



Horror VR as a tool supporting the emotional training of students of the uniformed services. Results of a research experiment

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Abstract

One of the most popular video game genres that have been attracting the attention of players for years is horror games. Their unique character is that they evoke a range of strong emotions. From a VR perspective, the above game genre gains a new, and more immersive dimension and, as a result, enables particularly intense experiences. The presented research was a pedagogical experiment and was conducted in 2024. The results covered a group of 140 players – students of the uniformed services. The selection for the research was intentional. The study used a quantitative-and-qualitative method. The collected data showed that VR horror games evoke statistically significantly higher levels of emotions such as fear, disgust, vigilance, ecstasy, and admiration, compared with PC horror games. According to the respondents, this tool supports learning how to manage stress, panic, and negative emotions, while offering an interesting and credible form of presentation. Consequently, it may be applied in emotional training. Compared with traditional training methods, VR horror provides a more immersive, emotionally intense experience, suggesting potential added value in this respect. Statistical calculations were performed using the Student's T test and the Mann Whitney U test. During the analyses, the mean, mode, as well as the minimum, and maximum values were also determined. This study is not without limitations. It includes a relatively small and homogeneous sample limited to Polish students of the uniformed services. These constraints should be taken into account when interpreting the findings.

Keywords Virtual reality in education · VR horror games in education · Emotional training of students · Plutchnik's wheel of emotions · VR and emotions · Students of the uniformed services · Immersive learning

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1 Introduction

Aleksandra Gałuszka defines emotions as mental states causing specific physiological changes (e.g. adrenaline secretion), somatic (e.g. change of body posture, facial expression - “sad” or “frightened”), cognitive (e.g. appearance of thoughts of escape at the sight of a dangerous dog), related to behaviour (e.g. increased vigilance, escape) (Gałuszka, 2022, p. 147).

According to Robert Plutchik’s theory of emotions, we distinguish eight basic emotions that are universal in nature and determine the functioning of society.

These include: joy, trust, fear, surprise, sadness, disgust, anger, anticipation (Fig. 1). Of course, people can experience a combination of two (marked in white on the graph) or three emotions, with varying intensity (Plutchik, 1980).

Experienced emotions can trigger physiological, psychological, or behavioural responses.

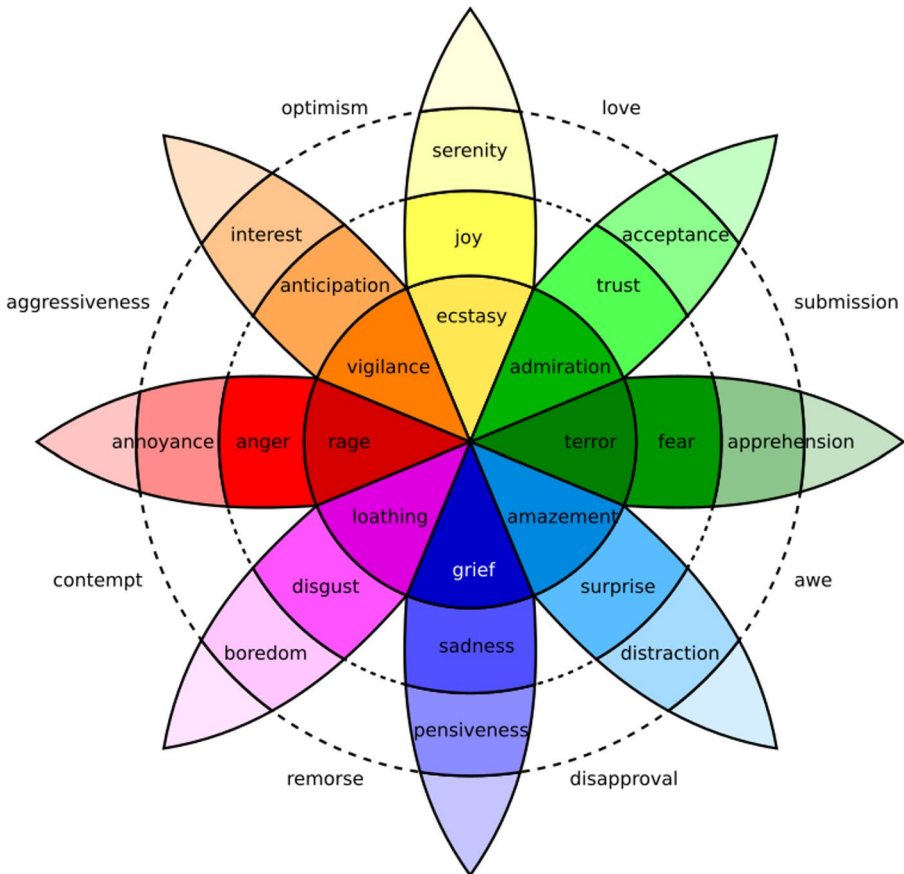


Fig. 1 Plutchik’s wheel of emotions. Source: Wikimedia, https://commons.wikimedia.org/wiki/Category:Plutchik%27s_Wheel_of_Emotions#/media/File:Plutchik-wheel.svg

In the process of training certain professions, such as uniformed services, emotions should also be considered from the perspective of developing the ability to manage them. It is emphasised that “officers should regulate their own emotions and behaviours in order to make good decisions when interacting with the public, regardless of how antagonistic the situation becomes. In many cases, this can make it possible for officers to achieve important goals” (Kurdziel, 2025). The lack of these abilities can lead to a biased perception of threats, errors in assessing the situation, and making inappropriate and sometimes destructive decisions.

In this article, emotions and emotional training in virtual reality are examined from the perspective of students of the uniformed services and the potential benefits they may gain from it. This group was selected because emotional resilience is a critical component of their professional competence. For the purpose of this study, the term ‘students of the uniformed services’ refers to cadets of police, military, and other service academies. These persons are preparing for future professional duties under high-pressure conditions. Their education requires not only theoretical knowledge, but also the ability to regulate emotions, manage stress, and maintain composure in potentially dangerous situations.

2 The literature review

2.1 The importance of emotions in the educational process

In educational research, the importance of an individual’s emotions and engagement, which “can lead to better outcomes at the cognitive level”, is often emphasized (Vesisenaho et al., 2019, p. 1.). According to the observations by Chai M. Tyng, Hafeez U. Amin, Mohamad N. M. Saad, and Aamir S. Malik, taking into account emotional factors in the education process may result in longer and more accurate memorization of the message, compared to data presented in a way devoid of them (Tyng et al., 2017).

