DOI: 10.22122/jrrs.v15i5.3488

Published by Vesnu Publications

Interactive Visualization of Data on the Impact of Violent Games on the Behavior of Children and Adolescents: Action Research

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Original Article

Abstract

Introduction: The purpose of the present study is to graphically and comprehensively illustrate the data on the impact of violent video games on the behavior of children and adolescents.

Materials and Methods: This visualization system was designed based on the Schneider principle using the results of a clinical study carried out by psychologists at the Ohio University, Athens, Ohio, United States that included 242 children aged 8 to 12 years in three groups. All groups played different versions of the Minecraft game, then using data recorded in an Excel file on the Figshare site, four variables were depicted. The variables including finding the gun, length of time the gun was held, the number of trigger pulls, as well as demographic or control characteristics of age and gender of the children were evaluated.

Results: Visualization was designed in the Processing software environment and it was easy to compare the three groups using the color, shape, and coordinate channels. Accordingly, it appeared that violent behaviors in children who experienced gun play were greater than those played the sword; both of them showed more violent behaviors compared to the group who played the non-violent version. Violent behaviors were also more prevalent in male children in all three groups. In other words, girls in the 8-12 age group in all three groups were less likely to exhibit post-game aggression.

Conclusion: In this study, data on the impact of violent video games on the behavior of children and adolescents were graphically and comprehensibly visualized based on the Schneider Principle and revealed that violent behaviors in children who experienced violent video games were higher than those in the control group. Violent behaviors were also more prevalent in male children in all three groups.

Keywords: Information visualization; Violent games; Computer games; Violent behaviors; Children

Citation: Jozi M, Mahmoudiasl K, Sekhavat YA. **Interactive Visualization of Data on the Impact of Violent Games on the Behavior of Children and Adolescents: Action Research.** J Res Rehabil Sci 2019; 15(5): 273-9.

Received: 26.09.2019 Accepted: 07.11.2019 Published: 06.12.2019

Introduction

Today, computer games have become one of the most popular entertainments among teenagers; So that with their expansion, watching TV programs has laid in the second row of their pastimes (1). Children associate with the main characters and heroes of the game and try to imitate their behaviors (2). One of the influential factors in children's interest in weapons is their exposure to media containing weapons (3). Studies show that children who are exposed to characters who smoke are more likely to smoke in the future (4) and the ones who are exposed to characters who drink alcohol may be more likely to use alcohol (5). Promoting violence and killing is an important part of many computer games. Additionally, the availability of cold weapons or firearms at home can be another reason for violent behavior in children (2). In television programs, children and adolescents only watch violence, but they experience violence directly in computer games (6).

Information visualization is one of the new methods of display and visual presentation of information that is used with the aim of better understanding and recognition of data and for efficient use in various scientific fields through the proper use of visual tools (7). Visualization accelerates the ability to make decisions based on data and reduces the need for training to understand

information (8). This method allows users to analyze a large amount of information (9). The need for intelligent data analysis in various scientific and educational fields to determine the correct and practical strategy and planning highlights the importance of visualization (7). In information visualization, the designer must be familiar with the skills of designing user interfaces, computer graphics, human-computer interaction, cognitive theories, artistic design, and creativity in order to properly categorize and convey information to the clients (10).

Remarkable efforts have been made to visualize game information; Drachen and Canossa in their study, for example, examined the player's performance during the game and presented data related to it, including the place of death, the causes of death, and the number of deaths in each coordinate in a spatial visualization system in the game environment. In their system, the manner of death of players in different places of the game was shown through the color channel (11). In a study, Drachen et al. explored the effect of gameplay on psychological arousal, including heart rate (HR) and electrodermal activity (EDA) in the players. The results indicated a significant correlation between the psychological arousal and the player's gameplay experience. They visualized the information obtained from their study in the form of several bar graphs to clearly depict the effect of gameplay on HR and EDA (12).

Moura et al. developed a spatial visualization system that allowed analysts to measure, integrate, filter, and compare the behavior of the players based on data. Moreover, in their method, it was possible to view the data of all players in different time periods and special clusters (players with similar game style) in a certain time period, and thus, this system offered a scalable solution. In this system, it was possible to move on the timeline, select a specific map, and analyze it. Analysts could assess whether this information was in line with the designers' goals. For instance, did the game designers expect players to complete 5 maps in the first gameplay hour? Therefore, the system was also a good tool for the game designers to use it to analyze player behavior (13).

