

Serious Violence: The Effects of Violent Elements in Serious Games^{*}

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Abstract. In serious game development, violent elements are not used as widely as in the industry. Very few studies looked at the effects of violence in interactive educational contexts. This paper explores the effects of violent versus non-violent audiovisual and narrative elements. In which a better understanding can lead to a positive and appropriate use of violence in serious games. We present 2 experiments (n = 30 and 38) using a custom-made game for human bone anatomy learning. We conducted our first experiment incorporating violent and non-violent audiovisuals without narratives. Small negative effects were observed in the sample group with violent audiovisuals. Afterward, We conducted the second experiment incorporating narratives that aim to negate the negative effects. Our results found significant improvements in short-term memorization in all conditions in both experiments. Player experience evaluation indicates that the non-violent condition results in greater intuitive control, but only in the first experiment.

Keywords: HCI · Serious games · Violence · User study

1 Introduction

It is a topic for ongoing debates in many modern societies that violence in video games could be harmful and might have negative effects. However, it is also a non-negligible fact that violence in medias obviously have a certain appeal. A large proportion of games, movies and novels have violent elements such as crime, murder or war [25, 24, 21]. It is therefore an interesting question if violence as a dramatic element of media might also have a positive and motivational effect. In fact, some studies support this and have shown that violence may positively stimulate perception, attention and cognition as well as giving players more self-control in video games [2, 1, 5]. But when we examine the use of violent elements in video games for educational or other serious purposes, the lack of violence may at first be obvious when considering possible ethical reasons. But if audiovisual violence obviously attracts so many players in entertainment games, what cognitive and motivational effects could such stimuli elicit in an educational application?

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To answer our research question: Can violent audiovisual elements in serious games make users learn any different than the traditional non-violent counterparts? We first developed an educational serious game on the subject of basic bone anatomy with three different audiovisual elements as stimuli: *Non-violent*, *Violent*, and *Neutral*. The game’s objective is to interact with a talking skeleton which will announce each bone part that players have to interact with, enabling players to learn what the bones are called and what they look like in 3D space. We evaluated the game design in two aspects: 1) Measuring player experience: through self-reported Player Experience Need Satisfaction (PENS) questionnaire [19]. 2) Effects on memorization: how different the users perform on the bone anatomy quiz before and after the gameplay.

We consider both the supportive and discouraging arguments in our background research. This leads to our research objective focusing on exploring both negative and positive cognitive effects and effects on player experience of violent audiovisual element in a serious game. By comparing it to the neutral, and non-violent (pleasant, constructive) audiovisual elements to find out if there are any advantages or disadvantages from the integration of these different conditions. And if there are negative effects in using violent audiovisual elements, can an integration of a moral disengaging narrative be used to lessen said effects and improve the experience. The better understanding about the effects and appropriate integration of these violent elements from this study can lead to an improved and more versatile serious game design.

2 Related Work

Many studies investigated the positive usage of video games. Such as, how the formal and dramatic elements in game design play important roles. [6] Both can highly influence the player experience. Game mechanics can be used together with different premises resulting in quite different games even though the formal elements of the games are the same. Violence in games is often less linked to certain game mechanics but rather conveyed through audiovisual elements and the appearance of a game and its asset design. Furthermore, from a psychological perspective, a phenomenon of human attraction to violence in real life is also observed. In medias, including video games. Lastly, we look at the investigations of positive effects of violent, non-violent and other unconventional elements in video games.

2.1 Video Games and Learning

Playing video games often requires the player to monitor and to react to stimuli rapidly involving quick decision making. Consequently, multiple studies have found evidence of cognitive skill improvements that can be gained from playing video games. These improvements include attentional control and enhanced adaptability [9], information processing [17] and possible working memory enhancement [16]. Serious games share many of these characteristics found in entertainment video games.

