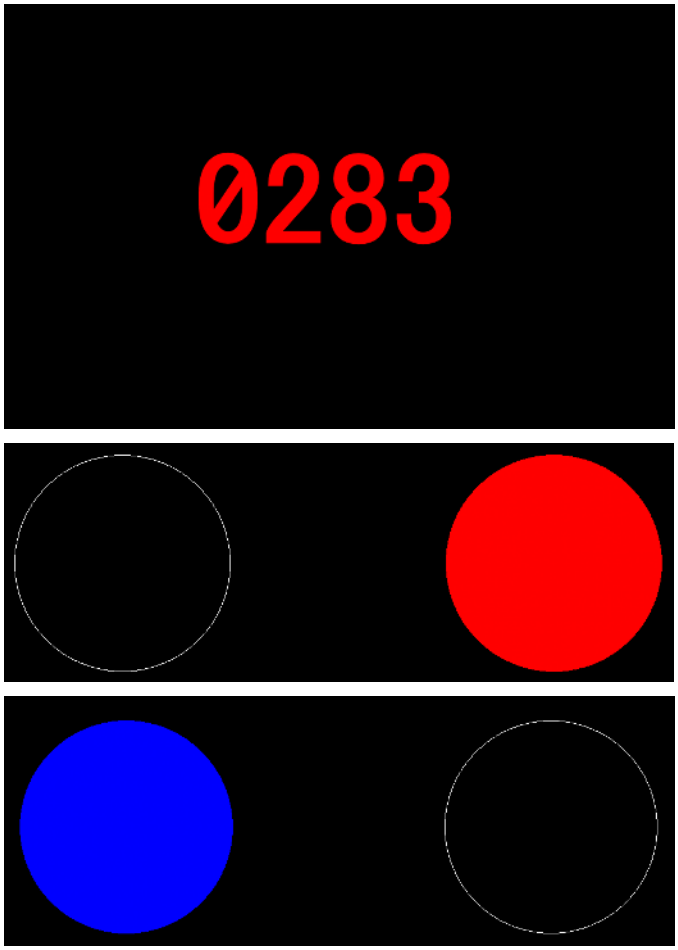

Figure 1 PVT and PS-PVT.

Upper:PVT, Middle and Lower:PS-PVT

Table1 Experiment protocol.

Events	PVT	PS-PVT	Rest	VR	SSQ	Rest	PVT	PS-PVT
Time[min]	5	6	5	3.5	1	5	5	6

III. Analysis

“ Nausea(N), Oculomotor(O), Disorientation(D) and Total Scores (TS)” were calculated by SSQ. Response time (RT,ms) evaluated using PVT and minor laps (ML,%) calculated as the frequency of RT over 500ms were calculated. RT evaluated using PS-PVT and frequency of false response(FFR,%) were calculated. We calculated one dimensional analysis of variance for placement for three group of virtual amusement rides. To check significance test of RT ML and FFR before and after VR, we executed paired t-test. And adopted $P<0.05$ as criterion for the significance.

IV. Result of Experiments

Figure 2 is result of one-dimensional deviation analysis of SSQ for the virtual amusement rides. While any of four indexes did not show significant difference however, Nausea showed some trends. Figure 3 is change of PVT and PS-PVT index before and after virtual amusement ride. As the results of PVT, RT of swing ride became significantly smaller after the use of VR($p=0.023$). Both ML after roller coaster and ML after swing ride tended to be smaller after use of VR amusement rides. As the results of PS-PVT, RT of rotating cart became significantly smaller after the use of VR($p=0.034$). Both FFR after roller coaster and FFR after rotating cart became smaller after use of VR amusement rides.

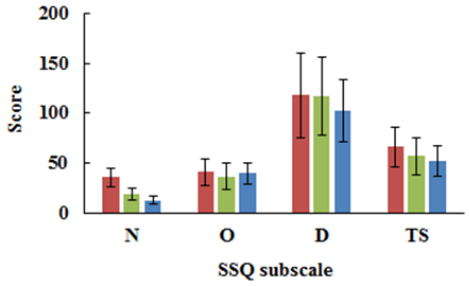

Figure 2 One-way ANOVA for SSQ for amusement ride ■: roller coaster, ■: swing ride, ■: rotating cart N(P=0.084), O(P=0.964), D(P=0.948), TS(P=0.857), Mean ± S.E

