Psychological Effect of Telescope Virtual Screens using VR Headset

Masahiro Yamaguchi
Graduate School of Information Science and Technology Hokkaido University
Sapporo, Japan
from2001@eis.hokudai.ac.jp

Masayo Matsumura
BiPSEE Inc.,
Tokyo, Japan
bipsee.vr@gmail.com

Hikari Shimada
Medical Corporation Iryouhoujin Koukeikai
Osaka, Japan
contact@koukeikai.net

Kenji Araki
Graduate School of Information Science and Technology Hokkaido University
Sapporo, Japan
araki@ist.hokudai.ac.jp

***Abstract*— We carried out a psychological experiment using Virtua Reality Head Mount Display (VR-HMD) with small FOV (Field of view) camera and a screen in virtual environment, telescope virtual screen, to analyze the change of subjects' pain tolerance. We manipulate FOV of the virtual camera in VR to change the view of contents. Decreasing FOV makes view of angle narrow, therefore the view in VR looks similar to the one using telephoto lens, in which environment the view greatly moves with even small camera movement. With smaller value of FOV for a virtual camera, the view in VR is more sensitive to VR-HMD movement and requires subjects to keep concentrating not to move their heads to watch target properly. Hand immersion into cold water is a standard test for pain tolerance evaluation and is known as the cold pressor test. Cold pressor test with the VR-HMD shows that pain tolerance was increased with telescope virtual screen environment. The result indicates that pain tolerance can be controlled with VR-HMD without meaningful contents. The contents independent pain management technique can potentially be used in various applications especially in medical field.**

Keywords—VR, Psychology, FOV, Tolerance, Cold pressor test

I. Introduction

Virtua Reality Head Mount Display (VR-HMD) is getting widely used in various fields because of low cost and high quality devices recently. As more people use VR-HMDs for long period of time, psychological impacts are considered as one of important factor for healthy growth of VR industry.

Side effects of VR such as nausea, oculomotor and disorientation symptoms are one of concerns for long period of usage of VR. Sarah S et al. shows induced more symptoms and effects comparing to other displaying devices such as desktop, projection and theatre screen [1].

On the other side, the psychological effect of VR is widely studied for a usage of pain management. Hunter G et al. applied VR as analgesic for burn injured patients to reduce procedural pain. Interactive immersive VR contents was used and reported 35–50% reductions in procedural pain [2]. Hunter G et al. also studied the effectiveness of VR for dental pain [3]. The logic of pain reduction was discussed that humans have limited attentional capacity and patients have less attention available to process incoming signals from pain receptors while in VR. Previous studies show that VR works as an efficient anxiety and pain management tool to patients. However, the result of the effectiveness may depend on contents. VR contents related to snow significantly works for burn injured patient as a pain reduction tool [4].

We developed virtual screens in FOV manipulated virtual environment with VR-HMD and evaluate emotional response with different FOV values in our previous study. Evaluation test with the screens in small FOV environment, telescope screens, shows emotional responses enhancement [5]. To find contents independent pain management technique, we carried out an experiment using the telescope screen with just makers displayed on it.

II. Background

We developed small FOV virtual environment with VR-HMD and used it to evaluate emotional responses in previous study. Seeing screen located in the virtual environment looks like viewing the screen with a telescope in real world. This small FOV telescope virtual environment requires much concentration to see contents on a screen because screens in the environment moves a lot even with small VR-HMD movement.

FOV manipulated environment with VR-HMD was used in our previous study, and emotional response was evaluated with displayed images on a screen in the virtual environment. Experiments in the previous study was carried out with International Affective Picture System (IAPS) [6] as emotional stimuli and Self-Assessment Manikin (SAM) [7] method.

Two types of virtual screen environments were used in the experiment. In the telescope type virtual screen environment, 8x6m screen was located at 1200m distance from subjects as shown in Table 1 and Fig 1.

Stronger emotional responses were observed with smaller value of FOV telescope environment. The result indicates the possibility of controlling effectiveness of contents with displaying software in VR.

Further experiment was carried out and, psychological effect of the telescope virtual screen environment was studied in this paper.