For educational interactive media, serious games can be effective teaching tools. Wouters et al. [26] conducted a meta-analysis towards serious games, which indicated that serious games can be more beneficial for learning purposes in comparison with conventional analog methods. Further, they can even be translated to real-life benefits as demonstrated by Malaka et al. [14] that serious games can be used for serious applications such as health and fitness. However, many educational serious games still cannot escape the stigmatization of being dull and boring. A recent finding by Maheu-Cadotte et al. [13] on the effectiveness of serious games in terms of engagement and educational outcomes with healthcare professionals and students showed mixed results. The differences in the level of success of educational games can be attributed to the differences in design elements of serious game. This suggested that the investigation into a novel approach to serious game design can be of significance in gaming research.

2.2 Attraction to Violence

Our research question is based on the assumption that humans are somehow and to some degree attracted to violence. When considering physiological explanation, Strenziok et al. [22] suggested a link between violence and brain reward circuits, indicating that humans can crave violence in the same way as we do for intercourse, food, and narcotics. This implies that we are likely to give more attention and feel pleasure from performing a task related to any of them. Thus it almost seems to be natural that media and fiction focus a lot on "sex and crime" and news, movies, novels and games are flooded with such elements. Popular examples include the recent success of the TV show *Game of Thrones* that has been recognized as the most successful TV series ever and also been criticized for its violent and sexual content [12]. In Goldstein's assembly of expert views on the reasons why people are attracted to media violence [7], Dolf Zillmann summarized his findings ranging from multiple catharsis hypotheses, Jungian and Freudian doctrines, evolutionary notions, protective vigilance and fear mastery, among others. While there is no universal theory, it becomes clear that multitudes of factors can draw a person toward violence in media.

2.3 Violence in Video Games

When we look specifically at violence in video games, the negative effects and the correlation to real-life aggression have been studied and debated extensively for decades. Numerous studies have suggested that there are links between aggression and violent video games [10]. Yet, several studies also suggested a counterpoint that a link between real-world violence and violent video games does not exist and there are more factors to be concerned about when discussing the correlation [15, 18]. Despite the ongoing debate, an undeniable fact is, violent video games sell. An example from the US market in recent years shows the two most played video game genres are first person shooter and action-adventure,³ both

³ <https://www.statista.com/statistics/189592/breakdown-of-us-video-game-sales-2009-by-genre/>

of which generally have violent elements. Furthermore, in another survey, the majority of players also purchase more games with violent element⁴.

2.4 Positive Effect of Violent Video Games

Violent video games have not only been studied in the field of computer science but also in developmental, behavioral, and educational psychology. While the concern is focused on the negative effects of violent media content, some psychologists and computer scientists also look into the positive effects which can be mediated by such contents.

Agina et al. [1] presented the idea of safely turning violent arousal into positive use in children's learning. The authors believe that it is almost impossible to stop the market releasing violent video games and to entirely avoid children from being exposed to them. They conducted a study on 100 preschool children with two violent and two non-violent video games. The participants were separated into two groups, one started with playing violent games and the other started with playing non-violent games. The results showed that children who started with violent game-playing were able to regulate themselves better than the other to understand the benefit of the non-violent learning tools.

2.5 Violence and Short Term Memory Impairment

Despite the positive effects that arise from learning through video games, it is also possible that simulated violent audiovisual elements can also have negative cognitive effects. A research by Bogliacino et al. [3] found that exposure to violence or recalling the violent event can reduce short term memory and cognitive control. In a similar study focusing on media violence, Bushman et al. [4] investigated the effect of watching TV advertisements that contained neutral, sexually explicit, and violent content on the audience's memory. The study found that both sexually explicit and violent advertisements impaired the participants' memories of all gender regardless of whether they liked the programs or not. These examples suggested that despite the positive cognitive skills that can be improved by learning through video games, violent and explicit content can negatively impact the learning process, especially on memorization.