Borner and Penumarthy introduced a type of visualization system that could be employed to visualize three-dimensional virtual environments, distribution of their virtual inhabitants in time and space, formation and spread of groups, influence of group leaders, and more. These visualizations were utilized to analyze and visualize data recorded during events in virtual worlds as well as simulated data, but were also used for real-world data (14). In a study, Wallner developed a visualization tool to help analyze the behavior of players and showed the game space as a set of nodes that players visited during the gameplay. He used two different types of games as case studies to demonstrate the flexibility of his approach (15).

In their visualization system, Coulton et al. tried to use place and time variables for the player movements using the geographical techniques. They also discussed how anthropologists employ these techniques to examine the behavior of mobile users (16).

Thawonmas and Iizuka proposed a visualization method for analyzing player behaviors that included two techniques: Classical multidimensional scaling (CMDS) and KeyGraph. In fact, CMDS and KeyGraph were used in discovering clusters of players behaving similarly and in interpreting player performance behaviors in a desired cluster, respectively (17). In their study, Marczak et al. proposed a new method to obtain data on player behavior by analyzing video and audio streams. The game interface features were automatically analyzed, reflecting player behavior and gameplay events (18).

In accordance with the Schneider principle, one of the best visualization techniques is to provide users with a general, uncomplicated image, and then provide zooming and filtering features using appropriate tools (19). In the system designed in the present study, an attempt was made to present a practical and understandable visualization system for all types of users according to the Schneider principle and to visualize data related to the effect of violent games on the behavior of children and adolescents in a graphic and understandable way.

Materials and Methods

Proposed visualization system: This visualization system was designed and implemented based on the Schneider principle (19); it first provides an overview to the user and enables him to access the details of the data using the tools provided for him.

Various software is used for visualization that is used in research fields. For this project, the Processing software [a type of programming language and graphic library that was first designed in 2001 by Reas and Fry (20)] was utilized. This software is a collection of Java libraries and a Processing Development Environment (PDE) built for interactive-visual programming (20) and is used by programmers. Using this software, it is easy to create two-dimensional and three-dimensional interactive and graphical programs and run them on all major operating systems (21). It can also be used to visualize data with PDF output or interactively (20). In the present study, this system was designed in the Processing environment and the effect of computer

games on children's behaviors was shown graphically based on the variables of finding the gun, touching the gun, duration of holding the gun, number of trigger pulls, and a number of control variables such as child gender and age.

Data set: The data used in this visualization system were the results of a clinical study conducted by psychologists at the Ohio University, Athens, Ohio, United States (3). In this study, 242 children in the age group of 8 to 12 years were studied in three groups. The three groups played different versions of the Minecraft Game (Mojang AB, Sweden) in a specific time period. The first group played the gun-free version, the second group the sword-containing version, and the third group the firearm version for 20 minutes. The children then entered in pairs in a room where a number of toys and two real firearms without bullets were hidden. The guns contained sensors on the body and trigger that allowed researchers to detect and record the child's behavior with the gun. The researchers and parents monitored the children's behavior while they were playing in the room. Besides, the children's parents provided researchers with information about their background about guns in a questionnaire. Finally, all the data obtained was placed in the format of an Excel file on the Figshare site. This file had many records, and according to the purpose of the present study, only 4 of them, including finding the gun, touching the gun, duration of holding the gun, number of trigger pulls, as well as demographic characteristics including the age and gender of the child were evaluated (3).

In the system used, using the shape, color, and coordinates channel, it was tried to adjust the information graphically, clearly, and simply for each of the variables tested in the study so that users can understand and resolve these types of important social issues in a shorter time and with a higher understanding.

Results

The first step was to design a visual-interactive system. The information had to be turned into visual elements and their types had to be used to represent each section. In information visualization, the correct choice of video channels is very important; because visual elements can improve the client recognition by increasing memory and processing of the available resources, reducing information search, improving pattern recognition and inferential-conceptual functions, and using perceptual methods to control and encode information (22).

In this system, it was attempted to convey the main purpose of the study to the clients in a general view. Considering figure 1, the gender of the participants in the experiment was displayed in pink and blue, and the classification of the groups was presented to the clients using the shape channel; So that the square, circle, and triangle shapes showed the first to third groups, respectively.

The two variables "gun holding time and gunshots" on the graph axes indicate which group was most inclined to violence in dealing with guns. The user can view the filtered data on the chart by pressing any of the buttons at the bottom of the image. For example, by pressing the first group button, only the visualized data of the first group can be seen on the chart. Additionally, by pressing each of the girl and boy buttons, the user is able to see only the information about the participating girls or boys.