V. Discussions

When elderly subjects used VR amusement rides, weak Nauseous was caused by the strong disorientation and motion. When authors executed same evaluation in the previous report, to evaluate younger subjects, Disorientation for the younger subjects was three times over the average value for elderly subjects[7]. This result suggests that elder subjects has weaker VR motion sickness compared to younger subjects. And when VR motion sickness happened, sympathetic nervous system is activated[8-10]. Attention level of sympathetic nervous system is activated in case of VR amusement ride and score for PVT is improved, because VR motion sickness is smaller than younger subjects. From the results of SSQ, the intensity of sickness was roller coaster, swing ride and rotating cart in that order. In the PVT, The performance after roller coaster and swing ride was improved than after rotating car. On the other hand, after rotating car improved the performance in the PS-PVT. These results suggest that the finger reaction and the foot reaction were improved depending on the intensity of VR sickness in elderly .

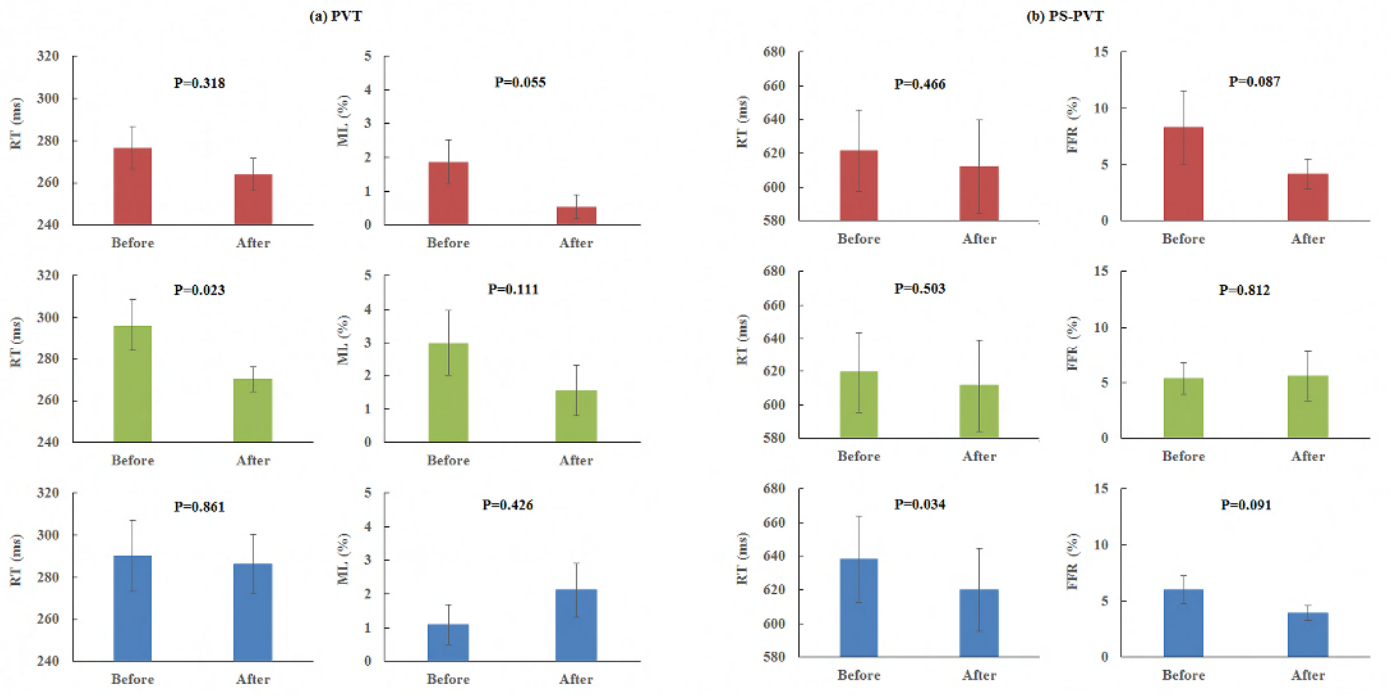

Figure 3 Changes in PVT and PS-PVT indices before and after attractions.
■: roller coaster, ■: swing ride, ■: rotating cart, Mean±S.E
(a) PVT indices are Response time (RT, ms) and minor laps (ML,%)
(b) PS-PVT indices are RT and frequency of false response(FFR,%)

VI. Conclusion

In this report, we are only evaluating SSQ and PVT. However, we also have record of electrocardiograph. We are planning to proceed heart rate variability analysis from electrocardiograph and analysis of eardrum temperature using ear drum thermo prove.

Acknowledgement

Authors would like to thank Prof. Kiyoko Yokoyama of Nagoya City University for her great support for the experiments.

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