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## Effects of Representational Realism in 3D Violent Games

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### Abstract

*This study investigated whether realistic violence cues - blood color (red or blue), pain sounds (screams), and perspective (first-person or third-person) - affect players' arousal, sense of presence, and their memory for the game events. Results indicated that both manipulations of realistic cues of violence (red blood and screams of pain) increased the player's arousal regardless of the user's level of game experience, and arousal had a significant relationship with engagement by strongly affecting the sense of presence. Presence (engagement) was stronger than other variables in explaining the memory effect (recognition test), and engagement mediated the effect between arousal and memory. Presence (engagement) was significantly higher for the third-person perspective than the first-person view on game violence.*

### 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 have become more realistic and interactive [59]. 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 [9, 34]. 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' perceptions, memories, and behaviors [3, 33, 36, 59]. 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 violent 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. Previous literature and hypotheses

#### 2.1. Representational Realism (blood, screams of pain and perspective) on the Experience of Virtual Violence

Researchers and policy makers have argued that the representational realism of violence affects users' arousal (excitement) and memory for mediated violent experiences. Emotional reactions to stimuli such as color and sound have long been a topic of interest for scholars [19, 45, 60, 64]. When people experience emotionally arousing pictures or sounds, their physiological responses vary significantly with reports of affective arousal [14]. In some cases, images of "blood and gore" are seen to increase arousal in the user, with the potential to desensitize the user to violence. Interestingly, the increased realism of pain cues such as facial contortions and screams are claimed to increase not only arousal but also empathy with victims.

**2.1.1. Effects of Blood and Color on Arousal.** The sight of realistic blood has been shown to be inherently arousing for most viewers. As a result the representation of blood in violent games is one factor that differentiates adult games from youth-oriented games by game rating boards. For example, games with realistic depiction of blood cannot be purchased 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 (e.g. blue or white) or by eliminating blood entirely. Fundamentally, the policy belief is that non-realistic blood color and bleeding is less arousing and less memorable, therefore it is likely to have less of an effect on the player. In this study we directly test this 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 thought to influence aggressive behavior through their impact on arousal [2]. Farrar, Krcmar,

and Nowak [24] reported that the presence of blood in games caused users' gore perception and aggressive thoughts to increase. Likewise, in the study about blood effect at a first-person shooting game, *Mortal Kombat*, users playing with depictions of blood showed higher arousal than those without blood [6]. In a study of violence perceptions associated with television viewing, Potter, Pashupati, Pekurny, Hoffman, and Davis [51] found that a strong effect of violence was not necessarily due to the number of violent acts but more to the graphic and explicit violence depicted. Because violent environments in Virtual Reality (VR) affect the arousal and aggressive thoughts of young adults [18], graphically violent games might cause high arousal and an increased probability of aggressive thoughts and behaviors.

With respect to game studies, there is relatively little research into the effects of color. Wolfson and Case [64] found that game scores were higher when backgrounds were red rather than blue. Stark, Saunders, and Wookey [60] examined the effects of red and blue colors on the gaming behaviors of gamblers, and reported that people exposed to red lighting took more risks and staked more money. Even though these studies focused on the effects of screen color or background lighting, they are consistent with the notion that red evokes more arousal than blue.

**2.1.2. Effects of Auditory Pain Cues on Arousal.** Other than the sound of weaponry, 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 users' empathy [20]. In this study we examined the effects of audio pain cues – specifically screams of pain – on player arousal.

For game players, sound effects with intermittent sirens or bells have been shown to increase game players' arousal [30]. According to Bradley and Lang [14], listening to unpleasant sounds (e.g. screams of pain) resulted in higher arousal than neutral sounds. Likewise, listening to annoying or unpleasant sounds (e.g. noise) is reported to affect both arousal and task performance [19, 25, 45].