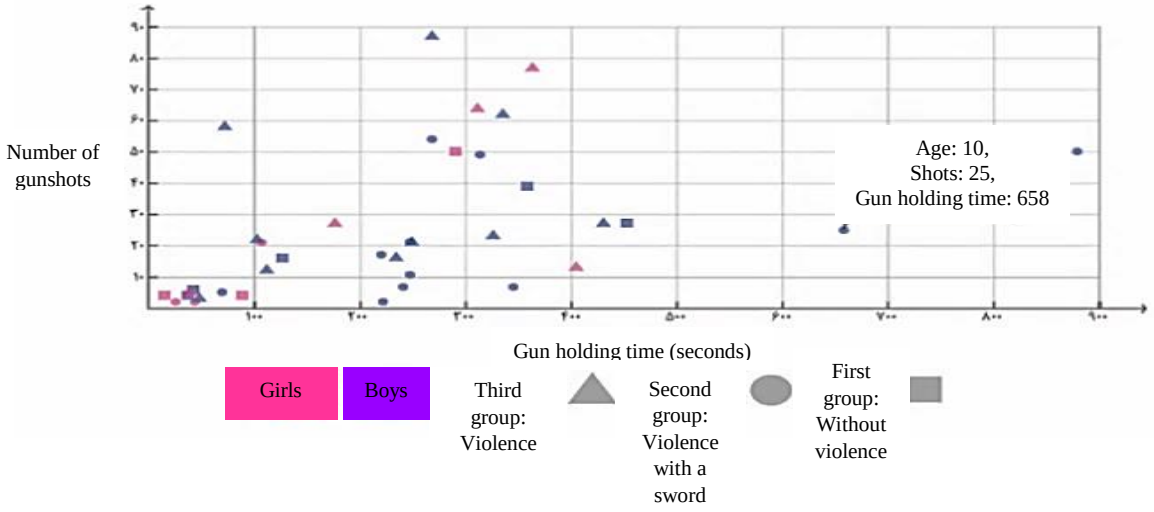

Figure 1. General visualization system

By pressing each of the visualized data on the chart, more detailed information including the age of the participant, the exact number of the gun holding time and the exact number of shots are displayed in a text box.

The full details of all participants in this experiment are shown by groups in figure 2 so that the user can compare the results of all participants in all three groups. Moreover, in this visualization system, the participants in each group can be clearly compared with all their groups and interpreted, or by pressing the visualized data of each participant, a gray box will appear and more details about them will be displayed.

Accordingly, it seems that violent behaviors in children who experienced playing with a gun were more compared to the group that played with swords, and in these two groups, these behaviors were more prominent in comparison to the violence-free group. Furthermore, in all three groups, violent behaviors were more common in older boys. In other words, despite playing with violence, girls aged 8 to 12 were less likely to engage in post-game violent behavior; while, violent behavior was the same for boys and girls in the group who experienced nonviolent play.

Discussion

Information visualization involves the process of converting information, statistics, and data into images through which individuals use their mental and visual ability to comprehend and receive information quickly (23). Such visual aids help create a sense of meaning and, with the structure and patterns of information, contribute to abstract knowledge and facilitate the construction of mind maps of information spaces (24). In the present study, using the data reported in the study by Chang and Bushman (2), the effect of computer games on violent behaviors of children aged 8 to 12 years was investigated and displayed graphically.

Discovering patterns and finding similarities and differences visually is one of the human abilities, and his visual systems can detect changes in size, color, shape, and movement easily and in the fastest possible time (25).

