

Realism Cues and Memory in Computer Games : Effects of Violence Cues on Arousal, Engagement, and Memory*

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폭력성게임 내에서의 사실적 묘사 방식이 사용자 각성(arousal)과
현존감(presence) 및 기억(memory)에 미치는 영향에 관한 연구

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요 약

본 연구는 폭력성 게임 내에서 사실적인 묘사(선혈 색, 비명 소리, 일인칭 시점) 방식이 사용자 각성(arousal), 현존감(presence), 그리고 게임 내에서의 사건 장소에 대한 기억력(memory)에 미치는 영향력을 테스트 하였다. 또한 사용자가 느끼는 현존감과 각성의 관계도 분석되었는데, 최신 3D 슈팅 게임인 CounterStrike를 변형시켜 실험을 진행하였다. 실험 결과, 사실적인 선혈(붉은색)과 소리(날카로운 비명)는 사용자의 경험 정도에 관계없이 각성 정도를 증대시키는 것으로 나타났으며, 각성 정도는 사용자의 현존감과 유의미한 상관 관계를 보여주었다. 특히, 현존감의 세부 요인인 관여도(engagement)는 기억력을 높이는 데 가장 결정적인 역할을 하였으며, 각성과 기억력을 매개하는 변수인 것으로 분석되었다. 그러나, 일인칭 시점은 각성에는 영향을 주지 않았으며 관여도에 부적인 영향을 주는 것으로 나타났다.

ABSTRACT

This study examined if realistic cues of violence - blood color (red), sound cues (screams of pain), and perspective (first-person) - influence user arousal, feeling of presence, and their memory for the game events and positions with personal experience of games. The relationship between arousal and presence was also analyzed with their effects on memory in a 3D modified shooter game (*CounterStrike*). Results indicated that both realism cues of violence increased the player's arousal regardless of the user's level of game experience, and the arousal had a significant relationship with engagement by affecting presence strongly. Especially, engagement (a sub-factor of presence) was stronger than other variables in explaining the memory effect, and it mediated the effect between arousal and memory. However, the first-person perspective did not show any significant effect on arousal, and had a negative effect on engagement.

Keywords : Arousal(각성), Memory(기억), Violence(폭력성), Presence(현존감),
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1. Introduction

Portrayals of violence are among the most common forms of media content. With the evolution of media from books to virtual environments these portrayals become more realistic and interactive. The arrival of more interactive and immersive 3D games increasingly supports active emotional and behavioral engagement of the user in more realistic portrayals of violence[1,2]. When using more immersive computer games, users increasingly experience their own acts of virtual violence in more realistically violent virtual worlds.

A long standing concern has been on how the realistic portrayals of virtual violence affect users' cognitions, memories, and behavior[3]. In this study we examined whether the increased representational realism of violence, specifically blood color and screams of pain, affects users' arousal, sense of presence(immersion) in the game, and memory for the experience. We reason that increased arousal may increase users' pleasure in playing violent games and that increased memory for the experience may make the users memory of their own acts of virtual violence more accessible.

Finally, we explored whether it is not the realistic content per se but the users' sense of presence that mediates the memory, that is the more the user feels "present" in the game the more likely they are to remember the experience and that this sense of presence may mediate the effects of representational realism.

2. Representational Realism in Virtual Violence

Researchers and policy makers have argued that the representational realism of violence affects user's arousal(excitement) and memory for mediated violent experiences. Emotional reactions to stimuli such as color and sound have long been an interesting subject for scholars[4,5]. When people look at affective pictures or sounds, people's patterns of physiological change vary significantly with reports of affective arousal[6]. In some cases "blood and gore" are seen as increasing arousal in the user, and potentially desensitizing the user to violence. On the other hand, the increased realism of pain cues, such as facial contortions and screams, are claimed to increase arousal but also empathy with victims.

2.1 Effects of Blood and Color on User Experience

The sight of realistic blood has been shown to be inherently arousing for most viewers. Because of the potential effects of blood images, blood manipulation in violent games is one factor that differentiates adult games from youth games in game rating boards. For example, games with realistic depiction of blood (e.g. color or bleeding) cannot be used by adolescents (see the "Game Ratings & Descriptor Guide" by Entertainment Software Rating Board (ESRB) in USA, Computer Entertainment Rating Organization (CERO) in Japan, Game Rating Board (GRB) in Korea etc.). A common design solution is to make blood "less realistic" by changing its color to

different ones (e.g. blue or green) or by eliminating blood bleeding. Fundamentally, the policy belief is that non-realistic blood and bleeding is less arousing and less memorable, therefore it is likely to have less of an effect. In this study we directly test this policy assumption.