2.6 Video game narratives and Moral disengagement

It is a possibility that having players commit virtual violent acts in video games can lead to negative emotional effects which can undermine the players' experience of the game. This is especially crucial in an educational game that could benefit from player engagement and players having positive experience while playing the game. Hartmann et al. [11] found in their experiments which tested the assumption that moral disengagement cues provided by a violent video

⁴ <https://www.statista.com/statistics/246715/share-of-violent-vs-non-violent-video-games-played-in-the-us/>

game’s narrative, framing the situation as ”Just a game” or ”Just an experiment” and having a just purpose for the violent actions, can lessen the users’ guilt and negative effects. By designing a game narrative according to these concepts, we believe it is possible to reduce or prevent any negative emotional effects from virtual violence and create a better player experience.

2.7 Anatomy Learning with Interactive Systems

The requirement to mentally visualize many parts of the human body in detail and to learn human anatomy by heart can prove to be a challenge to many students. This can lead to lack of motivation and negatively impact the learning outcome. Yammine et al. [27] found that 3D visualization technology has been used for improving the anatomy learning process with great effects. The 3D modelling allow the learner to explore structure of anatomy in more dimension which lead to improvement of spacial knowledge acquisition and user satisfaction compare to traditional 2D study aid methods.

In *Anatomy Builder VR* [20], the authors conducted studies on how a VR system can support embodied learning in anatomy education. The results indicate that the participants prefer to interact with *Anatomy Builder VR* system rather than to interact with the real skeletons.

While these examples demonstrated the positive effects of game technology for anatomy learning, we see a distinct higher potential of the technology beyond these initial setups. When we look at the trend in the current entertainment game market, there are many approaches to designing games that focusing on human body, especially if violent elements can be introduced. A video game like *Surgeon Simulator* [23] tasks players with simulated non-realistic surgical operations on a human body. The game distinguishes itself by incorporate comical interactions and violent elements such as blood and gore into surgery, a serious situation in real life. Despite being non-realistic, the anatomy aspect of the game is accurate enough for beginners and can be a fun introduction into various medical procedures and the human anatomy.

In this paper, we take a closer look at violent game elements that are highly popular in entertainment media but rarely used in educational serious games. We investigate their effects on learning such as memorization in a anatomy learning game.

3 Prototype Development

This section details our serious game design and development for this study, as follows:

3.1 Game Design

We developed a game for Android devices with the main goal to teach basic bone anatomy to the players. We created a talking, full-bodied, human skeleton character, called ”Skelly”, whose 37 bone parts can be tapped on by the



Fig. 1. Game play with 3 stimulus conditions: (from left to right) Non-violent, violent, neutral.

player. the three different game conditions all shared identical game mechanics. As the player taps a certain bone, Skelly will announce the name of the bone immediately in the form of the speech bubble and it will also be displayed in a comic style text. The game scene can be rotated around the skeleton, letting the player see each bone part in 3D. This allows players to associate with the visual representation of the bone parts, their spatial positions on the body and to learn the bone names through the gameplay. The game consists of two play modes. 1) Free Play Mode: the player can tap on any part of the skeleton to reveal the name of the part. 2) Challenge Mode: upon a prompt naming a certain bone, players have to find it and identify it by tapping on it correctly in order to move on to another part. Both modes have a time limit of three minutes.

3.2 Audiovisual stimuli

To determine the effect of violent elements as a stimulus in an educational game setting, we have identified three different audiovisual stimuli as the experimental conditions (Fig. 1).

Neutral In this condition, the bone information is displayed directly when the player taps on a body part. The display background and text colors are in a neutral grayscale tone. Skelly will make neutral mumble sound when each part revealed.

Violent In this condition, each tap on a bone part will break and destroy the part like a hammer smash with added blood splattering visual effect. Each

bone break will result in Skelly's announcement of the bone part's name in pain, accompanied by a scream and hurting animation. The background and displaying text color are in black and red to reinforce the violent context.

Non-violent or pleasant In this condition, the player will have the tasks to rebuild Skelly from a semi-transparent stage into a solid skeleton. Each tap on a bone part will materialize the part with its name revealed with an added burst of hearts as visual effect. Skelly will also enthusiastically announce the names, accompanying with a happy giggle and exciting, nodding animation. The color of background and display text is in refreshing blue and green.

