Emotional Evaluation for Images Displayed with Different Type of Screens in Virtual Reality Headset

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Abstract:

We carried out an experiment to examine emotional effect with images displayed in different type of virtual screen in VR-HMDs, and evaluate the emotional response. We manipulate FOV (Field of view) of a 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 HMD movement and requires subjects to keep concentrating not to move their heads to watch target images properly. Stronger emotional responses were observed with smaller value of FOV in the experiment. The result indicates the possibility of controlling effectiveness of contents with displaying software in VR. This result is expected to improve medical usage of VR contents.

Keywords: VR, Psychology, FOV, Self-Assessment Manikin, IAPS

1 INTRODUCTION

Low cost and high quality Virtual Reality Head Mounted Displays (VR-HMDs) are getting popular and used for various applications these days. 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. Positive psychological effect can also be used for medical usage such as therapy or pain reduction.

To obtain high immersiveness of VR experience, better equipment is needed to use. However, it would be useful if we could control emotional responses with same contents and same VR-HMDs.

We carried out an experiment to examine emotional effect with images displayed on a different type of virtual screen in VR-HMDs, and evaluate the emotional response with different type of virtual screen using International Affective Picture System (IAPS) [1] and Self-Assessment Manikin (SAM) [2] method.

Kawai T. et al. shows enhancement of emotional arousal by stereoscopic images with IAPS and SAM in a previous study [3].

2 METHOD

2.1 Participants

12 volunteers (9 males and 3 females) were participated in the experiment as subjects. Ages are 21 - 61 years old.

2.2 Setup

HMD

Smartphone based HMD was built up with 5.8-inch smartphone and Cardbord type VR component kit. The HMD is 18.5 x 16.1 x 1.1 cm size and 224g light weight including the smartphone. Subjects hold the HMD in front of their face, 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.

SAM

Self-Assessment Manikin (SAM) was developed by Lang P.J. and used to evaluate emotional response of the subjects. SAM is a widely used non-verbal assessment technique which measures pleasure, arousal, and dominance with cartoon characters graphic scales. Morris J.D. shows that SAM is effective as a cross-cultural measurement of emotional response [4].

Arousal value was only measured and used in this experiment. Previous studies show that the relationship between affective pictures and arousal. Gil S. et al shows that emotional time distortions are induced by arousal [5]. Manikin image for rating (Fig. 1) was prepared to measure arousal level in 9 scales, and selected by subjects for each photo display in HMD.

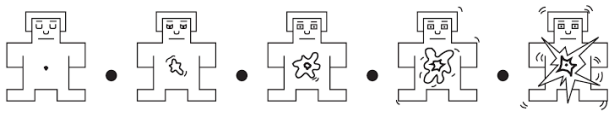

Fig. 1. Self-Assessment Manikin (SAM) scales for arousal

Pictures

International Affective Picture System (IAPS) is used as emotional stimuli in the experiment. IAPS is a widely used database of pictures designed to provide a standardized set of pictures for studying emotion and attention in psychological research. Lang P.J. et al show its effectiveness as an affective rating tool.

Pictures of the experiments were selected from IAPS photo data set. All pictures of IAPS are rated in reactions of arousal, valence and dominance. Pictures were sorted by arousal and selected 20 most high rated and 20 most low rated pictures, and the categorized groups are named “Intense” and “Normal” group. Pictures of Intense group were expected to stimulate subject’s emotion, and pictures of Normal group were expected to keep subject’s emotion calm.

Software

Software for the experiment was installed to a smartphone, and the device was attached to a goggle and used as a VR-HMD. We use monocular lens goggles instead of the one 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. During the experiment, randomly selected images from a list are displayed after a countdown on a virtual screen in the VR-HMD. FOV of a virtual camera in VR also randomly changes, and relationship between FOV and emotional response were analyzed.

Software randomly selects a type of the virtual screen and a picture to display. Two types of the virtual screen "FOV:108" and "FOV:2" were selected by 50% probability, and the two photo set groups "Intense and Normal" were also selected by 50% probability. The software choses a picture to display at random from the selected group of the photo set. Selected type of the virtual display was used to display the selected picture in the HMD by the software.