The key mechanism for effects of realistic violence such as blood and gore is the effect on the players' level of arousal. Violent games have been regarded to influence aggressive behavior through their impact on arousal[7]. Farrar, Krcmar, and Nowak[8] reported that the presence of blood in games caused users' gore perception and aggressive thoughts to increase. In the study about the violence perceptions of television, Potter, Pashupati, Pekurny, Hoffman, and Davis[9] found that viewers who perceived high violence were not necessarily from the number of violence acts but more from graphic and explicit violent scenes.

In the studies of color effects, colors were reported to affect viewer arousal or emotion [10]. Specifically, red color was known to be related to viewer arousal(or excitation) than blue color[11,12]. Red color was reported to be related to arousal(or excitation) and stimulation; blue color was to be related to consolation and security[12].

With respect to color effects, there is relatively little research in gaming studies. Regarding color light effects on gambler behaviors, Stark and his colleagues[13] showed that red lighting led the gamblers to take more risks and to stake more money. Likewise, Wolfson and Case[5] reported that game players in red background of game

screen had higher scores than those in blue background screen.

2.2 Effects of Screaming Pain Cues on Arousal

In the area of auditory cues other than the sound of weaponry, representational realism of violence may be represented by realistic audio pain cues such as screaming and moaning. Such cues are often left out of videos and games precisely because they are seen as "disturbing" and arousing. On the other hand some researchers argue that these audio pain cues increase empathy. In this study we examined the effects of audio pain cues, especially screams of pain, on player arousal.

For game players, sound effects with intermittent sirens or bells have been shown to increase game players' arousal. According to Bradley and Lang[5], listening to unpleasant sounds(e.g. screams of pain) resulted in higher arousal than neutral sounds. Likewise, previous literature shows that there are the mediating effects of arousal between sound and health, academic, or occupational performance. Listening to annoying, unpleasant sounds (e.g. noise) is reported to affect both arousal and task performance[4].

There is a proposition in previous studies and in public policy that realistic violence cues such as the presence of blood and gore, and blood color specifically, affect user arousal while playing games. Therefore, we tested the following hypotheses:

H1 (a/b): There will be main effects of game manipulations ((a) blood color and (b) screams of pain) on arousal, even after controlling the experience time of games.

2.3 Effects of Blood Color and Sound on Presence

Presence has been defined as the sense of being there in the virtual environment. Presence is defined as the degree of psychological state to which user's sense of location is body location and experiential consciousness is focused on experience in a virtual reality environment rather than the real physical world that the user inhabits[14,15].

Color and sound effects on arousal have been reported in previous research[5,6], which have also been regarded as causes of presence in VR studies[15]. Since video games are played in VR environments, color and sound are likely to affect not only a users' arousal but also their feeling of presence. However, there is little research on the effects of color and sound in gaming studies. Furthermore, few studies on the emotional aspects of VR environments have shown relationships between arousal and the feeling of presence.

From the previous literature about the causing variables of presence, realism of perceptual cues such as realistic color and sound are argued to be media variables that affect presence[15]. Since red color is more similar to the real world blood color, red blood would be more realistically felt by users than blue blood. So, red color might increase the feeling of being present, "being there" in realistic world of the game.

In addition, the added sound effects of screaming pain cues might function as an additional sensory information environment compared to more silent environments where no audio pain cues are provided.

Thus, the following hypotheses are proposed:

H2 (a/b): Representational realism of violence ((a) blood color and (b) screams of pain) will increase the users' feelings of being present in the game environment.

2.4 Effects of Perspective on Mediated Experience of Violence

Point of view or user perspective is another important factor of representational realism to influence user experience. Games are often experience from a third-person perspective, which is of viewpoint in the virtual space that unnaturally hovers over the avatar body that represents the user in the virtual environment. On other hand, virtual world is experienced directly from the viewpoint of the body. Some games simulate this viewpoint by using "more realistic" first-person perspective, which is a view of the world position near the "head" of the character.