3.3 Narratives

In order to create moral disengagement and lessen the negative effects that could effect players' performances and experiences, mainly by the violent stimulus, we created 2 narratives. Each for Violent and non violent conditions of the game in the form of an in-game cut-scene. Each cut-scene was set to play right after the pre-test section and before the free mode of the game-play section in each version. We strictly focused the writings in the narratives to explain and justify the action that the player about to perform to the talking skeleton and framed the situation as being a somewhat comical incident that happens in an experiment. Both narratives were designed to be symmetrical and comparable to its counterpart. The details of the two narratives are as follow:

Violent narrative The participant is a part of an experimental program that aims to create an artificial talking skeleton for teaching human bone anatomy, but there's a gruesome defect in this particular model. In which the skeleton keeps killing puppies (Corgis) that live in the lab for no reason. "Doing so just makes him happy". The player were then tasked with decommissioning the murderous talking skeleton by destroying its parts one-by-one.

Non-violent narrative The participant is a part of an experimental program that aims to create an artificial talking skeleton for teaching human bone anatomy, but there's a comical problem happening to this particular model. In which the skeleton's parts keep getting stolen by puppies (Corgis) that live in the lab, because dogs love bones. The player were then tasked with reconstructing the poor talking skeleton with its retrieved parts one-by-one.

3.4 Classification of Violence in Video games

According to ESRB ⁵ and PEGI ⁶rating system, a "violence" descriptor is assigned to a computer game which contains depictions of blood, graphic violence

⁵ https://www.esrb.org/ratings/ratings_guide.aspx

⁶ <https://pegi.info/what-do-the-labels-mean>

towards human-looking characters, and dismemberment. Such elements are displayed in the violent condition of our application and fit the descriptor. As such, the mode with violent stimulus of the application should be considered suitable only for teens above 13 years old. While the other two modes with positive and neutral stimuli do not contain any such elements and hence, should not be considered for violence descriptor.

3.5 Ethical Concerns

The experiment was conducted with consenting, adult volunteers, who understood the scope of the experiment. All participants read the information document on the experiment procedure and signed the consent form beforehand. Participants were clearly informed that they were free to stop the experiment at any time without negative consequences. All steps of the procedure were conducted in accordance with the institution’s ethical regulation and did not need additional ethical approval.

4 Study

We conducted a pilot study to evaluate the application, followed by the main user study. Our experiments are structured as follows:

4.1 Material

The application was deployed on an Android tablet with a 10-inch screen, running Android 8.0. The players’ actions were recorded in the text log via the built-in recorder. All quizzes and questionnaires were built into the application. The recorded data included the correct and incorrect choices, together with timestamps. Except for the pre-study trial, the pre- and post-tests were identical multiple choice quizzes including 37 items (same as the number of the bone parts in the game). Audio recordings of the post-experiment interview were conducted using the same tablet under the participants’ consent.

4.2 First Experiment: Audiovisuals

We conducted a between subject experiment with $n=30$ participants who are volunteering international students of various age and gender (average age of 24. 12 females and 18 males). First, the participants were asked to fill in a demographic questionnaire to gather some basic information including age, education level, gender, how often do they play video games, preference of game genres. In addition participants filled in the Ten-Item Personality Inventory (TIPI) [8] Afterward, each took a pre-test evaluating prior knowledge of basic human bone anatomy. Next, they were instructed to play the game under the only one condition which each of them were assigned to in the Free Play Mode. After three minutes of Free Play Mode, the participants were asked to switch to the

Challenge Mode under the same condition. Following that, the participants were asked to take a post-test which we would compare with the result of the pre-test. Lastly, we collected participants' experience data from a PENS questionnaire. All aforementioned questionnaires were built-in into the application.