Emotions play a pivotal role in shaping learning outcomes. They influence, for example, learning activity, attention, and memory, making them a critical factor in both formal and informal education. Neuropsychological evidence suggests that emotion and cognition are inseparably linked (Immordino-Yang & Damasio, 2007).

Emotional memory enhancement appears to involve the integration of cognitive and emotional neural networks, in which activation of the amygdala enhances the processing of emotionally arousing stimuli while also modulating enhanced memory consolidation along with other memory-related brain regions, particularly the amygdala, hippocampus, MTL, as well as the visual, frontal and parietal cortices (Tyng et al., 2017, p. 17).

Additionally, emotions have a motivating function, which helps to concentrate on the task and, consequently, facilitates remembering the content (Majewska, 2023).

The role of emotions in learning has been highlighted in classical theories of education. Kolb’s experiential learning model (Kolb, 1984) assumes that knowledge emerges through the transformation of experience, and such experiences are inevitably accompanied by strong emotional components. Meanwhile, Piaget (1954)

emphasizes that cognitive development occurs through adaptation to challenging and novel experiences. Emotionally charged situations can therefore foster both assimilation and accommodation processes, enabling students to build new coping strategies and improve decision-making under pressure.

3 VR games and emotion

VR technologies provide unique opportunities to evoke intense emotions. This fact can be used harnessed to enhance various experiences of the individual, resulting from the application's storyline. This prepare users for decision-making in different situation. Research consistently highlights the close relationship between VR environments and emotional responses (Slater & Sanchez-Vives, 2016; Riva et al., 2018). Immersive VR stimulates both physiological and psychological arousal, engaging the amygdala and memory-related regions, and thus influencing emotional memory consolidation (Tyng et al., 2017). Generally VR games elicit a wide spectrum of emotions: disgust (Susindar et al., 2019), stress/tension (Pallavicini et al., 2018), fear/anxiety, surprise/startle (Lin, 2023), enjoyment/fun (Riva et al., 2018), excitement (Slater & Sanchez-Vives, 2016), vigilance (Susindar et al., 2019), empathy (Herrera et al., 2018).

In the literature on the subject it is emphasized that horror games in VR have proven usually fear, disgust, and vigilance (Lin, 2023; Susindar et al., 2019). These emotions, while often negative, can support emotional training by simulating stress-inducing conditions in a safe environment (Pallavicini et al., 2018).

Referring to Kolb's theory, VR games (particularly those evoking intense emotions), provide concrete experiences that can be reflected upon, conceptualized, and reapplied for example in future training scenarios. VR environment are also extremely valuable from the perspective of Piaget's perspective. VR scenarios forcing participants to actions, adapt and reorganize their strategies for coping in new situations. Such experiences not only enrich knowledge structures but also enhance flexibility in decision-making, which is essential for students.

Awareness of emotions and the ability to regulate them in difficult situations is developed, *inter alia*, during emotion training, where new technologies have been used for some time. These include tablets (Houck et al., 2022), biofeedback and neurofeedback (Culbert, 2017), and Smartphone applications (Colombo et al., 2019). They enable the monitoring of emotions and the learning of regulation strategies. They also increase participants' engagement and motivation to take action. They contribute to greater acceptance of the educational process. In this context, it is also worth mentioning VR goggles, which enable personalization of the educational process (Gamito et al., 2024; Binsch et al., 2021; Lacle-Melendez et al., 2025). Additionally, thanks to the immersive nature of the experience, they provide an impression of authenticity.

4 Virtual reality in the education process of uniformed services students

In the context of virtual reality and VR goggles, it is emphasized that there are several levels of immersion and interactivity (low-immersive, semi-immersive, and immersive) (Majewska, 2021), which determine how the subject experiences the sense of presence (Riva et al., 2018) and, as a result, emotions in the VR space. In case of high immersion and interactivity, there is complete immersion in the content being conveyed and the available environment. “This means that when you put on the goggles, you really feel like you’re actually in the game world. Fiction seems incredibly credible” (Sobiepan, 2021). Mel Slater emphasizes in one of his articles that realistic reactions are largely due to a combination of factors such as ‘being there’, i.e. ‘the sense of presence’, also known as the Place Illusion (PI) and the Plausibility Illusion (PSI) giving the subject the belief that “the presented scenario is actually happening” (Slater, 2009, p. 3549). The above feature of VR games is currently used, for example, in exposure therapy, which is an effective tool in the treatment of phobias and anxiety disorders. Research shows that high immersion in a virtual environment and VR games (including horror games) can help an individual gradually confront objects, animals, or situations that cause anxiety, and so leads to the gradual weakening of the anxiety (Parsons & Rizzo, 2008; Lindner et al., 2020; Spyridonis et al., 2024; Krzystanek et al., 2021). This form, as research analyses show, is helpful in overcoming the fear of excessive heights or in becoming accustomed to the sight of blood, which sometimes causes a feeling of discomfort or disgust (Francová et al., 2025).

It should be emphasized that identifying with the avatar enhances the feeling of emotions and the illusion of being transferred to the VR space. It is also emphasized that the player, unlike the viewer or reader, is not in the comfortable position of an outside observer, because his or her decisions and actions are characterized by agency, which makes it much easier for him to put himself in the place of the character being played and empathize with the threat (Markocki, 2016, p. 195).

Consequently, VR games are extremely valuable in the education of the uniformed services, whose members must be prepared to act rationally, especially in extreme and very stressful situations (Bucăța et al., 2023; BBC News, 2018); Police Professional, 2020; Henderson, 2005). The research shows that the technology can effectively simulate the actual combat environment, promote the coordinated development of the stress response and psychological adjustment ability of the trainees, and reduce the equipment loss and time cost, which has important practical value...” (Du, 2025, p. 58534). The importance of VR is also increased by the possibility of repeatedly practising patterns of specific behaviours, the correct reproduction of which in real conditions can even save an individual’s life.

Works on the use of VR goggles emphasize that VR games and presentations can trigger a number of physiological reactions. These include: shaking hands, faster breathing, rapid heartbeat, dizziness, etc. “Only a few people can hide their reactions to this incredibly convincing simulation – most people’s heart rates increase noticeably. Their hands start to sweat. For some people, however, the illusion is so convincing that their limbic system goes into overdrive” (Bailenson, 2018, p. 27).

Virtual presentations can be so convincing that participants smile, blush, or duck to avoid being hit by a virtual object. This proves the power of the VR presentation and the emotions that accompany it. This is owing to the fact that virtual experiences trigger reflections and thoughts that correspond to those experienced in the real world (Meehan et al., 2002).