Table 1. Parameters of two virtual screen environments

Type	Screen size	FOV	Distance
Normal	8 x 6m	108°	4m
Telescope	8 x 6m	2°	1,200m

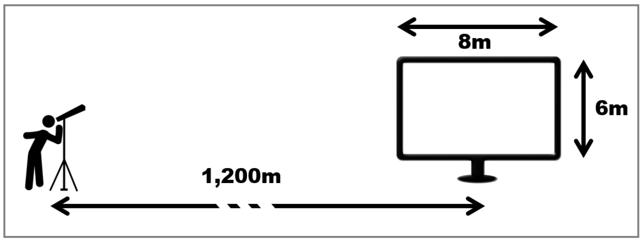

Fig. 1. Schematic drawing of the telescope virtual screen environment.

III. METHOD

A. HMD

Smartphone based HMD was built up with 5.8-inch smartphone and VR Headset (ELECOM P-VR1G01WH). The HMD is 20.3 x 19.3 x 11.8 cm size and 482g light weight including the smartphone. Subjects wear the HMD, and the HMD displays contents based on its gyroscope. The HMD is connected to a PC, which controls the contents of the HMD and records logs of the experiment. We used monocular lens goggles instead of binocular lens used for typical VR goggles since binocular lens VR-HMD is not recommended for people under 13 years old because of the risk of crossed eyes. This study is expected to be used for children as well as adult people.

B. Virtual Screen and FOV

FOV (Field of view) of a virtual camera was manipulated in VR HMD to change the view of contents for subjects. Decreasing FOV makes view of angle narrow, therefore the view in VR is similar to telescope, in which environment the view moves a lot with even small movement.

With smaller value of FOV for a virtual camera, the view in VR is more sensitive to HMD movement and requires subjects to keep concentrating not to move their heads to watch target images properly.

8m x 6m flat screen was located at 1,200m from eyes in virtual environment with 2°FOV virtual camera, which works like telescope view. In the telescope screen environment, only 2°movement of the HMD makes the screen out of the view.

C. Software

Software for the experiment was installed to a smartphone, and the smartphone was attached to a VR headset, which was used as a VR-HMD. The VR-HMD was connected to a PC, which controls the display of the VR-HMD based on its gyroscope. The software shows a virtual screen with a target marker in VR, and displays a sight marker at the center of the view as shown in Fig. 2. The created visions look identical in both normal and telescope environments when subjects face the screen, but the screen moves more in telescope environment with HMD movements.

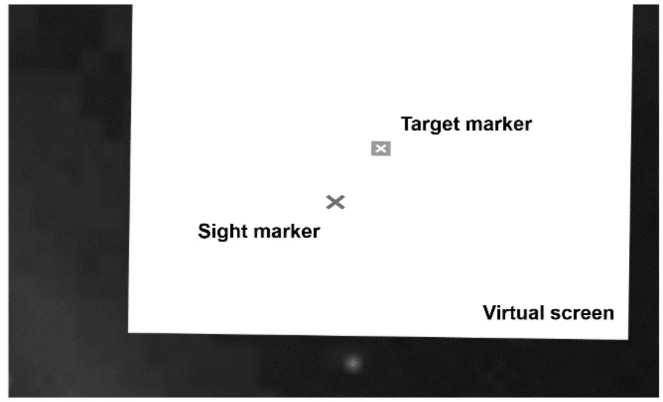

Fig. 2. Displayed contents screenshot in VR-HMD with annotations

D. Cold Pressor test

Hand immersion into cold water is a standard test for pain tolerance evaluation and is known as the cold pressor test. Wash ball (φ315) was prepared and filled with water and ice for the experiment as shown in Fig 3. Participants were asked to place their hand in the cold water until the pain is unbearable. Duration time until subjects removed their hand out of cold water was recorded as pain tolerance.

Temperature of water and tolerance time in cold pressor test was studied by Laura M et al. [8]

Fig. 3. Cold pressor test set up

E. Participants

14 working adult volunteers (10 males and 4 females) were participated in the experiment as subjects. Ages are 25 to 52 years old.

