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Research paper

Effects of VR Presence on Health Risk Perceptions

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Abstract

Background/Objectives: This study aimed to examine the effects of presence in VR video on changes in health risk perceptions – health self-efficacy, perceived susceptibility, and perceived severity – about infectious disease prevention behavior.
Methods/Statistical analysis: The experiment was conducted to observe whether participants perceived health behavior differently after watching VR video about washing hands. Participants were consisted of 75 males and 75 females and they were asked to fill out the pre-questionnaire about health perceptions before watching VR video and post-questionnaire after watching the video. The collected data were analyzed by R-MONOVA to examine the interaction effect of gender and the VR video presence.
Findings: The results showed that the VR video presence had significant impacts on changes in health risk perceptions not only at multivariate level but also at univariate level. The results of this study imply that the effect of presence in VR video can influence the changes of health perceptions and eventually it can make individuals behave in healthy way. In addition, gender influenced the changes of health risk perceptions only at multivariate level but it did not cause any change at univariate level. Most of all, the interaction effect of gender and the presence of VR video only appeared at univariate level. Especially, perceived severity was affected by the interaction effect. Since perceived severity was changed depending on not gender but the effect of presence when analyzing separately, it implies that experience in VR can be different according to gender group. This study proved that the vividness effect of VR video was persuasive in changing health risk perceptions and it can be used in health industry to promote healthy behavior.
Improvements/Applications: This study was improved in suggesting the effect of presence on changes of health perceptions according to gender. Thus, differences in presence depending on gender should be taken into consideration.

Keywords: *VR video, Presence, Health risk perception, R-MANOVA, Interaction effect*

1. Introduction

Virtual reality (VR) has attracted attention as an emerging therapy and education tool in the medical and healthcare industry. VR refers to "a real or simulated environment in which a perceiver experiences telepresence" [1]. The user can explore the virtual world by means of motion tracking attached to a head mounted display (HMD). In a quality virtual environment, users experience a high level of "presence" through the medium, which causes them to perceive virtual reality as if it were the real world. When defining virtual reality in terms of human experience rather than technical hardware, the important thing is the concept of presence [1]. Presence is defined as "the subjective experience of being in one place or environment, even when one is physically situated in another" [2] and it also described as "the perceptual illusion of non-mediation" [3]. Recently, VR technology has been applied in various industrial fields and has been proved effective. Thus, this study produced VR video and investigated whether presence influences changes in health risk perceptions about infectious disease prevention.

2. Theoretical Background

2.1. The Vividness Effect: Presence

The vividness effect claims that photos, concrete examples, or materials in TV presentation are more persuasive than text-based messages, ambiguous assertions, or print representations [4]. Vivid information increases the perceived importance of information by attracting more attention [5]. In regard to vividness effects of video contents, Tamborini argued that video game's influences on cognitions and behaviors could be enhanced by its ability to improve users' feeling of immersion and involvement during playing games and these feelings are associated with the technological feature of video games such as vividness and interactivity [6]. In other words, interactivity and vividness of video games can be a key determinant of presence. In addition, Riva and colleagues claimed that the vividness of perceptible displays is the basis for forming a core presence that is described as an activity of selective attention created by the perceptions of the self and present external world [7]. Based on the previous studies, this article expected that the vividness of VR video might be able to affect formation of presence and increase persuasive effect of message in order.

However, according to the mixed results on the vividness effect reported through previous studies, the vividness effect has been exerted only in a narrow range of environments [4], [8]. Rook [9] viewed the vividness effect from the viewpoint of health communication and argued that the vividness effect arises from under conditions of low vulnerability. In other words, if the perceived risk is high, the vividness of the media could have no effect on receivers and the message is not persuasive. Thus, this study assumes that the vividness effect of VR video can produce the presence and it will increase the persuasive power of the message and eventually change the health risk perceptions in a

condition of low vulnerability such as washing hands to prevent infectious diseases.

2.2. Health Self-Efficacy

Health self-efficacy is defined as "individuals' beliefs about their ability to manage their health" [10] and it was derived from the concept of self-efficacy. Bandura claimed that cognitive processes mediate behavior changes, and through self-reflection processes, people can evaluate their experiences and thought processes [11].

In terms of self-efficacy, the way how individuals behave can be variable depending on the belief and judgement of their own abilities. For example, those with high self-efficacy tend to set higher goals and continue to strengthen their efforts until they succeed [12]. From the viewpoint of health self-efficacy, those who believe in the ability of individuals to achieve health-related goals are more likely to actively seek health information and better convert health information into positive health behaviors [13].

Block and Keller demonstrated that vivid information is more persuasive in conditions of high self-efficacy [14]. In addition, individuals with a high level of health self-efficacy are motivated to elaborate on health messages [15]. In other words, it can be assumed that the presence, health self-efficacy, and health information are related to each other. Thus, this study expected that the presence of VR video will affect the health self-efficacy. The following hypothesis was posited.

H1: Health self-efficacy will increase after watching VR video.