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 looks similar to the one using telephoto lens, in which environment the view moves a lot with even small camera 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 in order to watch target images properly.

Two types of virtual screen environments were prepared for the experiment.

Table 1. Parameters of two virtual screen environments

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

Both screens are 8x6m size square flat screen, and displayed as almost same size and fitted to HMD screen width. However, normal screen was located at 4m from eyes in virtual environment, and the FOV for a virtual camera was set to 108°, so that the virtual environment was similar to an environment in which actual 8x6m size screen was located at 4m from subjects. On the other hand, sensitive screen was located at 1,200m from eyes in virtual environment with 2°FOV virtual camera. The sensitive screen environment works like telescope view with the screen located at 1,200m distance from subjects.

In the sensitive screen environment, only 2°movement of the HMD makes the screen out of the view

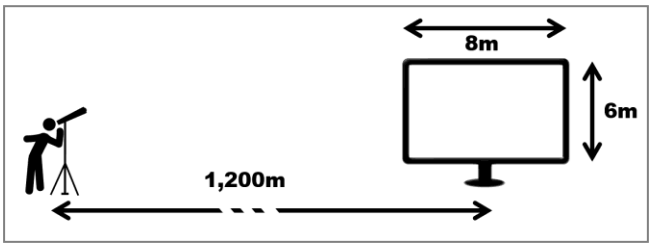

Fig. 2. Schematic drawing of the sensitive virtual screen environment.

2.3 Procedure

The experiment was carried out by two people in a calm room, and lights were tuned off so that subjects can be relaxed during the experiment. One person controls PC and another person recorded the result. Beginning of the experiment, overview of the procedure was explained to subject about what they need to do, but expected outcome or the purpose of the experiment were not explained to the subjects. Subjects were mentioned that unpleasant pictures may appear on screen and they may stop the experiments if they feel uncomfortable. Subjects were also asked not to tell other people about the detail about the experiment

because of prior information control of the psychological experiment.

One session was composed with 20 photo displays for one subject. In a session, a loading image appears for 8-13 seconds and a picture appears for 6 seconds. The duration of the loading image varies from 8 to 13 seconds because subjects should not know exactly when the picture appears. After the picture disappear, the subject indicates their arousal level with the SAM picture.

Picture type, screen type and arousal level were recorded along with picture and subject number.

Fig. 3. The condition of the experiment.