Referring to the structural model of presence proposed by Anil K. Seth, Keisuke Suzuki, and Hugo D. Critchley, it should be emphasized that the sense of presence is “a basic property of normal conscious experience” (Seth et al., 2012, p. 12). Consequently, properly conducted classes with VR goggles have the potential to improve the effectiveness of education (Majewska, 2021; Repetto et al., 2018). The possibility of experimenting in the VR space also has a positive impact: on the ability to solve problems (Wu et al., 2021), on the increase in the precision of performed activities (even by approx. 25%) compared with the results achieved after watching an educational film (Bailenson et al., 2008), on the reduction of the amount of time needed to master the material (UNIMERSIV, 2015). The literature on the subject emphasizes that VR presentations facilitate the understanding of issues and, consequently, practical and theoretical learning (Liu et al., 2020). VR also facilitates reflective observation through the ability to review and analyze interactions within the virtual space (Slater & Wilbur, 1997). Thus, VR not only enhances engagement but also operationalizes experiential learning cycle in a dynamic, embodied way. This brings to mind the Kolb’s theory, which present learning as a cyclical process involving concrete experience, reflective observation, abstract conceptualization, and active experimentation (Kolb, 1984). Immersive virtual reality (VR) environments uniquely support this cycle by providing users with realistic, interactive experiences (Dede, 2009). Meanwhile, the possibilities for exploration and experimentation in VR environments echo Piaget’s stages of cognitive development through embodied, experiential learning (Piaget, 1954).

It is worth emphasizing, however, that given the limited time of classes with VR goggles, the role of the teacher – a guide in the virtual space – is significant. Without it, participants become so immersed in the VR environment that they are unable to complete the task planned for them fully.

Participants in the study noted that immersive VR is so fascinating that it is difficult for them to supervise their own time and activity in a way that ensures success. As a result, 70% of people working alone with VR goggles did not manage to familiarise themselves with all the material (Majewska, 2023, p. 61).

The research conducted by Li Xiaoyi, Hu Yongbin, Yang Xianmin, Bi Xinyu, Zhang Jinying, and Tao Pengrui suggests that the “VR social skills training can be an effective approach, particularly for complex social skills” (2025, p. 89). Chris Klein has an equally positive attitude to the above area, emphasising that VR games can help students to:

- develop empathy and compassion towards other people,
- analyse a given situation from a different perspective, which makes it easier to understand another person’s thoughts, feelings, and experiences,
- understand neurodiversity and reduce prejudices based on diversity,
- create group learning environments and train communication and interaction in

various teams,

- practise emotional behaviour regulation and stress management techniques (Klein, 2024).

As a result, the VR environment is successfully used in various areas of education, dedicated to different age groups.

5 Horror VR and emotions in education – a brief review of research

Discussions and the research on emotions emerging while using VR goggles, their quality, durability, and significance in the context of the educational process, gained momentum around 2015. This was related to the popularization of integrated sets. Many published analyses aimed to compare emotions experienced in the real and virtual worlds. The emotions achieved through transmission using VR goggles were also compared with those experienced during the presentation of 2D films or using a computer. In the above cases, the same or greater arousal and emotional valence of the VR space users was noted (Citron et al., 2014). Available analyses show that the above presentation methods “produce largely comparable results between the virtual and real world, but overall participants experience slightly stronger valence and arousal in VR” (Rivu et al., 2021, p. 93). Similar results were recorded in research conducted in 2019. The team of Alice Chirico and Andrea Gaggioli noticed that among the analysed feelings and emotions, significant differences were observed in the case of felt anger and joy. Anger was significantly higher in the real environment. Joy, on the other hand, was significantly higher in the virtual space (Chirico, & Gaggioli, 2019; Gilpin et al., 2021). In the context of comparing the reception of materials presented using films and VR goggles, it was noted that there were no significant differences between the analysed emotions “except the fear scene. We found that there are some conditions for the VR scenes to achieve a good emotional effect” (Liao et al., 2019, p. 1). In order to evoke appropriate emotions, e.g. sadness, anxiety, joy, relaxation, or fear, studies used changes in lighting settings, music, weather, or an appropriate plot (Dozio et al., 2021; Gilpin et al., 2021).

Among the cognitively interesting conclusions about horror games it is worth noting that:

- „the influence of the target emotions on decision-making behavior was more pronounced in the VR conditions than the desktop conditions” (Susindar et al., 2019, p. 255),
- VR presentations are more effective in triggering fear and anger than classical methods such as film or static images (Ibidem),
- horror games most often evoke fear reactions among subjects (Lin, 2023), but they can also arouse anger and pleasure (Barrett et al., 2007),
- VR games have a greater ability to induce fear than traditional computer games (Lin, 2023),
- some VR players, in addition to the immediate fear experienced while playing games, also experience it after several hours (Tetris effect) (Susindar et al., 2019),

- the intensity of emotions experienced while playing VR games depends on the sense of immersion in the virtual space (Parsons & Rizzo, 2008),
- games with a higher level of interactivity and immersion cause the emergence of more aggressive feelings than those that are less engaging (lower level of interactivity and immersion) (Persky & Blascovich, 2008),
- “female participants exhibit a higher sensitivity to fear stimuli” (Zhang et al., 2023).

Research results show that both positive and negative emotions accompanying student activity may have a beneficial impact on the learning process (Tyng et al., 2017; Zlomuzica et al., 2016; Desjardins, 2016; Matsunobu et al., 2023; LaBar & Cabeza, 2006).

In this context, it is worth mentioning the research conducted by Wang & Wang on how the affective priming effect of immersive VR horror games influences the cognitive processing of college students. The collected data showed that different lengths of time of using VR goggles resulted in different results in the context of cognitive processing and correctness of word identification. As noted by the authors, “the affective state of the fixed intensity level can improve cognitive processing, the hyper-high level of affective activation interferes with or even hinders cognitive processing, and the excessively low activation is insufficient to support cognitive processing” (Wang & Wang, 2020, p. 1213).

As a result, various types of games, including VR horror, can be used in the educational process. Owing to the fast-paced actions requiring a number of right decisions, strong emotions, repulsive visualizations, and numerous moments of horror, the above type of game is an interesting alternative to traditional films or PC games, which can be used, for example, in training the emotions of students of the uniformed services (Pallavicini et al., 2018).

6 Methodology

6.1 Research methodology and sample characteristics

The presented research was carried out in 2024 and had the character of a pedagogical experiment in which a horror game tool (PC or VR goggles) was a distinguishing factor. The research involved an assessment of causal relationships between independent variables and a random variable. The experimental design was based on Mill’s canon of one difference. The canon justifies that “the cause of phenomenon Y is phenomenon X if it belongs to one of the two sets to which Y also belongs, and X is the only phenomenon that differs both set” (Rubacha, 2008). The research was conducted in compliance with ethical principles.