Previous studies address that first-person perspective could increase user aggression through identification with the virtual body[7,16]. Likewise, regarding the feeling of presence, viewer perspective was one factor to increase presence[16,17].

We propose following hypothesis:

H3 (a/b): There will be main effects of perspective on (a) arousal and (b) presence, even after controlling for other variables.

3. Modeling the Experience of Violence : Relationships among Presence, Arousal & Memory

Key to understanding the effects of medium

and violent representations is to model the experience. The constructs of arousal, presence, and memory all characterize different facets of the user experience of violent content and their acts of virtual violence.

As we mentioned above, presence has been defined as the sense of being there in the virtual environment. The construct addresses the degree to which user's sense of body location and experiential consciousness is focused on experience and action in the virtual world of the media representation rather than the real physical world that the user inhabits [14,15].

Previous research on presence has focused on two set of causal variables: media form and individual difference variables[15]. As far as media variables, many aspects of media form that can be said to be related to "representational realism" have been show to affect the users sense of presence:: number of sensory dimensions and channels[14,15], color[15], and perspective[16,17]. As far as individual variables, individual vary in their ability and proclivity to feel as if they are "present" in the virtual environment. Variables reported to affect presence include prior experience to media[15], and personality type[18].

3.1 Arousal and Presence, and Their Effects on Memory

The users' sense of arousal and presence are likely to mediate some of the effects of the experience of virtual violence, including cues that make the representation of violence more realistic. Advanced and highly interactive virtual environments are associated with the

feeling of presence, which is often accompanied by high levels of arousal[19,20].

Previous studies regarding arousal and memory indicate that emotional information is more likely to be remembered than is neutral information, such that individuals seem to remember specific contextual details of arousing events better than of neutral ones[21]. Emotional content increases the vividness of memory, causing these experiences to be remembered richly.

A memory advantage for emotionally -arousing material over neutral material has also been shown in a number of laboratory studies[21,22,23]. Arousal influences dramati -cally the average speed of data accumulation in memory, such that higher arousal results in faster accumulation[22]. Effects of arousal on memory occur automatically, so arousal can enhance not only the subjective vividness of a memory, but also a memory's accuracy[21,23].

From the flashbulb memories effects, which means surprising and arousing events remembered by individuals, even years after the event occurred, the memory lasts long[21]. Bradley, Greenwald, Petry, and Lang[24] found that memory for the occurrence of an emotional stimulus associated with high arousal is better than for a stimulus rated low in arousal. In line with the previous studies, we can conjecture that the memory of killing event in a game, if it caused high arousal, will last long with high accuracy. Furthermore, if the blood caused high arousal, users will also remember the backgrounds where opponents' blood splattered. Otherwise, the blood-sprinkled backgrounds will show no significant differ -ence in the degree of arousal among experi

-ment groups.

Thus, in this experiment, since the blood is splattered to the ground and walls around opponents that were killed by players, each background of killing field can be memorized vividly by the players. Therefore, if the player feels high arousal at a scene during killing opponents, the scene of arousing background will be recollected well. Likewise, since arousal might be highly related with the feeling of presence, we can assume that presence could be also highly related with memory.

From these grounds, we propose the following hypotheses:

H4: Arousal and presence will be strongly correlated, such that arousal will increase presence even after controlling for other variables.

H5 (a/b): Representational realism of violence ((a) blood color and (b) screams of pain) will increase memory for virtual game experiences.

H6a: Arousal and memory for game events and places will be correlated, such that arousal will increase memory for events and places.

H6b: Users sense of presence in the game will be correlated with memory for events and places.

H6c: The feeling of presence will mediate the degree to which users' arousal affects their memory for game events and places.

3.2 Individual Differences

Individual differences can shape the experience of violence in computer games. Exposure to media is also an important control variable that affects users' affective and

cognitive experience. So in this experiment we controlled for user experience.

Media experience (e.g. exposure to television, video, and video games) has been reported that it is greatly related with users' aggressive affect, feeling of hostility through their cognition, affect, and arousal from the media[3,7]. Likewise, prior experience to media has been regarded to be an essential factor both in presence and in gaming studies[7,8,15].

In the same context, prior experience of media has been reported as an individual variable that affect the feeling of presence[15]. In VR game studies, Tamborini and his colleagues[16] showed that prior violent game use had a strong effect on presence. Thus, we can suppose that game experience might influence arousal and the feeling of presence. The following hypotheses can be proposed:

H7 (a/b): Experience playing computer games affect the users' reports of (a) arousal and (b) their sense of present in the game.