2.3. Perceived Susceptibility and Severity

Perceived susceptibility is defined as "individual's own perception of the probability of experiencing a condition that would adversely influence one's health." Perceived severity refers to "individual's own perception of the negative consequences of not treating the disease" [16]. Those at higher the level of perceived susceptibility and severity are more likely to protect or pursue their health [17]. Rook verified that vivid information is more persuasive only under the conditions of low perceived vulnerability of disease, and the effect can be affected by individual factors such as age [15]. The prevention behavior is an early stage of health behavior that prevents the onset of a serious illness, so it is assumed that the effect of VR video on the prevention behavior against infectious diseases can be persuasive.

In addition, negatively framed information that emphasizes perceived risk effectively promotes health behavior [18]. This result proved that messages that convey perceived risk effectively promotes health behaviors increases. Consequently, if the risk of infectious disease and the risk of not performing health behavior is effectively framed through the presence in VR video, audiences' perceptions of risk (susceptibility and severity) will increase. Thus, the following hypotheses were posited.

H2: Perceived susceptibility will increase after watching VR video.

H3: Perceived severity will increase after watching VR video.

In addition, this study assumes that there is a gender difference in having health risk perception. Thus, we expect that the three health risk perceptions suggested above will be influenced by the interaction effect of gender and the presence of VR video. The following hypotheses were posited.

H4: There is a gender difference in having health risk perceptions.

H5: Health risk perceptions will be influenced by the interaction effect of gender and the presence of VR video.

3. Methodology

3.1. Experimental Procedure

The experiment was set up to examine the effects of presence in virtual reality (VR) video on the prevention behavior against infectious diseases. The experiment was conducted for about 2 weeks from May 1 to 17, 2017 and 150 college students, consisting of 75 males and 75 females, were recruited. First, researchers briefly explained about the experimental procedures and precautions to participants. And then, participants were instructed to fill out the self-reported pre-questionnaire about their health perceptions before participating in the experiment. Next, participants were instructed to wear the HMD device by a researcher and watch the VR video designed for this study for 5 minutes, "infectious disease prevention through washing hands". This video showed that there were germs left everywhere each participant touched and emphasized on the risks of not washing hands with the effects of presence. After watching the video, participants were asked to fill out the post-questionnaire. To block noises from surrounding environment, the stereo headphones was set at the maximum level of volume, which allowed participants to focus on the VR video. In addition, VR's VR Player PRO was configured to allow participants to control their screens by themselves via head tracking.

3.2. Measures

Items were adopted from previous studies to measure the conceptual constructs in the study and slightly modified to reflect the context of washing hands to prevent infectious disease. Responses were provided using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The items for health self-efficacy were adopted from those used by Lee et al. [10]. In addition, the items pertaining to both perceived susceptibility and severity were adopted from those used by Champion [19]. Table 1 shows questionnaire items used in the study. Each variable was measured twice (pre/post). Cronbach's α coefficients for all items exceeded .70.

Table 1: Questionnaire Items

Variables	Statements
Health Self-Efficacy	I have confidence to set my own clear goals to prevent infectious diseases.
	I am confident to actively act to prevent infectious diseases.
	I am confident in myself to manage what I have to do to prevent infectious diseases.
	I have confident to keep my own goals to prevent infectious diseases.
Perceived Susceptibility	My chances of getting infectious diseases are great.
	I think that my chances of getting infectious diseases in the future are good if I do not often wash my hands.
	There is a good possibility that I will get infectious diseases if I do not often wash my hands.
Perceived Severity	The thought of infectious diseases caused by not washing my hands makes me scared.
	My life would be different from my previous life if I got infectious diseases due to not washing hands.
	Problems I would experience from infectious diseases would last a long time.
	If I got infectious diseases, it would be more serious than other diseases.

4. Results

To verify whether the presence in VR video significantly affected

the health risk perceptions about prevention behavior against infectious disease, repeated measure MANOVA (R-MANOVA) was performed. R-MANOVA is used to examine the differences between groups for multiple dependent variables and the interaction effects of several independent variables on dependent ones. This study used R-MANOVA to analyze the differences between gender groups and the interaction effect of gender and the presence in VR video. 2 X 2 multivariate analysis was used to analyze three dependent variables including health self-efficacy, perceived susceptibility, and perceived severity. The gender was set for the between-group factor and the effects of VR video was analyzed as the within-group factor. Mauchly's test of sphericity does not need to be performed because it was repeatedly measured at only two levels. The assumption on the homogeneity of variance was satisfied.

Table 2 shows mean value of each variable. In case of male participants, the mean value for health self-efficacy, perceived susceptibility, and perceived severity have increased after watching VR video. The mean value of health self-efficacy, perceived susceptibility, and perceived severity of female participants have also increased after watching VR video.