All participants provided informed consent prior to inclusion in the study. The research was conducted in accordance with ethical standards and was approved by the Ethics Committee of the Faculty of Philosophy and Social Sciences at Nicolaus Copernicus University in Toruń.

The aim of the activities undertaken was to verify the existence of statistically significant differences in the level of emotions experienced among students of the uniformed services using PCs and VR goggles to play horror games. The study also aimed to determine whether students of uniformed services consider horror VR games to be valuable in the context of their educational process. In the analysis of the research problem a combination of quantitative and qualitative approaches was used (survey with closed-ended and open-ended questions). Research tools were standardized and normalized during the planning and development phases of the research procedure. The survey contained:

- Closed-ended questions about emotions appearing during the game and their intensity on a scale from 1 to 5 (inspired by Plutchik's Wheel of Emotions),
- Open-ended questions about well-being and emotions which, in the respondents' opinion, were evoked by the game¹,
- Open-ended questions concerning opinions on the educational potential of horror VR games.

The research covered a total of 140 players – students of the uniformed services ($N=140$), aged 18–37. The sample was selected purposively and included 117 men and 23 women (students of higher police or military academies), who had been playing PC or VR games for at least a year on a regular basis (at least 5 times a month). The sample size of 140 participants was determined primarily by the availability of students enrolled in uniformed services programs during the research period. Recruitment was limited to specific cohorts of police and military academy cadets, which constrained the total number of participants. While the sample may be considered relatively small, it is satisfactory compared to similar experimental studies using VR to investigate emotional responses (e.g., Pallavicini et al., 2018; Susindar et al., 2019). The number was sufficient to conduct non-parametric statistical analyses and detect significant differences between VR and PC conditions, although future research should aim at larger and more diverse populations to improve generalizability. The people taking part in the study had no previous problems with motion sickness. None of the surveyed persons declared that they had ADHD, ADD, ASD or any other neurological disorder that is life-threatening or may affect emotions and the strength of their experience during the game (Masi et al., 2021). Students of the uniformed services joined the study and participated in it voluntarily. The Resident Evil game used in the experiment was previously known to the players. This step was intended to eliminate the effect of surprise and fascination that would likely work to the advantage of the VR space. Before starting the game, the students of the uniformed services were asked to calm down emotionally (sitting quietly at a table for 20 min). The research procedure went smoothly, and none of the participants discontinued the study owing to feeling unwell. The research participants were divided into two equal groups (70 people each). The first group played the Resident Evil game on PC ($n=70$), the second group played using VR goggles ($n=70$). As intended, the

¹ The survey was conducted twice – before the start of the game and immediately after the end of the game, in order to exclude people experiencing extreme emotions unrelated to the research situation.

players played for 90 min (none of the students of the uniformed services finished the game early) (Juszczak, 2001; Konarzewski, 2000).

6.2 Research questions

As a consequence, the following research questions were formulated:

1. Are there any statistically significant differences between the level of fear experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles?
2. Are there any statistically significant differences between the level of amazement experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles?
3. Are there any statistically significant differences between the level of sadness felt by students of the uniformed services in the group playing on PC and in the group playing using VR goggles?
4. Are there any statistically significant differences between the level of disgust experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles?
5. Are there any statistically significant differences between the level of rage experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles?
6. Are there any statistically significant differences between the level of vigilance felt by students of the uniformed services in the group playing on PC and in the group playing using VR goggles?
7. Are there any statistically significant differences between the level of ecstasy experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles?
8. Are there any statistically significant differences between the level of admiration experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles?
9. Do students of the uniformed services consider VR horror games valuable in the context of their education?

The following variables were distinguished in the study: dependent variable – the emotion felt, including the feeling of: fear, amazement, sadness, disgust, rage, vigilance, ecstasy, admiration (measured on a five-point scale); independent variable – the tool used during the game (PC or VR goggles).

6.3 Research hypotheses

On the basis of the analysed literature, the following hypotheses were adopted:

H1. There are no statistically significant differences between the level of fear experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles.

H2. There are no statistically significant differences between the level of amazement experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles.

H3. There are no statistically significant differences between the level of sadness experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles.

H4. There are no statistically significant differences between the level of disgust experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles.

H5. There are no statistically significant differences between the level of rage experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles.

H6. There are no statistically significant differences between the level of vigilance felt by students of the uniformed services in the group playing on PC and in the group playing using VR goggles.

H7. There are no statistically significant differences between the level of ecstasy experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles.

H8. There are no statistically significant differences between the level of admiration experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles.

H9. Students of the uniformed services do not consider VR horror games to be valuable in the context of their educational process.

6.4 Analysis methods

The statistical significance of the hypotheses was verified using the Student's T-test and the Mann-Whitney U-test. Normal distribution (owing to group size) was verified using the Shapiro-Wilk test. The analyses performed showed that the distribution of results in the analysed groups was not close to normal distribution ($p < 0.001$). There was homogeneity of variance between groups as assessed by Levene's test. The statistical significance level of $\alpha = 0.05$ was assumed in the study.

6.5 Research results

The analysis of the research sample showed that the majority of the study group were men aged 23 to 27 Fig. 2.

The research tools (PC or VR) had been known to the experiment participants for a long time. The responses collected showed that they had been using PC or VR, respectively, regularly for at least a year. The subjects played the VR or PC game for 1.5 h, between 4:00 p.m. and 9:00 p.m. Fig. 3 (starting time was chosen individually). The subjects played the game Resident Evil in home conditions, which was intended to approximate the experiment to normal conditions.

Statistical verification of the hypothesis was performed using the Mann-Whitney U test and Student's T test. During the main study, hypothesis H1 – There are no statistically significant differences between the level of fear experienced by students of

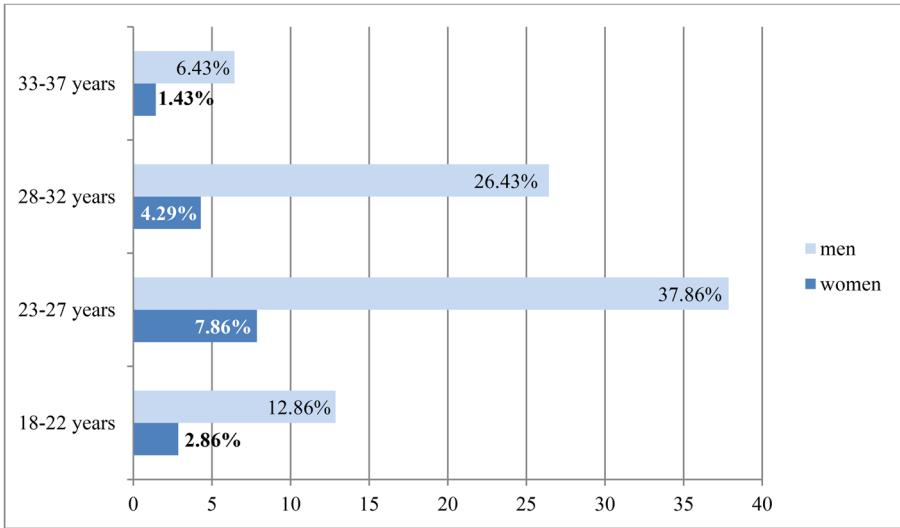


Fig. 2 Characteristics of the research group. Source: Own development.