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): (a) Red blood and (b) the screams of pain will lead to increased arousal compared to blue blood and the absence of screams*

### 2.1.3. Effects of Blood Color and Sound Cues on Presence

Presence has been defined as the sense of “being there” in a virtual environment. The construct addresses the degree to which a 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 physical world that the user inhabits [10, 38, 46, 61]

Effects of color and sound on arousal have been reported in previous research [14, 64], which have also been regarded as *causes* of presence in VR studies [46]. Since video games are played in VR environments, color and sound are likely to affect not only a users' arousal but also their sense 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 sense of presence.

From the previous literature about the causal variables of presence, realism of perceptual cues such as color and sound are argued to be media variables that affect presence [46]. Since real blood is red, red blood within a game might increase the feeling of being present in the game world.

Adding pain cues such as screaming adds further sensory information to the virtual environment [38, 46, 61] as opposed to environments that lack this cue, and should augment the sense of presence.

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.*

**2.1.4. Effects of User Perspective on Mediated Experience of Violence.** Another dimension of representational realism in computer games that is believed to affect user experience is perspective. Games are often experience from a third-person perspective, which is a viewpoint in virtual space that unnaturally hovers over the avatar body that represents the user in the virtual environment. On the other hand, the real world is experienced directly from the viewpoint of the body. Some games simulate this viewpoint by a “more realistic” first-person perspective, which is a view of the world position near the head of the character.

Previous literature about violent games says that first-person video game playing heightens aggression through identification with the virtual characters compared to third-person perspective [2, 62]. Likewise, viewer perspective has been shown to influence the sense of presence in games (i.e., first-person vs. third-person; [22, 56, 62]). Specifically, first-person perspective games are reported to enhance the sense of presence through the identification process [56, 62].

We propose following hypotheses:

*H3 (a/b): (a) Arousal and (b) presence will increase for first-person perspective compared to third-person.*

## 2.2. Modeling the Experience of Violence: The Relationship between Presence, Arousal and Memory

Key to understanding the effects of medium and violence representation is to model the experience. The constructs of arousal, presence, and memory all characterize different facets

of the user experience of violent content and acts of virtual violence.

As we mentioned above, presence has been defined as the sense of being in the virtual environment. The construct addresses the degree to which a 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 [10, 46, 61]

**2.2.1. Presence and Its Relationship with Arousal.** The user's sense of arousal and presence are likely to mediate some of the effects of experiencing virtual violence, including cues that make the representation of violence more realistic. Advanced and highly interactive virtual environments are associated with the sense of presence, which is often accompanied by high levels of arousal [26, 54, 61]. Virtual environments like televised graphic presentations through television are reported to produce high level of arousal [63], as to make people immersed in the media for the excitement [65]. Likewise, media presentations that bring forth a strong sense of presence often elicit greater self-reported and physiological arousal [46, 55].

In video games, a strong sense of presence has been shown to elicit greater enjoyment [29]. Ravaja et al. [55], monitoring facial expressions, found that a higher sense of presence was related to increase emotional response during video game play. In other words, arousal is strongly associated with presence in VR environments, and it might increase the sense of presence. Thus we propose the following hypothesis:

*H4: Arousal will increase the sense of presence.*

**2.2.2. Effects of Arousal and Presence on Memory.** Previous studies into 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 or materials better than neutral ones [13, 16, 17, 21, 31, 32]. 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 [37, 50]. Bradley, Greenwald, Petry, and Lang [15] found that memory for the occurrence of an emotional stimulus associated with high arousal is better than for a stimulus rated low in arousal.

Additionally, recent studies illustrate the effects of arousal on both VSTM (Visual Short-Term Memory) and users' attention [1, 37]. Therefore, individuals may orient their attention toward aspects of emotional events that will later allow correct assignment to internal or external sources, and these contextual elements also may be more likely to be bound together into a stable memory [27, 37]. However, within the gaming and VR literature, there are relatively few studies into the effects of arousal and presence on memory.