4. Method

4.1 Design and Participants

The experiment used a 2(screams of pain) X 2(blood color) X 2(perspective) between-subjects design that crossed screams of pain(on vs. off), blood color (red vs. blue), and user perspective(first-person vs. third-person). Each subject was randomly assigned to ly asight groups. They played the game "CounterStrike," a popular shooting game worldwide, then answered questions about arousal and presence, and took a memory test.

A total 80 subjects(Mean = 20.0 years, SD =

1.87) were recruited from a major University in northwestern area of the United States. Subjects were recruited for the study on a voluntary basis from two undergraduate classes, and they were randomly assigned to one of the eight conditions. In each condition, there were 8 male and 2 female subjects. The average game-playing time for each subject was 12 minutes. Subjects received course credit for their participation in the experiment.

4.2 Stimulus Materials

“CounterStrike” was used in the experiment, which is rated “M (Mature)” by the ESRB due to realistic blood description, gore, and violent actions. Manipulation conditions were modified for the experiment. One session of about 12 minutes were provided to the participants. They passed 10 sites in the game and shot 20 opponents. All subjects were required to wear head-sets for clear hearing by blocking external noise. Depending on experimental conditions, blood(red/blue) was splattered on the background of each site(e.g., background or pictures on the wall). The screams of pain were heard whenever an opponent was shot, only for the experimental condition; all other sound effects(e.g., foot steps, shooting, water drops, etc.) could be heard in all conditions. The enemies attacked the participants with guns, but the player-character was controlled with “god-mod,” so there was no death of the player characters in the game.

4.3 Measures

Presence was measured by the revised ITC-SOPI (Independent Television Commission

- Sense Of Presence Inventory) scale. The ITC-SOPI contains 44 items, pertaining to (a) *physical presence*(20 items; $\alpha = .92$), (b) *engagement*(13 items; $\alpha = .86$), (c) *ecological validity*(5 items; $\alpha = .76$), and (d) *negative effects*(6 items; $\alpha = .89$). The ITC-SOPI focus -ed on users’ experiences of media with no reference to objective system parameters[25].

Arousal was measured by self-report (perceived) scale that was used by Anderson, Deuser, and Deneve[26]. The perceived arousal scale was composed of 15 adjective words (e.g., active, excited, lively, vigorous, depressed, tired, etc.); each has a 7-point rating scale to measure the degree of arousal ($\alpha = .753$).

Potential links between arousal and memory were assessed by a recognition memory test that followed the game play session. Each subject viewed a series of 40 screenshots taken from the game. Twenty screenshots depicted locations visited by the player during the game (referred to as “old” screenshots). Twelve of these “old” screen-shots were composed of backgrounds from killing sites that had been experienced with red blood and screams of pain. The other eight “old” screenshots were backgrounds where neither blood-splatter nor pain-screaming occurred. The remaining 20 screenshots were “new” locations not encountered during the game (although they were taken from the same video game to keep the look consistent across memory probes). Each user’s memory score was summed from the right-answered scores of the twelve screenshots where the user could experience blood-splatter(red vs. blue) and screams of pain(on vs. off). Each screenshot

was shown for eight seconds or less(display was response terminated). Subjects were instructed to determine whether they had seen the location during game play or not($M = 9.63$, $SD = 1.55$).

Previous game experience(daily gaming time of shooting games) was measured by question about subjects' daily hours of playing shooting games: "How many hours a day do you play shooting games like in the experiment?" Many violent shooting games like the experiment game are "M(Mature)" rated games that are suitable for persons 17 ages and older. All subjects were above the age of 17, making them all eligible players of these types of games.

4.4 Procedures

Subjects were asked by e-mail to complete an online questionnaire prior to arriving for the experiment. The questionnaire gathered information from the subjects about their daily game-playing time and experience, whether they had played the game used in the experiment, and demographics such as age, gender, and grade-level in college.

Just prior to starting an experimental session, each subject practiced moving their character and using weapons. For this practice, a printed page of instructions was provided, and a trained experimenter read these instructions aloud and aided in their practice. The practice phase did not exceed 10 minutes, and there was no opponent at this level: the only difference was the player-character's perspective that was set for each group(i.e., practice took place using the perspective assumed during the experimental phase).