After each participant finished with the application, we conducted a post-experiment interview. We asked for the participants' usual memorization methods and their opinions on our game. We then investigated the participants' preferences toward different conditions of each participant. These were conducted to determine any correlations between the participants' preferences and methods and their other results. To analyze learning style and the preference of players, we asked questions related to the method of memorization and game elements, as well as specific question related to audiovisual elements. In relation to the learning aspect, we asked what are the methods that the participants normally use for memorizing when they need to learn a subject. Additionally, we asked their opinion of using our game prototype to memorize content from the game. We also asked the participants to specify the most impactful audiovisual element(audio, animation, graphic or other) to them. Finally, We showed videos of gameplay of the other 2 conditions that the participants did not play and asked them to choose one of three versions of game(*Non-violent*, *Violent* or *Neutral*). For the latter, we wanted to know their opinion on audiovisual of the game. Additionally, we also asked for their overall opinion on the game.

4.3 Second Experiment: Narratives

The second experiment were conducted with $n = 38$ volunteering participants. Who are all international students (Average age: 20. 23 males, 15 females). The participants were randomly assigned into 2 groups, each played a version of the game with violent or non-violent condition. All participants followed the same procedures as in the first experiment, except for the additional viewing of the in-game cut-scene before the game-play started. All data recordings, questionnaires and interviewed were conducted identical to the first experiment. The neutral condition was omitted from the second experiment because we determined a neutral narrative to be the same or similar to having no narrative.

5 Result

In the following, we will present and analyze the result from the questionnaires, participants' pre- and post-test scores and post-experiment interviews from both experiments.

5.1 Effect on Short-term Memorization

We determined the short-term memorization effect by looking at the improvements between pre- and post-test scores of participants in each group (full score of 37 points). First, we conducted a one-tailed dependent T-test on the scores of

participants within each group. In the first experiment, the results from each pre-test (Neutral: $M = 9.7$, $SD = 7.39$; Violent: $M = 10.4$, $SD = 8.36$; Non-violent: $M = 13$; $SD = 7.8$) and post-test (Neutral: $M = 22$, $SD = 10.38$; Violent: $M = 19.7$, $SD = 6.36$; Non-violent: $M = 23.1$, $SD = 8.1$) indicate that the Integration of all audiovisual elements resulted in an improvement in short term memorization, Neutral: $t(9) = 5.36$, $p < .001$; Violent: $t(9) = 3.58$, $p = 0.003$; Non-violent: $t(9) = 7.09$, $p < .001$.

The same improvements in short term memorization also present in all conditions in the second experiment. The results from each pre-test (Violent: $M = 4.9$, $SD = 4.33$; Non-violent: $M = 4.26$; $SD = 4.64$) and post-test (Violent: $M = 15.11$, $SD = 6.61$; Non-violent: $M = 17.26$, $SD = 6.02$) indicate that the Integration of all audiovisual elements with the narratives resulted in an improvement in short term memorization, Violent: $t(18) = 8.469$, $p < 0.001$; Non-violent: $t(18) = 7.34$, $p < .001$. All groups have significant improvements in the post-test scores compare to their pre-test scores.

Secondly, we look at the improvement scores (Post-test scores minus pre-test scores) of each participant to compare between groups. Overall, the lowest improvement score being 2 points and highest being 23 points from the first experiment. Participants in neutral condition had the highest mean improvement scores. One-way ANOVA analysis on the scores of the 3 conditions showed no significant differences. While in the second experiment, the non-violent condition with narrative has the higher mean score compares to its violent counterpart. Similar to the first experiment, no significant different were found in One-way ANOVA analysis.

5.2 Adverse Effect on Memorization from Violent Elements

In the first experiment, even though there are no significant difference in the data between the three groups, a closer look reveals an interesting insight: Only two participants (P09, P11) scored lower in the post-test than in the pre-test. Both were female who played the condition with violent audiovisuals and aggression questionnaire scores of both participants were low on all sub-scales. This reduced score was no longer found in the second experiment. This different outcomes suggest that by incorporating narrative, the negative effects of the violent elements in our serious game can be eliminated or lessen.