In line with the previous studies, we conjecture that the memory for a violent event in a game, if it caused high arousal, will last relatively longer and be accompanied by higher recall

accuracy than non-arousing events. Furthermore, if the sight of realistic blood induced arousal, users may also remember the contexts in which they saw the blood. Likewise, we can assume that presence will also affect memory significantly. Specifically, if arousal co-occurs with strong presence, we suspect that the sense of presence might mediate the effect of arousal on memory.

We propose the following hypotheses:

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

*H6a: Arousal will increase memory for events and places.*

*H6b: Users' sense of presence in the game will increase memory for events and places.*

*RQ: Will the sense of presence mediate between users' arousal and their memory for game events and places?*

From the above hypotheses, we constituted a hypothetical model (see Figure 1).

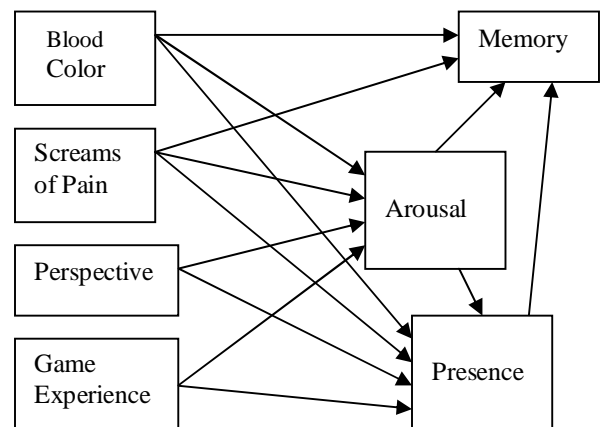


Figure 15 Research model

## 2.3 Individual Differences: Experience with Gaming Media and Violence

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 the experiment presented here, we controlled for user experience.

Media experience (e.g. exposure to television and video games) has been shown to covary with aggressive affect and arousal [3, 4, 57]. Prior experience of media has been regarded to be an essential factor both in presence and in gaming studies [2, 24, 46, 57].

In the same context, prior experience of media has been reported as an individual variable that affects the sense of presence [46]. In VR game studies, Tamborini and his

colleagues [62] showed that prior experience with violent game use had a strong effect on presence. Thus, we can suppose that game experience might influence arousal and the sense of presence. The following hypothesis follows:

*H7 (a/b): Experience of playing computer games will increase (a) users' arousal and (b) their sense of presence in the game.*

### 3. Methods

#### 3.1. Design and Participants

The experiment used a 2 (screams of pain) X 2 (blood color) X 2 (perspective) between-subjects design. The independent variables had the following levels: "screams of pain" had two levels, on or off; blood color, had two levels, red blood vs. blue blood; and user perspective had two levels, first-person vs. third-person. Participants played the game *Half-Life 2*, a popular first-person shooter game, then answered questions about arousal and presence, and took a memory test.

A total 80 participants (Mean = 20.0 years, SD = 1.87) were recruited from Michigan State University. Participants were recruited for the study on a voluntary basis from two undergraduate classes. They were randomly assigned to one of the eight conditions. In each condition, there were 8 male and 2 female participants. The average game-playing time during the study for each participant was 12 minutes. Participants received course credit for their participation in the experiment.

#### 3.2. Stimulus Materials

The experiment used the game *Half-Life 2*, which is rated "M" (Mature) by the Entertainment Software Rating Board (ESRB) because of violence, blood and gore. Since perspective and blood color are not modifiable in the game, these were modified using Garry's Mod ([www.garrysmo.com](http://www.garrysmo.com)), which is an interface designed to give the player control over game events and characteristics. Participants played one session of the modified game for approximately 12 minutes. During the game the player's task was to walk through several locations in the game terrain, a maze of rooms and corridors, while fighting opponents along the way. There were 20 opponents encountered during the experiment at 10 different sites in the game. During play, all participants wore head-phones to maximize the clarity of auditory cues and block external noise. Red Blood was splattered on the background of each location in the game (e.g., background wall or pictures on the wall), while the color of blood emitted by wounded enemies was either red or blue, depending on experimental condition. However, there was no amputation or rupture of the bodies.