After the experiment, a questionnaire was administered to assess the subject's feeling of presence(during the game) and perceived arousal. A recognition-memory test, followed the post-questionnaire. Each subject viewed 40 screenshots depicting locations in the game. Half of the locations had been viewed during game play, and half had not.

5. Results

5.1 Realism Cues on Arousal

To test the effects of blood color(red vs. blue) and sound(on vs. off screams) on arousal, we used one-way analysis of covariance(ANCOVA). In each analysis, prior experience time of shooting games was used as a covariate. With arousal as the dependent variable and experience of shooting games as the covariate, there was also a significant difference between blood colors, $F(1, 78) = 5.75$, $p < .05$; and there was a significant effect for the covariate, $F(1, 78) = 6.76$, $p < .05$, $h^2 = .08$. Specifically, subjects in the red blood condition showed higher arousal than those in the blue blood condition. Likewise, there was a significant effect for the screaming sound on the arousal, $F(1, 78) = 4.23$, $p < .05$; and for the covariate, $F(1, 78) = 5.55$, $p < .05$. Player exposed to the pain screaming sound during violence showed higher arousal than when deaths were silent. Players with experience playing games showed more arousal in general. However, there was no significant effect of the player's perspective on arousal, $F(1, 78) = 1.45$, $p > .10$. Players in the first-person perspective had no substantive

difference in arousal than those in the third-person. Thus, H1a and H1b were supported, but H3a was rejected.

5.2 Realism Cues on Presence

With each of four factors of the presence scale(ITC-SOPI) as the dependent variable, and experience time of shooting games as the covariate, the effect of blood color on engagement approached significance($F(1, 78) = 2.78, p < .10$), with a significant effect of the covariate($F(1, 78) = 13.55, p < .01$).

There was no effect for blood color on other factors of presence. On physical presence, $F(1, 78) = .25, p > .10$; for covariate on physical presence, $F(1, 78) = 2.17, p > .10$. On ecological validity, there was a significant effect for the covariate, experience time, ($F(1, 78) = 5.45, p < .05$), but no effect for blood color($F(1, 78) = .59, p > .10$). For blood color on negative effects, there was no effect($F(1, 78) = .57, p > .10$), although there was an effect for covariate($F(1, 78) = 12.20, p < .01$). These results indicate that subjects in red blood condition showed marginally higher engagement than in blue blood condition. However, on the other factors of presence, subjects in the red blood condition did not show higher scores than those in blue blood condition.

In the same way, we found no effects of sound(screams) on the four presence factors, indicating that subjects in the scream-sound condition had no difference in presence than those in no(screams) sound condition. Thus, H2a is marginally supported only on engagement, and H2b was rejected.

5.3 Arousal and Presence

For the test of the relation between arousal and presence, we conducted multiple regressions for each factor of presence as a dependent variable since H4 predicted that there would be an effect of arousal on presence even when other variables(blood color, sound, experience time, and perspective) were controlled for. As indicated in Table 1, with physical presence as a dependent variable, arousal had a significant effect when controlling for other variables, $B = .29, p < .01$; with engagement as a dependent variable, $B = .39, p < .001$; with ecological validity, $B = .30, p < .01$; and with negative effects, $B = -.32, p < .05$. Thus, H4 was supported.

5.4 Effects on User Memory

For the test of the relationships among arousal, presence, and memory, another multiple regression was conducted. With the memory variable as a dependent variable, all other variables were entered as independent variables($R^2 = .28, F(7, 72) = 3.77, p < .01$).

Specifically, those who were exposed to red blood showed significantly high memory scores($B = .73, p < .05$) and those who could hear the screams of pain when they were killing opponents had significantly higher memory scores($B = .82, p < .05$). Thus, both H5a and H5b were supported. However, when other variables were controlled for, those who felt high arousal did not show any significant difference in memory scores($B = -.16, p > .10$). Thus, H6a was rejected. To test the relation between presence and memory, the four factors of presence were analyzed in the

regression. Because of collinearity(VIF > 2.0) among the factors, however, only two factors - engagement and negative effect - were included in the regression. The result showed that those who feel high engagement had high memory scores(B = .87, p < .01). Thus, H6b was supported only with engagement.