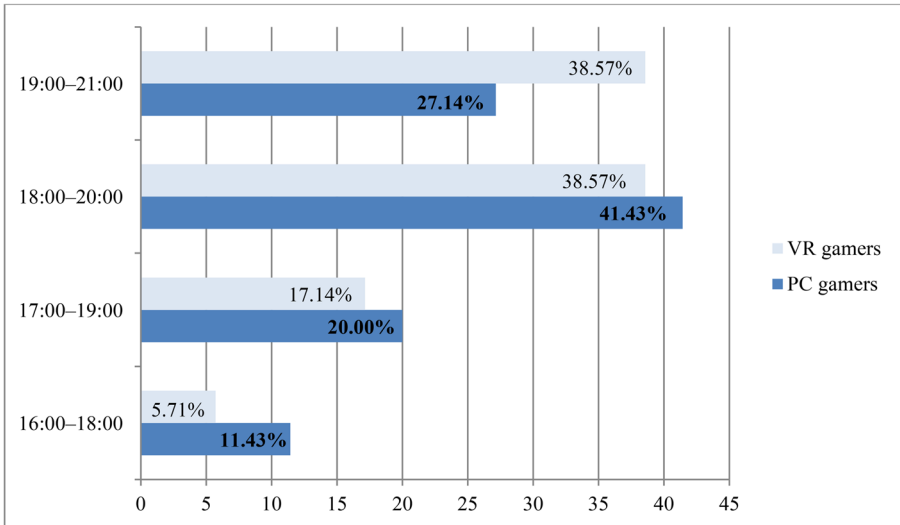


Fig. 3 Hours played by students of the uniformed services. Source: Own development

the uniformed services in the group playing on PC and in the group playing using VR goggles – was rejected. On the basis of the collected data, it was determined that the results of the measurement carried out in the experimental group were significantly different from the results of the measurement carried out in the control group - students of the uniformed services playing the VR horror game experienced a statistically significantly higher level of fear than students of the uniformed services playing

the PC horror game, $U = 4123.000$, $p < 0.05$. This was also confirmed by the results of the Student's T-test $t(138) = -9.14$, $p < 0.05$ Fig. 4.

It is worth noting that:

- The average sense of fear for VR horror games was 3.99 (SD=0.98), while for PC games it was 2.59 (SD=0.82).
- In the group playing a VR horror game, subjects most frequently (38.6%) indicated a very high sense of fear after finishing the game (D=5), while in the case of PC games, the most frequently declared feeling of fear (D=3) was average (45.7%).
- The responses of VR goggles users showed that they felt a sense of fear ranging from low (Min=2) to very high (Max=5), while in the case of PC game players, the reported sense of fear ranged from very low (Min=1) to high (Max=4).

Hypothesis H2 – There are no statistically significant differences between the level of amazement experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles – has been accepted. On the basis of the collected data, it was determined that the results of the measurement performed in the experimental group did not differ significantly from the results of the measurement performed in the control group, $U = 2448.500$, $p = 0.986$. For Student's T-test, it was found that $t(138) = 0.338$, $p = 0.736$.

Hypothesis H3 – There are no statistically significant differences between the level of sadness experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles – has been accepted. On the basis of the collected data, it was determined that the results of the measurement performed in the experimental group did not differ significantly from the results of the measurement performed in the control group, $U = 2414.000$, $p = 0.641$. For Student's T-test, it was found that $t(138) = 0.715$, $p = 0.476$.

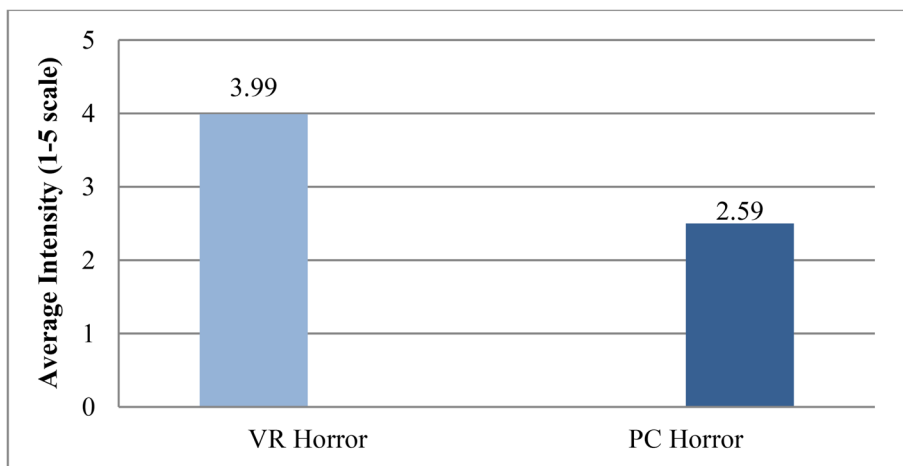


Fig. 4 Average fear levels in VR vs. PC horror games. Source: Own development using IBM SPSS

Hypothesis H4 – There are no statistically significant differences between the level of disgust experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles – has been rejected. On the basis of the collected data, it was determined that the results of the measurement carried out in the experimental group were significantly different from the results of the measurement carried out in the control group. Students of the uniformed services playing the VR horror game experienced a statistically significantly higher level of disgust than students of the uniformed services playing the PC horror game, $U = 2984.000$, $p < 0.012$. This was also confirmed by the results of the Student's T-test $t(138) = -2.381$, $p < 0.05$ Fig. 5.

Statistical analyses showed that:

- The average feeling of disgust for VR horror games was 2.26 (SD=0.77), while for PC games it was 1.91 (SD=0.65).
- The feeling of disgust in both VR horror game players (60%) and PC horror game players (57.1%) was most often low (D=2).
- The responses of VR goggles users showed that they felt a sense of disgust ranging from low (Min=1) to very high (Max=4), while in the case of PC game players, the reported sense of disgust ranged from very low (Min=1) to high (Max=3).