The sounds of pain were heard whenever an enemy was killed, but only for participants in this experimental condition; all other sound effects (e.g., foot steps, shooting, water drops, etc.) could be heard by all participants. All enemies were male; some wore prisoner clothes, others wore military clothes with

gas-proof masks covering their faces. The opponents attacked the participants with guns or environmental objects, but they were designed to be weaker than the player-character controlled by the participant.

#### 3.3. 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; e.g., "I felt as though I was in the same space as the characters and/or objects," "I had a sense of being in the scenes displayed,"  $\alpha = .922$ ), (b) engagement (13 items; e.g., "I felt involved in the displayed environment," "I paid more attention to the displayed environment than I did to my own thoughts,"  $\alpha = .856$ ), (c) ecological validity (5 items; e.g., "The scenes depicted could really occur in the real world," "The content seemed believable to me,"  $\alpha = .758$ ), and (d) negative effects (6 items: e.g., "I felt dizzy," "I felt I had a headache,"  $\alpha = .892$ ). The ITC-SOPI focuses on users' experiences of media with no reference to objective system parameters [44].

Perceived arousal was measured by a self-report scale that was used by Anderson, Deuser, and Deneve [5]. The arousal scale was composed of 15 adjectives (e.g., active, excited, lively, vigorous, depressed, tired, etc.); each with a 7-point rating scale to measure the degree of arousal ( $\alpha = .753$ ).

A recognition memory test followed the game playing session. Each participant 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 screenshots were composed of backgrounds from killing sites that had been experienced with blood emission 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 correctly-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). Participants were instructed to determine whether they had seen the location during game play or not. The results showed that about 80% of the screenshots were correctly answered ( $M = 9.63$ ,  $SD = 1.55$ ), and the average reaction time was about 2.06 seconds for each screenshot.

Previous game experience (daily playing time of shooting games) was measured by questions about participants' daily hours of playing shooting games (in the last 6 months). Participants rated their previous experience on an 8-point scale: 1 (none), 2 (less than 30 min.), 3 (more than 30 min. – 1 hour), 4 (more than 1 hour – 2 hours), 5 (more than 2 hours – 3 hours), 6 (more than 3 hours – 4 hours), 7 (more than 4 hours – 5 hours), 8 (more than 5 hours). ( $M = 3.15$ ,  $SD = 1.51$ )

### 3.4. Procedure

Participants were asked by e-mail to complete an online questionnaire prior to arriving for the experiment. The questionnaire gathered information from the participants 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.

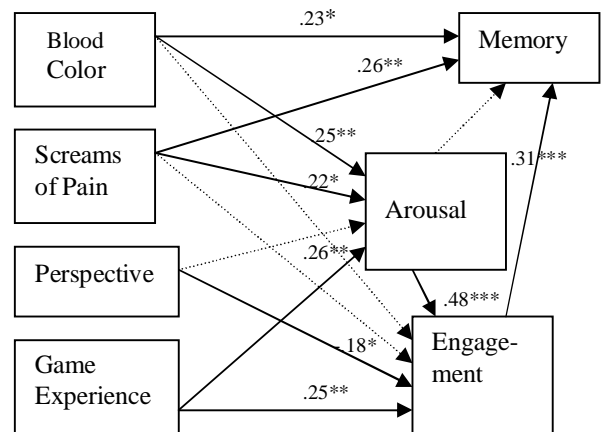
Just prior to starting an experimental session, each participant practiced moving their character and using weapons. For this practice, a printed page of instructions was provided, and a trained experimenter read these instructions aloud and aided in their practice. The practice phase did not exceed 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 assigned during the experimental phase).