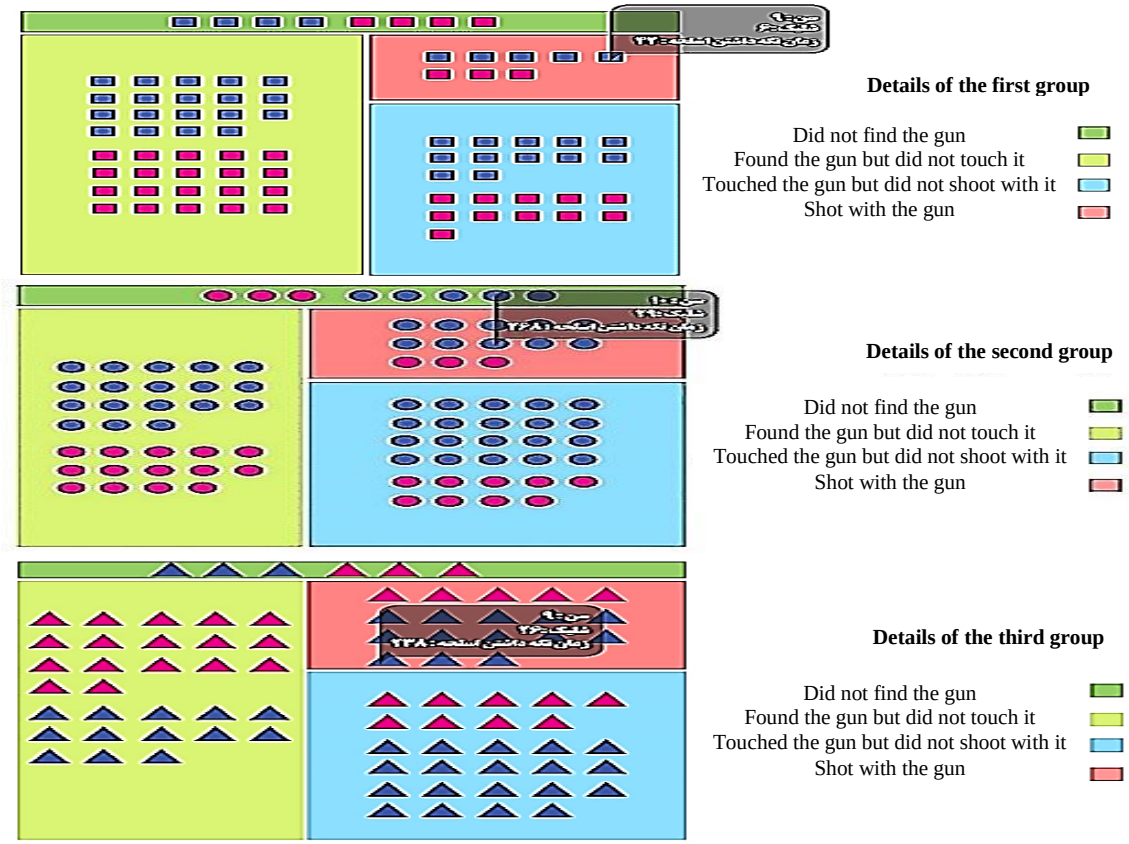

Figure 2. Detail visualization system of the first group (a: non-violent version), the second group (b: violent version with sword), and the third group (c: violent version with gun) in Minecraft Game

Visualization employs this ability, and by presenting information in the form of visual elements, help them be understood quickly. The objective of developing visualization methods and applications is to provide appropriate conditions for information retrieval and better presentation for a better understanding of numbers and figures. Proper visualization provides users with preprocessed data models to create higher levels of interaction instead of having to examine the data in the raw form (24).

Systems that use information visualization techniques display prominent patterns and structures in information and enable users to discover unforeseen properties by facilitating the understanding of information properties and formation of hypotheses (26). Effective user interfaces and the use of appropriate video channels, the ability to detect and filter, and fast and effective interaction with data in visualization, make it possible to quickly understand the information and patterns hidden in images. Therefore, the impact of information visualization in various fields is very fundamental and widespread and can be used as an important decision-making tool (23).

Today, various companies and organizations have been established with the goal to collect information and micro data in various fields (10). This data is provided to researchers at reputable sites to use it to analyze the relationships between variables. In the field of game development, there is a high volume of data that helps researchers, game developers, and sociologists to study and analyze them to be able to make decisions in various fields. In the present era, computer games have become a global phenomenon and an important and profitable business market (10). In addition to economic issues (27), games can play an important and effective role in socio-cultural issues (28). Given that the new generation shows a great interest in computer games, they can also be used in the field of education and learning (29). In most studies that have been performed in the area of visualization of computer game data, the highest focus has been on data related to player behavior in virtual and in-game environments (11-15) and most of these studies allow users to interact well with the system and gain a better understanding of information. Given the investigations, there was no case of examining users' behavior following playing a computer game and visualizing data related to the effect of the game on users.

One of the most important and influential problems of computer games is the issue of violence in children (2,3), something the effect of which on children and adolescents cannot be ignored. Sociologists and psychologists need organized information that can be applied to predict what factors can lead to the spread of violence in society so that they can suggest methods to prevent the spread of violence. A series of violent incidents in schools in the United States led psychologists to design experiments in which they could find a clear link between violent games and the occurrence of violent behaviors in children after using these games (3). The results of these experiments have been provided to researchers in the form of quantitative and qualitative data. Due to the complexity of information, understanding and analyzing the relationship between data are not easy, but by using techniques of visualization and conversion of information into simple and understandable images, the relationship between violent games and violent behavior in children can be expressed in a short time. The present study was able to reflect the important results of a large study on 242 children in the form of four images in a comprehensible and simple way. The designed system made it possible to present complex data from children's behavior in the form of simple and understandable graphics to the user so that he can search among the data, review each one, and achieve useful results with a quick observation.