5.3 Player Experience

We conducted a one-way analysis of variance (ANOVA) mean comparison on the sub-scales of competence, autonomy, presence/immersion, and intuitive controls of PENS to compare and evaluate the player experiences between different groups and measuring the effect from the violent elements. From the first experiment, our the analysis of the mean scores between 3 groups of neutral, violent and non-violent conditions revealed a significant difference in the sub-scales intuitive control ($F(2, 27) = 4.678$, $p = 0.019$) between the non-violent and the violent conditions. In which the PENS intuitive control sub-scale of the non-violent

group was significantly greater than the violent group. In other words, without any narrative in the game the participants in the non-violent group found the controls to be significantly easier to understand and use when compared to the participants in the violent group.

However, in the second experiment when we incorporated the narratives to lessen the negative effects, no significant difference in player experience were found between the two groups of violent and non-violent conditions from the one-way ANOVA mean comparison. The plot of the sub-scales on both experiments is presented in Fig. 2.

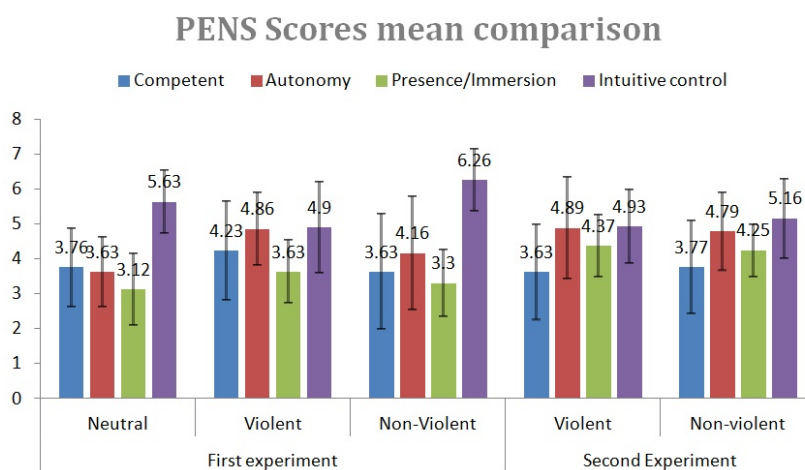


Fig. 2. PENS questionnaire scores' mean comparison per condition from both experiments.

5.4 Interviews

To analyze the interview results, we first collected the answers and categorized them into 4 categories: Opinion on using this game for memorization, overall opinion of the game, audiovisual, usual method of memorization, and the most impactful game element. In the following, we present the results along these categories.

All participants had positive responses to our approach to memorization used in this game and thought they would preferred this game, or thought it can be used to aid the traditional learning methods such as from textbooks and lecture.

Overall opinion on the game on both experiments: 33 percents of the participants had highly positive opinion on the game. Found themselves to be motivated and found the approach to be novel. other 33 percents found the game to be more

like an edutainment or e-learning tool. Less than 2 percents thought the game was boring. The rest had various other opinions.

For participants' usual methods of memorization: 25 percents of the participants preferred some form of writing-down technique, 23 percents preferred using visual aids, visualization, 25 percents preferred using repetition or focus on repeat reading and the rest of the participants preferred other methods. Interestingly, The participants who had the highest improvement in Pre- and post-test scores (above 60 percentile) preferred the methods which can be associated with our game, visualization (15 percents) and repetition (15 percents). There is only 1 participant with high improvement who preferred other memorizing method and none from writing-down group.

For the most impactful element: 26 percents of the participants found the audio of the game to be the most impactful to them. Other 25 percents also thought the same for the graphics. 13 percents chose the animations. The rest thought the most impactful element was the combination of two or more audio-visual elements.

For participants' preferences: the neutral condition was preferred by 12 participants from the first experiment and 6 from the second due to having the least distractions. The violent condition was preferred by 5 participants in the first and 9 in the second because of the more exciting setup, more pressure and its potential to grab more attention. The non-violent condition was most preferred ($n = 13 + 17$) due to the more exciting experience than the neutral condition but less disturbing than the violent condition. The majority of participants in the first experiment mentioned the lack of a story or narrative that might further affect the experiences.