After the experiment, the questionnaires were administered to assess the participant's sense of presence (during the game) and perceived arousal. The recognition-memory test [12, 15, 23] followed these post-questionnaires. Each participant viewed 40 screenshots depicting locations in the game. Half of the locations had been viewed during game play, and half had not. Participants were asked to quickly decide within 8 seconds whether they had seen the location before or not.

### 4. Results

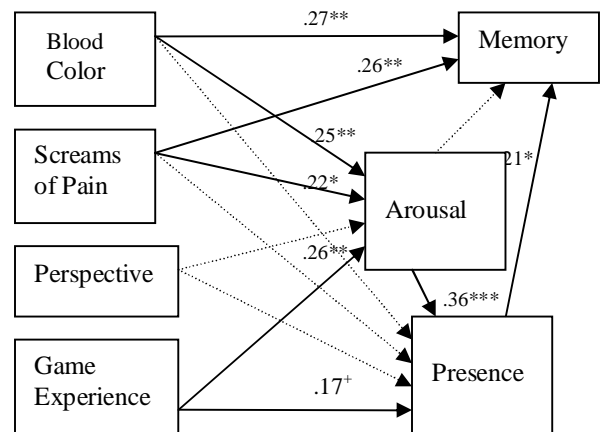
We evaluated our structural equation model (SEM) using AMOS 5.0. The structural model specifies the effects of blood color, screams of pain, perspective, and game experience on both arousal and presence; and the model hypothesizes the relationships among arousal, presence and memory. Since the ITC-SOPI measure was used for the sense of presence, the four factors (engagement, physical presence, ecological validity, and negative effects) were all used in testing the effects of independent variables by using multiple regression tests with each factor as a dependent variable. Finally, in the structural model, we adopted two concepts respectively, engagement (model-1) and physical presence (model-2).

Overall, the two structural equation models were made with representational realism, arousal, presence (model-1 with engagement; model-2 with physical presence), and memory. Model-1 offers very good fit (RMSEA = .000, NFI = .955, CFI = 1.00, and GFI = .987) with using the criteria of RMSEA below .06, NFI/CFI above .90, and GFI above .80 (see Figure 2). Likewise, the model-2 also showed very good fit (RMSEA = .000, NFI = .964, CFI = 1.00, and GFI = .993.) with using the same criteria (see Figure 3).



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

Figure 2 Structure equation model-1 (engagement).



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

Figure 3 Structure equation model-2 (physical presence).

#### 4.1. Effects of representational realism of violence and game experience on player arousal

The effects of blood color (red) and sound (screams of pain) showed significant effects on arousal (red blood,  $\beta = .25$ ,  $p < .01$ ; screams of pain,  $\beta = .22$ ,  $p < .05$ ). Specifically, participants in the red blood condition showed higher arousal than those in the blue blood condition. Likewise, players exposed to the pain sounds during violence showed higher arousal than when deaths were silent. However, there was no significant effect of the player's perspective on arousal ( $\beta = .13$ ,  $p > .10$ ). Players in the first-person perspective showed no substantive difference in arousal than those in the third-person.

Controlling for other variables such as blood color, sound, and perspective, there was a significant effect of game experience on player arousal ( $\beta = .26, p < .01$ ): participants who had more experiences in shooting games showed higher arousal than those who had less experience. Thus, H1a, H1b, and H7a were supported, but H3a was rejected.

#### 4.2. Effects of representational realism and game experience on presence

To test the effects of blood color (red vs. blue), pain sounds (on vs. off screams), and perspective (first-person vs. third-person) on presence, we used multiple regressions. With each of the four factors of the presence scale (ITC-SOPI) as the dependent variables, the effect of perspective on presence was tested. The effect of perspective had a significant effect on engagement ( $B = -.26, t = -1.98, p < .05$ ). Participants in third-person perspective showed higher engagement than those in first-person perspective. However, there was not any significant effect on physical presence ( $B = -.13, t = -.92, p > .10$ ), on ecological validity ( $B = -.14, t = -.83, p > .10$ ) and negative effects ( $B = .23, t = 1.17, p > .10$ ). Thus, H3b was supported with only engagement in presence.