Limitations

One of the limitations of the present study was the lack of display of data averages, which due to the high importance, a case-by-case analysis of each participant's data was performed and thy were compared with each other. Furthermore, the lack of visualization of all the experimental data was another limitation of the study. In this system, the display of values of variables such as the presence of guns at home, children's previous tendencies towards guns, aggressive traits of children, etc., which were provided to the researchers by their parents, was omitted; Because the main purpose of this visualization system was to show the result of the study and the possibility of filtering and zooming among the variables used in this clinical study to show the perceptual value of the visualization process and the display did not intend the results of the study used.

Recommendations

The ability to display data averages, the ability to compare the average data of groups with each other, the ability to select groups and compare them in pairs as a bar graph, the ability to visualize data such as the presence of guns at home, previous inclinations to

guns, etc. are among the capabilities that can be added to the designed system. With the addition of these features to this visualization system, a complete software with a suitable user interface can be designed, providing users with more zooming and filtering capabilities as well as comparing all study data with each other and obtaining desirable results. It is suggested that this software be used in domestic journals so that readers of scientific articles can see and understand the most important findings of any study in a short time. In this way, it is possible to cite the studies available in the country and enhance the practical application of the results of these studies in the fields of health, economics, industry, etc.

Conclusion

In the present study, the data related to the effect of violent games on the behavior of children and adolescents were visualized graphically and understandably based on the Schneider principle. Four of the children's behaviors, including finding the gun, touching the gun, duration of holding the gun, number of trigger pulls, as well as the demographic characteristics including the age and gender of the child were examined. In the next step, the data on these variables were entered into the imaging system and it was revealed that the incidence of violent behaviors was higher in children who experienced a violent game version compared to the non-violent game group. Additionally, violent behaviors were more common in boys in comparison to girls in all three groups.

Acknowledgments

The present study was performed in the cognitive augmented reality laboratory (CARLab) of Tabriz Islamic Art University, Tabriz, Iran.

This article is among the articles submitted to the Secretariat of the Fifth International Conference on "Computer Games; Challenges and Opportunities" with a special focus on therapeutic games (February 2020, Isfahan, Iran), which was praised by the editorial board of the Journal of Research in Rehabilitation Sciences (JRRS). The authors would like to appreciate the Cyberspace Research Institute, National Cyberspace Center for supporting the publication of this article. The Entertainment Industry Innovation Center of University of Isfahan, which played an important role in collecting data and accomplishing this project is also appreciated.

Authors' Contribution

Mina Jozi: Preparation of scientific references for the study, design and ideation of the visualization system, implementation of the visualization system, manuscript preparation, specialized evaluation of the manuscript in terms of scientific concepts, approval of the final manuscript to be submitted to the journal office, the responsibility of maintaining the integrity of the study process from the beginning to the publication, and responding to the referees' comments; Kosar Mahmoudiasl: Preparation of scientific references for the article, preparing the article and data, implementing the visualization system, manuscript preparation, specialized evaluation of the manuscript in terms of scientific concepts, approval of the final manuscript to be submitted to the journal office, the responsibility of maintaining the integrity of the study process from the beginning to the publication, and responding to the referees' comments; Yoones A. Sekhavat: manuscript preparation, specialized evaluation of the manuscript in terms of scientific concepts, approval of the final manuscript to be submitted to the journal office, the responsibility of maintaining the integrity of the study process from the beginning to the publication, and responding to the referees' comments.

Funding

The study was funded by the research team. The review and publication of the present study in JRRS was carried out with the financial support of the Cyberspace Research Institute of the National Cyberspace Center, sponsoring the 5th International Conference on Computer Games with a Therapeutic Games Approach. This research institute did not contribute to the designing, compiling, and reporting this study.

Conflict of Interest

The authors declare no conflict of interest. Dr. Yoones A. Sekhavat is an assistant professor and a faculty member at the School of Multimedia, Tabriz Islamic Art University. Mina Jozi and Kosar Mahmoudiasl have been MSc students of Multimedia Arts, School of Multimedia, Tabriz Islamic Art University since 2019.

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