F. Procedure

The experiment was carried out in a calm room as shown in Fig. 4. so that subjects can focus on the VR display and be affected only by the contents of the experiment. Subjects were briefly explained about the procedure of the experiment, but the expected outcome or the purpose of the experiment were not explained to the subjects to avoid the bias of the result. Subjects were told to put their hand into cold water with ice until they cannot keep it due to the cold temperature.

The temperature of the water with ice was kept 0.4℃ in the experiment room. After each trial, we waited for several minutes to keep the temperature same to maintain the condition of the experiment.

Each subject was asked to put their hand twice in total in the experiment. One trial was performed with VR-HMD with virtual telescope environment, and the other trial was performed without VR-HMD. To avoid the effect of the order of the trial and hand dominance, the order of the with/without VR-HMD and the order of the left/right hand was shuffled before the experiment.

After subjects kept a relaxing posture, virtual screen was displayed just in the direction of the eyes of the subject controlled by an operator at the beginning of the trial with VR-HMD. Subjects were asked to try keeping the sight maker close to the target marker on the virtual screen in the virtual telescope environment while they keep putting their hand in the cold water. The duration time of the tolerance of each trial was recorded along with the subject information. Subjects took enough rest for the next trial until they didn't feel coldness of the previous trial on their hand.

The recorded data was analyzed with paired t test to see whether the telescope virtual screen environment affects tolerance of pain.

Fig. 4. Experiment setup including Smartphone based VR-HMD, controller PC, water with ice in wash ball.

IV. RESULT

14 people participated the experiments, and 28 data was obtained and analyzed in total. Fig 5 is a box-and-whisker plot of the data, which shows that tolerance duration of the cold pressor test with VR-HMD tends to be longer than the duration without VR-HMD. Mean value of the duration with VR-HMD was 66% longer than the duration without VR-HMD. 78.6% of subjects kept their hand for longer time with VR-HMD. 21.4% of subjects endured the cold temperature with VR-HMD for more than double of the duration without VR-HMD, and the duration increased 120.8 seconds at most as shown in Table. 2. Variance of the duration with VR-HMD was 1479.12 which is 5.4 times greater than the variance of the duration without VR-HMD.

P value of the paired t test was 0.04, which indicates that the effect of VR-HMD with telescope screen environment was statistically significant.

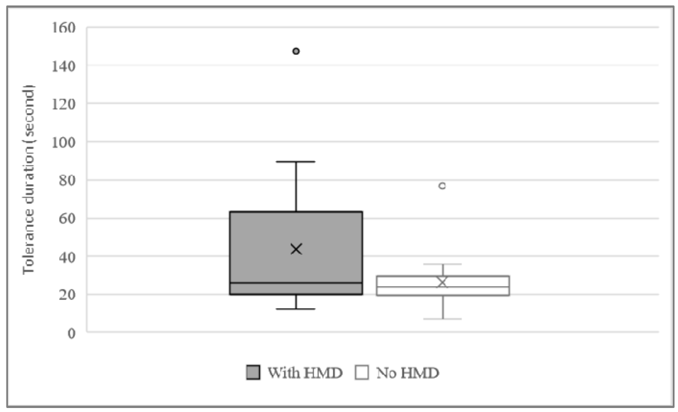

Fig. 5. Box-and-whisker plot of tolerance duration with and without VR-HMD

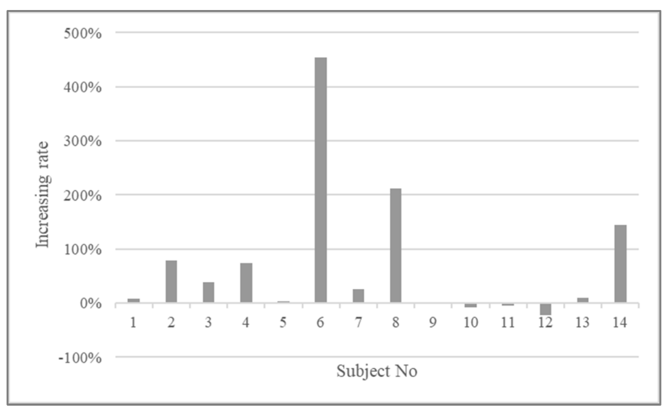

Fig 6. Plot of increasing rate of tolerance duration with VR-HMD for each subject