We also tested the effect of game experience on presence with the four factors of presence as dependent variables. For engagement, there was a significant effect ( $B = .12, t = 2.67, p < .01$ ). For physical presence, there was also a marginally significant effect ( $B = .10, t = 1.58, p < .10$ ); likewise, for ecological validity, there was a marginal effect ( $B = .10, t = 1.58, p < .10$ ). There was also a strongly significant effect of game experience on negative effects ( $B = -.19, t = -2.75, p < .01$ ). Thus, H7b was supported strongly with engagement and negative effects, and supported marginally with physical presence and ecological validity.

However, there was no significant effect of blood color on the factors of presence (for engagement,  $B = .07, t = .53, p > .10$ ; for physical presence,  $B = -.14, t = -.94, p > .10$ ; for ecological validity,  $B = .01, t = .01, p > .10$ ; for negative effects,  $B = .29, t = 1.45, p > .10$ ). This result indicates that participants in the red blood condition did not show a higher degree of presence than those in the blue blood condition. In the same way, we found no effects of screams of pain on the four presence factors (for engagement,  $B = .01, t = .01, p > .10$ ; for physical presence,  $B = -.01, t = -.06, p > .10$ ; for ecological validity,  $B = -.15, t = -.87, p > .10$ ; for negative effects,  $B = .10, t = .52, p > .10$ ), indicating that participants in the scream-sound condition had no difference in presence than those in the no (screams) sound condition. Thus, H2a and H2b were rejected.

#### 4.3. Relations between arousal and presence

Because of collinearity ( $VIF > 2.0$ ) among the factors of presence, just two - engagement and physical presence - were included in the structural model respectively. In structural model-1, arousal significantly affected engagement ( $\beta = .48, p$

$< .001$ ); in model-2, arousal also significantly increased physical presence ( $\beta = .36, p < .001$ ).

Thus, as H4 predicted that there would be a significant effect of arousal on presence even when other variables (blood color, sound, experience, and perspective) were controlled for, the degree of presence (both engagement and physical presence) was enhanced as participants' arousal was increased. Thus, H4 was strongly supported.

#### 4.4. Effects of arousal, presence, and realistic cues on memory

The effects of blood color (red) and pain sounds (screams of pain) showed significant effects on memory (in model-1, red blood  $\beta = .23, p < .05$ ; screams of pain,  $\beta = .26, p < .01$ ; in model-2, red blood  $\beta = .27, p < .01$ ; screams of pain,  $\beta = .26, p < .01$ ). Specifically, the results indicates that those who were exposed to red blood showed significantly higher memory scores, and those who could hear the screams of pain when they were killing opponents had significantly higher memory scores. Thus, both H5a and H5b were supported.

For the effect of presence on memory, there were also significant effects in both models. The result showed that those who feel high engagement had strongly high memory scores (in model-1,  $\beta = .31, p < .001$ ). Likewise, the effect of physical presence was also significant on memory scores in model-2: participants who feel high sense of physical presence showed significantly high degree of memory ( $\beta = .21, p < .05$ ). Thus, H6b was supported with both engagement and physical presence.

There was a significant correlation between arousal and memory ( $r = .26, p < .05$ ). However, when other variables were controlled for, those who felt high arousal did not show any significant difference in memory scores (in model-1,  $\beta = -.03, p > .10$ ; in model-2,  $\beta = .05, p > .10$ ). Thus, H6a was rejected.

#### 4.5. Mediating effects of the users sense of presence on their memory

Finally, to test the research question that supposes the mediating effect of presence between arousal and memory, we conducted regression analyses to make a path model among arousal, memory, and presence. The results showed that arousal significantly accounted for presence (engagement,  $\beta = .54, p < .001$ ; physical presence,  $\beta = .37, p < .001$ ). When we used arousal alone as an independent variable, there was a significant effect on memory ( $\beta = .26, p < .05$ ); and, presence also significantly accounted for memory (engagement,  $\beta = .37, p < .01$ ; physical presence,  $\beta = .24, p < .05$ ).