Hypothesis H5 – There are no statistically significant differences between the level of rage experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles – has been accepted. On the basis of the collected data, it was determined that the results of the measurement performed in the experimental group did not differ significantly from the results of the measurement performed in the control group, $U = 2386.500$, $p = 0.632$. For Student's T-test, it was found that $t(138) = 0.188$, $p = 0.851$.

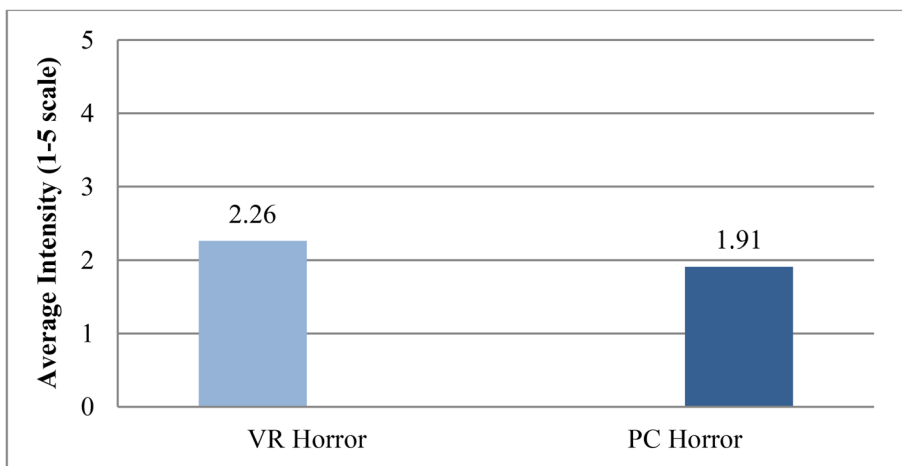


Fig. 5 Average disgust levels in VR vs. PC horror games. Source: Own development using IBM SPSS

Hypothesis H6 – There are no statistically significant differences between the level of vigilance experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles – has been rejected. On the basis of the collected data, it was determined that the results of the measurement carried out in the experimental group were significantly different from the results of the measurement carried out in the control group. Students of the uniformed services playing the VR horror game experienced a statistically significantly higher level of vigilance than students of the uniformed services playing the PC horror game, $U = 3854.000, p < 0.05$. This was also confirmed by the results of the Student's T-test $t(138) = -7.120, p < 0.05$ Fig. 6.

The calculations performed showed that:

- The average feeling of vigilance for VR horror games was 3.46 (SD=1.1), while for PC games it was 2.2 (SD=0.99).
- In the group playing a VR horror game, players (37.1%) most often felt a high sense of vigilance (D=4), while in the case of PC games (42.9%) – a low sense of vigilance (D=2).
- The responses of VR goggles players showed that they felt a sense of vigilance ranging from low (Min=2) to very high (Max=5), while in the case of PC game players, the reported sense of vigilance ranged from very low (Min=1) to high (Max=4).

Hypothesis H7 – There are no statistically significant differences between the level of ecstasy experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles – has been rejected. On the basis of the collected data, it was determined that the results of the measurement carried out in the experimental group were significantly different from the results of the measurement carried out in the control group. Students of the uniformed services playing the VR

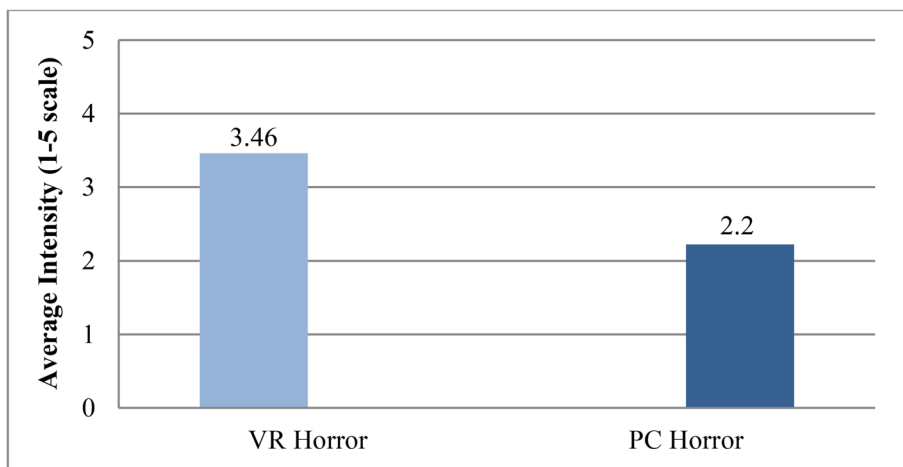


Fig. 6 Average vigilance levels in VR vs. PC horror games. Source: Own development using IBM SPSS

horror game experienced a statistically significantly higher level of ecstasy than students of the uniformed services playing the PC horror game, $U = 3865.500$, $p < 0.05$. This was also confirmed by the results of the Student's T-test $t(138) = -7.313$, $p < 0.05$ Fig. 7.

During the analyses it was found that:

- The average feeling of ecstasy for VR horror games was 3.89 (SD=0.91), while for PC games it was 2.81 (SD=0.83).
- In the VR horror game group, players most often (34.3%) indicated a high sense of ecstasy after the game (D=4), while for PC games (47.1%) it was medium (D=3).
- The responses of VR goggles players showed that they felt a sense of ecstasy ranging from low (Min=2) to very high (Max=5), while in the case of PC game players, the reported sense of ecstasy ranged from very low (Min=1) to high (Max=4).

Hypothesis H8 – There are no statistically significant differences between the level of admiration experienced by students of the uniformed services in the group playing on PC and in the group playing using VR goggles – has been rejected. On the basis of the collected data, it was determined that the results of the measurement carried out in the experimental group were significantly different from the results of the measurement carried out in the control group. Students of the uniformed services playing the VR horror game experienced a statistically significantly higher level of admiration than students of the uniformed services playing the PC horror game, $U = 4134.000$, $p < 0.05$. This was also confirmed by the results of the Student's T-test $t(138) = -8.552$, $p < 0.05$ Fig. 8. The differences in emotional intensity between VR and PC horror games are summarized in Table 1.