No correlation were found between the participants' opinions and preferences, or between TIPI personality scores and aggression scores to the differences in player experiences or short term memorizing effect in both experiments.

6 Discussion

According to the interview, overall the game was received positively and were found to be a good tool for memorization. Many participants who preferred visualization and repetition methods of memorizing also performed better in the game. However, the game was still viewed as an edutainment and even considered boring by some participants. Which means our game wasn't perceived more like an entertainment game just by adding the audiovisual elements. This could be caused by our decision to keep other game mechanics to the minimum and focus on examining the effects of different audiovisual and narrative elements.

Opinions on the three different audiovisual elements in the first experiment: The participants thought that the neutral condition had the least distractions and allowed for better concentration on memorizing, while opinions on the violent condition scores differ widely. The positive, non-violent condition was the most preferred in the interviews, which was also backed up by PENS having a significantly greater score on intuitive control. This result signified the appropri-

ate use of comfortable and approachable family-friendly audiovisual effects that can improve the experience in serious games.

The Player experience evaluation of the first experiment found that the non-violent audiovisual elements had greater effects on player experience compared to its violent counterpart. Furthermore, we also observed a negative effect of violent audiovisual element with no narrative with two female participants had an adverse memorizing effect. This might be explained by Bogliacino and Bushman's findings [3, 4] on the impairing effects of violence on short-term memory. Even though, these data are only observations without statistical proof, they might indicate an interesting new hypothesis. On the one hand, there could be a gender bias towards violence and the aversion towards violence could have a negative effect on the learning outcome.

In summary, our first experiment showed that without narrative, negative effects can be found when violent audiovisuals were added to the serious game. These effects are more significant in the player experience and smaller in memorization. However, both of these negative effects were effectively eliminated in the second experiment where the narratives designed to lessen the negative effects of violent elements were incorporated into the game. In the second experiment the player experience and the short-term memorization results were similar in both violent and non-violent conditions. Which indicates that the appropriate narrative can be helpful and even necessary when designing a serious game with violent elements.

6.1 Limitation

Some limitations of our research should be noted. First, the sample size of the experiment is small and possibly affected the significance of the result. A larger-scale experiment should be conducted in the future. Secondly, our sample comprised mainly of international university students with various degrees of prior knowledge and interest in the subject of human anatomy. Thirdly, the samples also had an unbalanced gender distribution, due to the randomized group assigning. Lastly, the amount of research on the positive use or learning effects of violence in video games, serious games or media, in general, is still very small.

7 Conclusion and Future Work

Our findings suggested that the integration of violent audiovisual elements in an educational serious game can be a double-edged sword that needs to be handled with care. While strong improvement can be found just as the same as in the other conditions, it also demonstrated a negative cognitive effect in some participants. While the neutral condition offered the least distracting experience, and non-violent condition is reliably positive and preferred by the majority of the participants. The pleasant and constructive non-violent audiovisual effects have proven to help improve user experience in educational application of serious

game, despite the contrast to the subject's grim nature, such as a human skeleton. Which means currently, we cannot recommend the use of violent audiovisual element in any educational serious game due to the possible negative effect without precautions. One such precaution is incorporating an appropriate narrative, framing the scenario as "being in an experiment or a game" and given a justifiable reasoning for the player's violent action. Our second experiment showed how this can eliminate negative player experience and memorization effects.

While the game-play can also be improved by incorporating more game mechanics. While We are planning for a more in-dept study on the other dimensions of violence in serious games, we suggest more researches in the future includes different player's actions and game mechanics in conjunction with the usage of appropriate violent elements in serious games. Long-term experiments can provide more in-depth understanding on the effect of violent elements in serious games. Larger number of subjects and the possibility of choosing one's own condition to catering toward different player preferences can also be examined.

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