In the regression with memory as dependent variable and the others (arousal, engagement) as independent variables, presence showed significant effect with engagement ( $\beta = .32, p < .01$ ) However, arousal had no significant effect on memory in the case ( $\beta = .08, p > .10$ ). Specifically, even though arousal itself had a significant relationship with memory, when presence (engagement) was included in the regression as

another predictor, the effect of arousal was significantly attenuated (from .26 to .08) as indicated in Figure 4.

In the same way, for physical presence, we conducted a regression analysis with memory as dependent variable and the others (arousal, physical presence) as independent variables. However, both physical presence and arousal showed marginal effect on memory (arousal,  $\beta = .19, p < .10$ , physical presence,  $\beta = .18, p < .10$ ) without any significant decrease.

The results pertaining to engagement meet the statistical criteria to be considered a mediating variable [see 7] between arousal and memory. Therefore, the research question that presence will mediate between arousal and memory was validated only with respect to engagement.

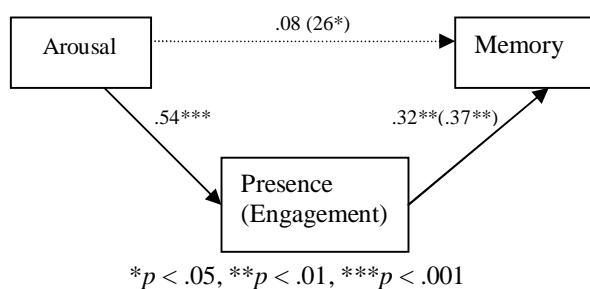


Figure 4 Mediating effect of engagement.

## 5. Discussion

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

This study provides empirical evidence that realistic blood color influences player arousal. Questions about the effects of graphic realism have been continuously raised in studies of violence content across all media. The results of the current study indicate that realistic blood color increases the player's arousal. This effect is not a novelty effect as arousal levels are raised regardless of the user's level of experience playing games.

These findings are in line with the public policy belief that less realistic violence is associated with lower levels of player arousal. Therefore, the results of this study support the decision by software rating boards in many countries (e.g. ESRB in USA, CERO in Japan, GRB in Korea) to differentiate games targeted to adults and youths based on the realism of violence cues. In some cases it has been a policy to make game violence less realistic by changing blood color. Our studies support the intuition that this decreased realism may affect arousal.

This study also corroborates previous studies about the relationships between unpleasant sound and arousal [14, 19, 25, 45] by showing that screams of pain are as significantly

influential as visual effects are on arousal. Thus, pain sounds need to be considered as an important factor in rating violent games.

Regarding arousal and presence, we conjectured that there would be a strong relationship between them in virtual game environments and hypothesized that self-reported levels of arousal would be related to self-reports of an increase in the sense of presence. This study shows that arousal has a significant relationship by affecting presence (both engagement and physical presence). This result is consistent with studies of VR environments that show the sense of presence may be related to user arousal [26, 46, 54, 61]. Notably, Ravaja and his colleagues [55] found that arousal affected the experience of presence accompanied by increased engagement in their game studies. The current study showed that people with higher arousal had strong feelings of being present in the game.

Additionally, the current study examined the influence of arousal on memory. In previous studies, emotional effects on short-term memory or attention have been found in the VSTM [1, 37]. Regarding the direct effects of arousal on memory, arousal is reported to influence the average speed of data accumulation in memory, such that higher arousal results in faster accumulation of memory [47].

In the current study, however, arousal did not affect memory directly in gaming environments, when controlled for other variables. Instead, arousal had indirect effects on recognition memory for scenes in the game by influencing the sense of presence (engagement and physical presence). Our study shows that emotional cues, such as the screams of pain and sight of red blood which cause high arousal, affect recognition memory for game scenes directly and strongly regardless of the arousal's effect on memory.