978-1-5386-5826-0/18/$31.00 ©2018 IEEE

Table. 2. Recorded and analyzed data of tolerance duration with and without VR-HMD

Subject	**With HMD**	**No HMD**	**With HMD / No HMD**
1	83.30s	76.80s	1.08
2	17.20s	9.60s	1.79
3	32.60s	23.40s	1.39
4	12.30s	7.10s	1.73
5	24.70s	23.90s	1.03
6	147.40s	26.60s	5.54
7	39.30s	31.40s	1.25
8	89.40s	28.70s	3.11
9	21.40s	21.30s	1.00
10	22.90s	24.70s	0.93
11	21.00s	22.00s	0.95
12	27.90s	36.00s	0.78
13	15.90s	14.40s	1.10
14	56.30s	23.10s	2.44
Mean	43.69s	26.36s	1.66
Variance	1,479.12s^2	271.98s^2	
Pearson Correlation		0.44	
df		13	
t Stat		1.88	
P(T<=t) one-tail		0.04	$p<0.05$

V. DISCUSSION

The result indicates that the small FOV telescope environment with VR-HMD increases the tolerance of subjects without meaningful contents displayed on a screen. This method could be used as a contents independent pain management for medical usage as well as controlling technique of concentration. Customized contents would not need to be prepared for each type of pains.

However it is needed to be considered that some of people would not be affected by the method. The method significantly worked for certain subjects comparing to others. Tolerance was increased more than double for 3 subjects, however, change rate of the tolerance was less than 10% for 5 subjects as shown in Fig 6. This result implies that the effectiveness of the method varies from subjects' characteristics.

To improve the method, the reasons of the effectiveness difference between subjects needs to be examined in the further study with the measurements of their characteristics such as ability to concentrate, dynamic vision or hypnotic susceptibility.

REFERENCES

[1] Sharples, S., Cobb, S., Moody, A., & Wilson, J. R. (2008). Virtual reality induced symptoms and effects (VRISE): Comparison of head mounted display (HMD), desktop and projection display systems. Displays, 29(2), 58-69.

[2] Hoffman, H. G., Chambers, G. T., Meyer III, W. J., Arceneaux, L. L., Russell, W. J., Seibel, E. J., ... & Patterson, D. R. (2011). Virtual reality as an adjunctive non-pharmacologic analgesic for acute burn pain during medical procedures. Annals of Behavioral Medicine, 41(2), 183-191.

[3] Hoffman, H. G., Garcia-Palacios, A., Patterson, D. R., Jensen, M., Furness III, T., & Ammons Jr, W. F. (2001). The effectiveness of virtual reality for dental pain control: a case study. CyberPsychology & Behavior, 4(4), 527-535.

[4] Hoffman, H. G., Meyer III, W. J., Ramirez, M., Roberts, L., Seibel, E. J., Atzori, B., ... & Patterson, D. R. (2014). Feasibility of articulated arm mounted Oculus Rift Virtual Reality goggles for adjunctive pain control during occupational therapy in pediatric burn patients. Cyberpsychology, Behavior, and Social Networking, 17(6), 397-401.

[5] Yamaguchi, M., Matsumura, M., Shimada, H. and Araki, K. (2018) Emotional Evaluation for Images Displayed with Different Type of Screens in Virtual Reality Headset. Proceedings of The Twenty-Third International Symposium on Artificial Life and Robotics: 557-560

[6] Lang P.J., Bradley M.M., Cuthbert B.N. (2008), International affective picture system (IAPS): Affective ratings of pictures and instruction manual, Technical Report A-8 University of Florida

[7] Lang P.J. (1980), Behavioral treatment and bio-behavioral assessment; Computer Applications. Technology in Mental Health Care Delivery System, ed. Sidowsky B.J.et al Ablex, Publishing Corporation

[8] Mitchell, Laura A., Raymond AR MacDonald, and Eric E. Brodie. "Temperature and the cold pressor test." The Journal of Pain 5.4 (2004): 233-237.