Table 2: Mean Value of Variables

IV		DV	Mean	S.D.	N
Male	Before watching VR	Health Self-Efficacy	3.32	.62	75
		Perceived Susceptibility	3.50	.53	75
		Perceived Severity	2.92	.65	75
	After watching VR	Health Self-Efficacy	3.74	.65	75
		Perceived Susceptibility	3.70	.59	75
		Perceived Severity	3.18	.80	75
Female	Before watching VR	Health Self-Efficacy	3.22	.56	75
		Perceived Susceptibility	3.43	.52	75
		Perceived Severity	3.01	.57	75
	After watching VR	Health Self-Efficacy	3.61	.57	75
		Perceived Susceptibility	3.74	.57	75
		Perceived Severity	3.40	.62	75

Table 3 and Table 4 shows the results of multivariate test and F-test for univariate follow up tests respectively. The results showed that the effects of presence in VR video was significant at multivariate level [Wilks's $\lambda = .55$, $F(3, 146) = 40.03$, $p < .000$, partial $\eta^2 = .45$]. In addition, as shown in Table 4, the effects of presence in VR was also found to significantly influence the increases of health self-efficacy [$F(1, 148) = 14.52$, $p < .000$, partial $\eta^2 = .41$], perceived susceptibility [$F(1, 148) = 3.27$, $p < .000$, partial $\eta^2 = .13$], and perceived severity [$F(1, 148) = 5.40$, $p < .000$, partial $\eta^2 = .18$], respectively. This result implied that the presence in VR video was effective in changing health risk perceptions such as health self-efficacy, perceived susceptibility, and perceived severity. Thus, according to these results, H1, H2, and H3 were supported.

Table 3: Multivariate Test

Effect	Wilks's λ	F	*df*1	*df*2	*p*	Partial η^2
Between-Subject Gender	.95	2.83	3	146	.04	.06
Within-Subject VR video	.55	40.03	3	146	.00	.45
VR video x Gender	.97	1.74	3	146	.16	.03

Additionally, the results of between-groups showed that there was gender difference in health risk perceptions at multivariate level [Wilks's $\lambda = .95$, $F(3, 146) = 2.83$, $p < .05$, partial $\eta^2 = .06$]. However, according to the results at univariate level, there was no difference of health self-efficacy [$F(1, 148) = .48$, $p = .41$, partial $\eta^2 = .01$], perceived susceptibility [$F(1, 148) = .59$, $p = .29$, partial $\eta^2 = .01$], and perceived severity [$F(1, 148) = 2.13$, $p = .11$, partial $\eta^2 = .02$] depending on gender group. Thus, H4 was not supported. Furthermore, there was no significant interaction effect of gender and the presence of VR video at the multivariate level [Wilks's $\lambda = .97$, $F(3, 146) = 1.74$, $p > .05$, partial $\eta^2 = .03$]. However, at univariate level, the interaction effect almost significantly influenced the increase of perceived severity [$F(1, 148) = .63$, $p = .05$, partial $\eta^2 = .03$]. This result implied that the effect of presence in VR video on perceived severity can be different depending on gender group. In case of health self-efficacy [$F(1, 148) = .05$, $p = .54$, partial $\eta^2 = .00$] and perceived susceptibility [$F(1, 148) = .05$, $p = .55$, partial $\eta^2 = .00$], these factors were not influenced by the interaction effect. Thus, H5 was partially supported.

Table 4: F-tests for Univariate Follow-Up Tests

IV	DV	Univariate F	*df*	*p*	Partial η^2
Between-Subject Gender	Health Self-Efficacy	.48	1/148	.41	.01
	Perceived Susceptibility	.59	1/148	.29	.01
	Perceived Severity	2.13	1/148	.11	.02
Within-Subject VR video	Health Self-Efficacy	14.52	1/148	.00	.41
	Perceived Susceptibility	3.27	1/148	.00	.13
	Perceived Severity	5.40	1/148	.00	.18
VR video X Gender	Health Self-Efficacy	.05	1/148	.54	.00
	Perceived Susceptibility	.05	1/148	.55	.00
	Perceived Severity	.63	1/148	.05	.03

5. Discussion

This study conducted an experiment to examine whether the interaction effect of gender and the presence in VR video can affect health risk perceptions such as health self-efficacy, perceived susceptibility, and perceived severity. The same number of male and female were sampled as participants and then, collected data were analyzed through R-MANOVA. The significant effects of presence in VR video on changes of health risk perceptions were examined. In addition, there was no difference in health risk perceptions depending on gender group. Especially, perceived severity was influenced by the interaction effect of gender and presence. This study is noteworthy in that it empirically demonstrated that the effects of VR user experience through presence can influence changing health risk perceptions.

The results showed that the presence of VR video had significant influences on the difference of the users' health risk perceptions. Based on the results, it can be expected that the presence of VR

video can affect to frame and change health risk perceptions and eventually promote individuals to perform healthy behavior. Next, it was found that the change of perceived severity was influenced by the interaction effect of gender and the presence in VR video. When gender and the presence of VR video were analyzed separately, the difference of perceived severity was attributed only to the effect of presence but there was no difference depending on gender group. It implies that the user experience in VR through the effect of presence can be different according to gender.

Consequently, the vividness effect of VR video through the presence was proved to be persuasive. The results of this study give a practical suggestion that VR practitioners can utilize VR technology to change people's health risk perceptions or healthy behavior. However, in order to verify the meaningful interaction effect with the presence in VR video, it is necessary to compare and analyze the groups with significant differences in the future.

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