Next, this study reveals that presence (both engagement and physical presence) substantially predicts memory effects. In both models, self reports of presence accounted for memory scores significantly. Specifically, the result suggests that engagement, as a factor of presence, is an essential variable in explaining memory scores. In addition, engagement has a much greater effect on memory than any other variables in predicting memory (see Figure 2). Furthermore, this study verifies that engagement mediates the memory effect between arousal and memory. These findings strongly imply that enhancing presence (engagement) will result in increased memory effects.

Theoretically, the mediating effects of presence have been found in human-computer interaction studies such as e-commerce, speech user interfaces, human-robot interaction, and entertainment games [39, 41, 40, 42, 43]. Specifically, in game studies, mediating effects of presence were on users' satisfaction, preference, and enjoyment between cues and the dependent variables [35, 41, 42, 43]. However, there are few studies that showed the mediating effect of presence between arousal and memory both in VR and gaming studies. Especially, as far as we know, there is no study that examined the mediating effect of presence on memory by dividing presence into sub-factors such as engagement and physical presence.



Interestingly, there was no significant effect for blood color and pain sounds on presence (neither on engagement nor on physical presence). These results may happen because of the discontinuity of such cues in the game. Previous studies into the effects of cues (e.g. image quality, size, color, and dimensionality) on presence used continuous cues that lasted until the end of their experiments [46] enabling participants a chance to feel presence without any pause of cues. However, the cues in this study could be experienced just at the moments of users' killing opponents.

We also found that, contrary to prediction, presence was significantly higher for the third-person perspective than the first-person view on game violence. Likewise, there was no effect of first-person perspective on arousal. These findings, however, are different from previous studies that found playing games in first-person perspective enhance the sense of presence or aggressive affect [2, 56, 62]. Users in first-person perspective may easily identify themselves with the characters in a VR environment because the perspective of users is identical with that of the virtual avatar.

However, the opposite result also has been reported: Farrar et al. [24] found that users' sense of presence increased in third-person perspective. In a VR environment, avatar realism is a required factor that creates users' sense of presence [8], such that mere presence of the virtual body can increase the sense of presence [58]. Thus, regardless of the identical perspective in first-person perspective between character and user, third-person perspective may encourage much higher identification because third-person playing can provide actual presence of virtual body with users [24].

This study suggests that game arousal and cues can be good tools in enhancing recognition memory. If this holds 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 [48, 49, 53] and intensive engagement [28, 52]. In addition VR games provide pleasure and excitement of arousal, and can be regarded as a valuable tool in offering presence experience with realistic graphics. However, previous studies have focused on learning games, in other words on the games for explicit educational purposes by adding gaming features such as interactivity and feedback to educational content. Considering that the experiment game of this study was not an education-purpose game, the significant effects of game manipulations and engagement on recognition memory explicitly verify that games themselves might be useful vehicles for educational content for which recognition memory might be enhanced.

Regarding individual game experience and presence, we found game experience effects both on arousal and on presence (engagement and physical presence as well). Experience of violent games is positively associated with arousal [4] and aggressive affect [2, 3]. In addition, it has been reported that continued experience of a medium make users feel presence with familiarity with the medium [29, 46]. These studies imply that prior experiences increase users' arousal and presence because users can be highly immersed in the media without

feeling any inconvenience in handling the medium. Matching with previous studies, this study shows that experience in violent games significantly affect both arousal and presence, even controlling other variables. Another explanation might be that prior experience allows greater engagement and diminishes the sense of mediation due to familiarity with games.

In conclusion, graphic violent cues appear to play a significant psychological effect in violent computer games. Cues such as blood color and screams of pain increase player arousal and the users' sense of presence in the violent game. It appears that the sense of being present in the virtual environment may mediate the relationship between content cues and recognition memory for environment.

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