[Table 1] Multiple Regression Results

	Arousal	Physical presence	Engagement	Memory
Blood (Red)	.44 *	-.04	.70	.73 *
Sound (Scream)	.38 *	-.17	.00	.78 *
Perspective	.23	-.27 +	-.26 *	.49
Prior Exp.	.15 *	.04	.12**	.05
Arousal		.29 **	.39 ***	.01
Engagement				.93 **
R ²	.20	.15	.39	.27

+p < .10, *p < .05, **p < .01, ***p < .001

5.5 Perspective on Presence

To test the effects of perspective(first-person) on presence when controlling for other variables, we used an analysis of multiple regressions. With physical presence as a dependent variable, first-person perspective had a marginally significant effect on physical presence, B = -.27, p < .10; with engagement, there was a significant effect, B = -.26, p < .05. However, for ecological validity, there was no significant effect, B = -.14, p > .10; for negative effect, there was no effect, either. Thus, H3b was supported with physical presence and engagement in presence.

5.6 Effects of Prior Experience

We also tested the effect of game experience on arousal by a multiple regression with the arousal as a dependent variable(see table 1). Controlling for other variables such as blood color, sound, and perspective, there was a significant effect of game experience on arousal, B = .15, p < .05. Thus, H7a was supported. For the test of the game experience effect on presence, multiple regressions with the four factors of presence as dependent variables were conducted. With engagement, there was a significant effect, B = .12, p < .01; there was also a significant effect on negative effects, B = -.19, p < .01. However, there was no effect with physical presence and ecological validity. Thus, H7b was supported partially with engagement and negative effects.

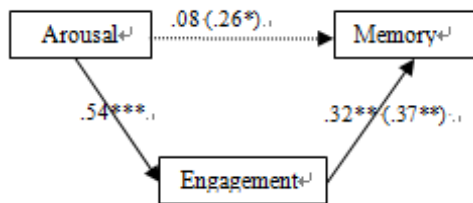
5.7 Mediation Effects

Finally, to test the mediating effect of presence between arousal and memory, we conducted regression analyses to make a path model among arousal, memory, and presence, as indicated in Figure 1.

The results showed that arousal significantly accounted for presence(engagement, $\beta = .54$, p < .001; physical presence, $\beta = .31$, p < .01; ecological validity, $\beta = .34$, p < .01; negative effects, $\beta = -.31$, p < .01). Arousal itself also significantly predicted memory($\beta = .26$, p < .05); and, presence also significantly accounted for memory with only engagement($\beta = .37$, p < .01; physical presence, $\beta = .11$, p > .10; ecological variance, $\beta = .15$, p > .10; negative effects, $\beta = .01$, p > .10). In the regression with the memory variable as a dependent one

and the others (arousal, engagement) as independent ones, presence showed significant effect with the engagement ($\beta = .32, p < .01$). However, arousal had not significant effect on memory in the case ($\beta = .08, p > .10$).

Especially, even though arousal itself predicted memory significantly, when presence (engagement) was included in the regression as another predictor, the effect of arousal was significantly attenuated (from .26 to .08). These results met the statistical criteria to be a mediating variable. Therefore, H6c was supported with the engagement.



* $p < .05$, ** $p < .01$, *** $p < .001$

[Figure 1] Mediation role of engagement

Note 1. Standardized coefficients are inside the arrows.

6. Discussion

This study investigated whether realistic cues of the effects of violence, specifically the use of realistic blood color and screaming pain sounds affected the players' level of arousal, the sense of presence in the game, and their memory for the experience. We also investigated whether the user's perspective, first-person or third-person views, and user's experience playing games had an effect or

interacted with the realism of violence.

The current study provides empirical evidence supporting the effects of blood color and sound cues on users' arousal in violent video games. Graphical effects on viewers or players in VR environments have been continuously raised in violence-related studies. The results indicate that realistic cues of violence, blood color and pain sounds, increase the player's arousal regardless of the user's level of experience playing games. Especially, these findings are in line with the public policy belief that less realistic violence is associated with decreased levels of player arousal. Therefore, the results of this study support the assumption of software rating boards in many countries (e.g. ESRB in USA, CERO in Japan, GRB in Korea) have set realistic blood representations to differentiate games targeted to adult games from games for youth. Additionally, we should not neglect the influence of sound cues on users' arousal. As this study verifies in match with previous studies, the sound cues areas influential as the graphic effect on arousal. However, the rating boards have focused mainly on realistic graphics such as blood, bleeding, or body rupture in violent games. Thus, sound cues, especially screams of pain, need to be considered as an important factor in rating violent games.