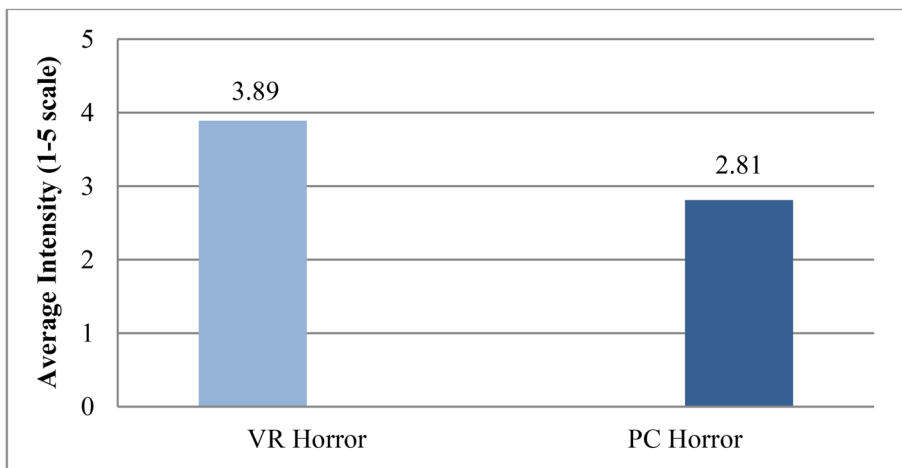


Fig. 7 Average ecstasy levels in VR vs. PC horror games. Source: Own development using IBM SPSS

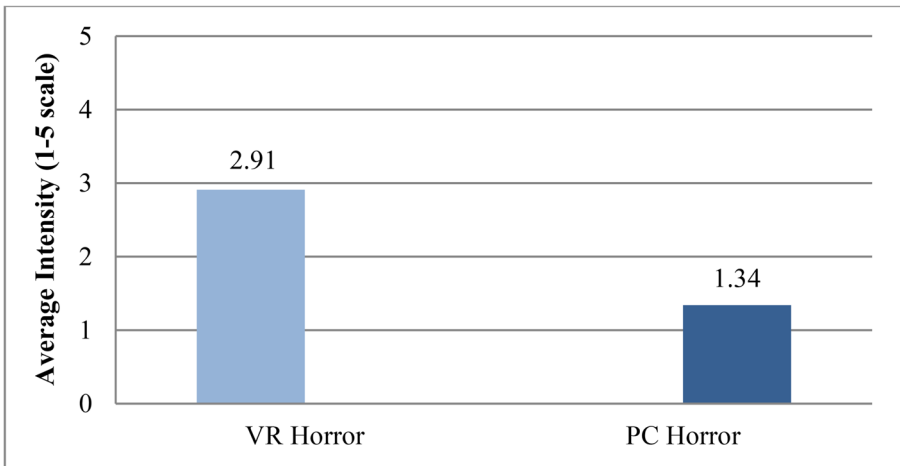


Fig. 8 Average admiration levels in VR vs. PC horror games. Source: Own development using IBM SPSS

Table 1 Comparison of average emotion levels in VR and PC horror games

Emotion	VR Mean	PC Mean	Difference	Interpretation
Fear	3.99	2.59	+1.4	Fear significantly higher in VR
Amazement	1.04	1.06	-0.02	No significant difference between VR and PC groups
Sadness	1.03	1.05	-0.02	No significant difference between VR and PC groups
Disgust	2.26	1.91	+0.35	Disgust slightly higher in VR
Rage	1.14	1.16	-0.02	No significant difference between VR and PC groups
Vigilance	3.46	2.20	+1.26	Vigilance significantly higher in VR
Ecstasy	3.89	2.81	+1.08	Ecstasy significantly higher in VR
Admiration	2.91	1.34	+1.57	Admiration significantly higher in VR

Source: Own development

During the analyses it was found that:

- The average feeling of admiration for VR horror games was 2.91 (SD=1.03), while for PC games it was 1.34 (SD=0.54).
- In the VR horror game group, players most often (32.9%) indicated a medium sense of admiration after the game (D=3), while for PC games (68.6%) it was very low (D=1).

- The responses of VR goggles players showed that they felt a sense of admiration ranging from very low (Min=1) to very high (Max=5), while in the case of PC game players, the reported sense of admiration ranged from very low (Min=1) to medium (Max=3).

On the basis of the collected data, hypothesis H9 – Students of the uniformed services do not consider VR horror games to be valuable in the context of their educational process, was rejected. The obtained responses show that the vast majority (91.42%) of uniformed services students would like to use VR horror games in the academic education process. According to them, VR horror games are very valuable (15.71%), or valuable (75.71%) mainly in the context of emotional training. None of the surveyed students described VR horror games as completely worthless. Only 8.58% rated them as of average value in the context of the educational process. Students emphasised that VR horror games:

- “make people resistant to stress” (V21), “make them accustomed to the need to act in a tense atmosphere” (V32), “teach them how to manage stress” (V44),
- “accustom one to repulsive images – the sight of blood, guts, or human entrails” (V11), “I am sensitive to the sight of blood. I think that these games help to get used to this problem” (V61),
- “enable the implementation of exercises involving making the right decisions in high-stress conditions” (V37),
- “teach perceptivity and quick action despite the perceived threat” (V19),
- “are interesting” (V2), “they have an interesting plot” (V52),
- “are more attractive than traditional educational films” (V28).

It is worth emphasizing that 75.71% of students of the uniformed services considered VR horror games to be of little value in the context of theoretical learning. According to them, this type of game is highly stressful, which makes it difficult to retain information.

7 Discussion

Analysis of the responses collected before the experiment showed that none of the subjects assigned to the VR horror or PC horror groups experienced extreme emotions during that time. Fear, amazement, sadness, disgust, rage, vigilance, ecstasy, and admiration were declared by the subjects at a very low level.

The collected data showed that VR horror games have a greater potential to influence certain user emotions, including fear, disgust, vigilance, ecstasy, and admiration than PC horror games. This was particularly evident in the context of fear. Most students of the uniformed services who used the VR horror game experienced this emotion at a very high level, whereas those who played the PC version reported only a medium level of fear. Of course, this relationship was reflected in the test results. Both the Mann Whitney U test and the Student T test showed a statistically significant difference in the level of fear experienced, which was 1.4 points (on a five-point

scale) higher in the case of VR games. VR players participating in the study typically experienced very high levels of fear (38.6% of respondents). After completing the game they noted: “I didn’t remember all the details of the game, it stressed me out a bit and at some points I felt very scared” (V8), “the atmosphere of this game is dark, I felt scared” (V46), “I like being scared and this game is very scary” (V68). Regarding PC horror games, the most common statement (45.7% of responses) was “it wasn’t very scary” (P78), “I once tested this game in VR, there was much more fear and anxiety” (P125). It should be emphasized that the power of the virtual message was supported by the first-person experience. Another important factor was the complete cut-off from the surroundings. It favoured immersion and the feeling of being transported to a different reality. The above observation is also confirmed by the comments of a VR game creator, who points out that virtual reality boasts a level of immersion unmatched anywhere else. This is a huge plus because it makes us feel everything that’s happening in the game more. The action is more interesting and raises our blood pressure, the horror elements are definitely scarier and give real goosebumps on the skin (Sobiepan, 2021).