RESULTS AND CONSIDERATION

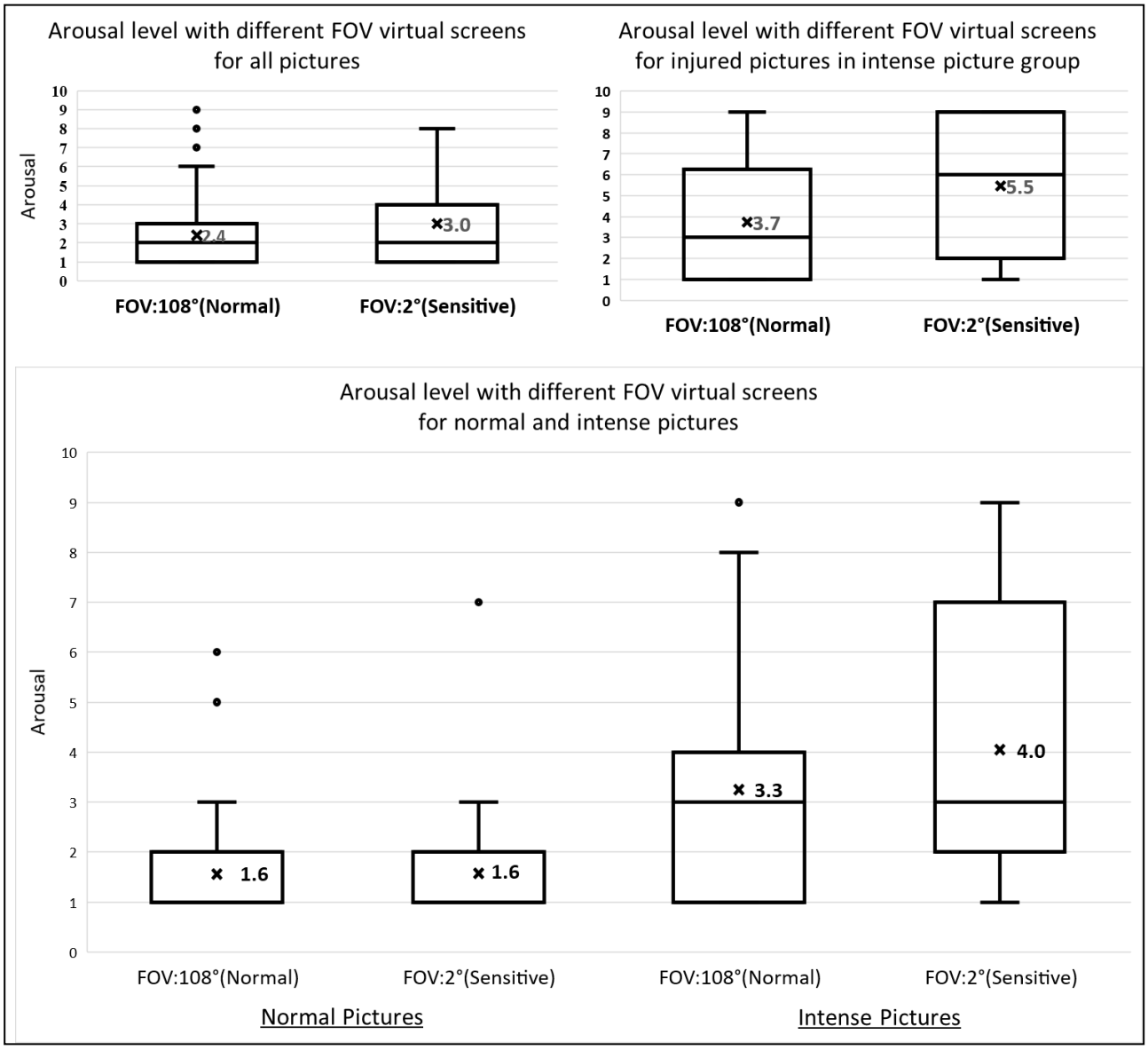

Fig. 4. Box and whisker chart of arousal level with Self-Assessment Manikin (SAM)

Table. 2. t test result and statistics of recorded arousal level for selected picture data set.

	FOV:108° (Normal screen)		FOV:2° (Sensitive screen)			
Used pictures data set	M	SD	M	SD	F test result	t test result
All pictures	2.4	2.0	3.0	2.6	F(106,119)=0.73, p<0.05	t(196)=1.65, p<0.05
Normal pictures	1.6	0.9	1.6	1.0	F(44,60)=0.63, p>0.05	t(104)=1.66, p>0.05
Intense pictures	3.3	2.3	4.0	2.9	F(58,61)=0.65, p>0.05	t(119)=1.66, p=0.05
Injured pictures	3.7	2.8	5.5	3.2	F(16,21)=0.46, p>0.05	t(37)=1.69, p<0.05

Note: M=Mean, SD=Standard deviation.

Emotional responses were recorded in 227 trials for 12 subjects. T test result with all pictures data set indicates that watching pictures in sensitive screen environment make subject feel more arousal.

To understand more about the relationship of the virtual screen environment and the arousal level, recorded data was also analyzed with categorized pictures set. Analyzed data with normal and intense pictures data set show that type of virtual screen environment does not affect emotional responses with normal pictures.

Injured pictures data set was selected from intense pictures for further analysis, which include mutilation and tumor pictures. The mean of the arousal ratings of injured pictures set were higher than the ratings of intense pictures set. The results of t test were p=0.04 for injured pictures set, p=0.05 for intense pictures set and p=0.46 for normal pictures set, which indicate that sensitive screen environment make subjects feel more arousal with higher arousal rating pictures.

4 CONCLUSION

The experiment result shows arousal level enhancement with sensitive virtual screen environment made by small number of FOV for virtual camera in VR-HMD. The result met our expectations since small FOV environment requires more concentration to watch a picture on the screen.

The result indicates the possibility of controlling effectiveness of same contents and same HMD just with displaying software in VR, and is expected to improve medical usage of VR contents.

We continue to study the way to enhance emotional responses also with non-intense contents.

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