Considering that games provide great pleasure or excitement of arousal, a player who is in great arousal might be naturally engaged in the game. Thus, we can conjecture that there would be a strong relationship between users' arousal and the feeling of presence in virtual game environments. The

results of this study, as we predicts, suggest that arousal may have a significant relationship with engagement by affecting presence even controlling for other variables. In addition, this result is consistent with studies of VR environments that show the feeling of presence may to be related with user arousal. As Ravaja and his colleagues[20] found that arousal affected presence experience accompanied by increased engagement, this study showed that arousal was strongly correlated with feelings of being present in the game(engagement). Especially, regarding memory effects, presence(engagement) was stronger than other variables including game manipulations in explaining the effect.

This study also shows that presence(engagement) is an essential variable in explaining the memory effect in games. In previous studies, emotional effects on short-term memory or attention have been found in the studies of visual short-term memory[27]. Additionally, arousal is reported to influence the average speed of data accumulation in memory, such that higher arousal results in faster accumulation of memory[22]. Thus, emotional cues that cause high arousal could result in higher memory. Especially, considering that arousal is highly related with presence and the feeling of presence is associated with memory effects, presence could do an important mediating role between arousal and memory.

As the hypothesis predicts, this study shows the effects of emotional cues, such as the sound of screaming pain and red blood that cause high arousal, increase memory effects. Furthermore, this study shows the engage-

ment, as a factor of presence, has a much greater effect on memory than game manipulations. More interestingly, this study verifies that engagement mediates the memory effect between arousal and memory. These facts strongly imply that enhancing presence (engagement) is one of the most effective ways in increasing memory effects.

Theoretically, the mediating effects of presence have been found in human-computer interaction studies[28,29]. Specifically, in game studies, mediating effects of presence were on users' satisfaction, preference, and enjoyment between cues and the dependent variables[29]. However, there are few studies that showed the mediating effect of presence between arousal and memory both in VR and gaming studies.

Contrary to expectation, realistic sound and blood color did not enhance the feeling of presence. This ineffective result seems to happen because of the discontinuity of such cues. Previous studies about the effects of cues(e.g. image quality, size, color, and dimensionality) on presence used continuous cues that last to the end. However, the cues in this study are experienced just at the moments of users' killing opponents. The difference of cue continuity seems to make such a difference in presence effect.

Besides, perspective does not affect arousal, but first-person condition affects presence negatively. This result, however, is different from that of previous studies that playing games in first-person perspective might increase the feeling of presence or aggression[7,16,17]. Since the environments felt by the first-person perspective users are

identical with those of virtual characters, the users in the first-person perspective may naturally identify themselves with the characters. However, Farrar and her colleagues[8] reported that users' feeling of presence increased in third-person perspective than first-person perspective. The presence of avatar is required in virtual environment for the feeling of presence[15], so mere presence of virtual avatar could elicit presence[30]. Thus, without regard to the perspective, third-person perspective could elicit much higher identification than the first-person perspective for the third-person perspective provides actual presence of virtual body[8].

This study implies that games can be a good tool in enhancing recognition: games are a very useful instrument in education and advertisement. It has been found that interactive games can provide educational benefits such as better memory retention and intensive engagement[29]. In addition, VR games provide pleasure and excitement of arousal, and regarded as an essential tool in offering presence experience with realistic graphics. However, previous studies have focused on learning games, in other words, on the games for mainly educational purposes by adding gaming features such as interactivity and feedbacks to educational content. Considering that the experiment game of this study was not an education-purpose game, the significant effects on recognition explicitly verify that games themselves could be a good vehicle for recognition: games could be an essential factor in education and advertisement.

Recently, advertisers are much interested in the effects of games as a tool of advertise

ment. The effects of advertising in games depend on whether the intermittent images or texts can be memorized to gamers effectively. In terms of the memory effects, this study suggests that some effective ways such as enhancing presence and arranging cues with high arousal in maximizing advertising effects. Practically, the result that memory effects are different by the blood and sound condition provides a useful hint to advertisers. In that the memory(recognition) effect was restricted on the scenes where the red blood or screaming sound was on, product icons or characters that are designed for viewers' recognition could have more effects when they are located on the places where such cues are evoked in games.

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