Although the Mann Whitney U tests and the Student T test showed a statistically significant difference in the level of disgust felt by VR and PC players, the difference was not so spectacular as in the case of the emotion of fear. The difference in the level of disgust felt between the analysed groups of students of the uniformed services was only 0.35 points (on a five-point scale). Regarding the feeling of disgust, it was noted that the majority of individuals, regardless of the tool used, felt this emotion at a low level. In general, the majority of students of the uniformed services (VR – 71.4%, PC – 76.8%) indicated that they felt a very low or low level of disgust during the game. This was due to the game’s design and the fact that the visualization did not contain many images that could trigger it. In the case of VR goggles, users who indicated that they felt a high level of disgust (8.6%) emphasized that: “the sight of the bodies was a bit repulsive” (V18), “the filth there was repulsive to me – bloody walls, rags, beds...” (V36). When it comes to PC horror games, the highest rated disgust level was average (3 on a five-point scale) and was reported by every seventh person (17.1%). These players emphasized that: “I didn’t feel too much distaste or repulsion” (P89), “those images were a bit disgusting, but not too much” (P133). It is worth emphasizing that the feeling of disgust at a medium or high level was declared mainly by women (86.96% of them). This finding is consistent with the observations of Michał Stefańczyk, according to whom “women are more sensitive to repulsion than men, even though their immune system is stronger” (Drózka, 2020). Perhaps using a different storyline and more intense visuals would help increase the level of disgust, which—due to the convincing VR experience—would be more pronounced in this group of players.

In the context of vigilance, it was noted that the majority of players of the horror VR game felt this emotion at a high level (37.1%), while for the horror PC game it was only at a low level (42.9%). The difference in the level of perceived vigilance was 1.26 points (on a five-point scale) and was higher for the VR game participants. In the case of VR goggles, players who indicated that they felt a high level of vigilance (18.6%) emphasized that: “I was very vigilant and tense, especially when I heard some knocking” (V7), “moving around was stressful, I was tense and vigilant. I was

afraid that something would attack me” (V51), “I stayed vigilant, in VR everything is so real” (V65). Regarding PC horror games, the students of the uniformed services most frequently (42.9%) commented that “the vigilance during the game was quite low, you know it’s just a game” (P91). People playing the PC horror game and experiencing high vigilance (14.3%) emphasized that: “I am always vigilant when I play adventure games or horror games” (P122), “when I get into the action, I am focused and vigilant. It is known that these emotions are stronger when nothing distracts me. It’s best when I’m home alone and I don’t have any responsibilities” (P139). On the basis of the collected responses, it can be concluded that the level of players’ vigilance is related to their dedication to the game. The greater the interest and immersion, the higher the vigilance. This is especially noticeable in the case of games with dark plots, such as adventure games, horror games, and war games. Of course, becoming fascinated by games plot is much easier when using VR goggles, which cut off players from external distractions. As a result, the vigilance felt by students of the uniformed services using VR was statistically significantly higher than the same emotion recorded by students of the uniformed services using PC horror game.

Regarding the emotion of ecstasy experienced by players, it was noted that it was higher in the case of VR goggle gamers by an average of 1.08 points (on a five-point scale). In the case of VR goggles, players who indicated that they felt a high level of ecstasy (30.0%) emphasized that: “when I found subsequent clues to solve the task, I felt wonderful, it can be compared to ecstasy” (V9), “when you feel fear and danger, and suddenly it turns out that you managed to go further, it is a wonderful feeling - true ecstasy” (V25). Regarding PC horror games, players with high ecstasy (20.0%) noted: “success in the game is a real ecstasy” (P93), “when you get into the PC game, you can actually enjoy a high level of ecstasy” (P131), “generally, until I knew VR, PC games seemed great and gave me much pleasure. Today I compare all PC games with those in VR. Virtual space is unmatched” (P140). The collected responses suggest that the emotion of ecstasy in the case of VR or PC gamers is associated with success. It is also the joy of being able to pursue one’s passion. Of course, in the VR space, the nature of the game is more interesting and the plot is more seductive. This arouses interest as well as the emotion of ecstasy flowing from the game. It is worth noting here that research conducted by Martyna Kotyśko shows that the strongest emotion associated with 2D computer games is happiness, which is recorded by 73.8% of boys/men and 71% of girls/women (Kotyśko, 2020, p. 105). These data correspond with the values collected in this study. It was found that 67.1% of students of the uniformed services who played PC horror game and 94.3% of those who played the VR horror game reported a medium, high, or very high sense of ecstasy after completing the game.

It is worth noting that the highest difference when comparing the average levels of emotions felt by students of the uniformed services using PC or VR games was recorded in the admiration category and amounted to 1.57 points (on a five-point scale). In the case of VR goggles, the players who indicated that they felt a high level of admiration (27.1%) emphasized that: “these visualizations are great, very credible” (V13), “I felt as if I had been transported to that space, I felt real fear and anxiety” (V45). Regarding PC horror games, players feeling high level of admiration (2.9%) noted: “all in all, you could say that at times I felt fascination, even

admiration, but it was not strong, rather moderate” (P99). The majority of PC gamers (68.6%) indicated that “I didn’t really think about it, but I didn’t really feel any admiration” (P132). For PC games, the majority of users (68.6%) felt a very low level of admiration. The strength of this emotion was greater in the case of the VR game, where the majority of players (32.9%) felt an average level of admiration, which resulted from the quality of the visualization, the realism of the message, and other emotions accompanying the game.

In the case of amazement, sadness, or rage, there was no statistically significant difference between these emotions experienced by players of PC horror games and VR horror games. On average, the above emotions were felt at a very low level, which was related to the game’s plot and the fact that the students of the uniformed services were already familiar with the game used in the experiment. The respondents and users of VR goggles indicated in their statements that: “I had played the game before, so most of the time I knew what to expect” (V58), “I felt no regret” (V42), “there was nothing there that would make me angry” (V67). A similar tone was expressed by the users of the PC horror game.

It is worth emphasizing that heightened emotions – such as fear, disgust, vigilance, ecstasy, and admiration – are significant in educational settings. They can be leveraged in training simulations (e.g. emergency response; Tasnim et al., 2024), empathy development (e.g. embodied perspective-taking in VR; Lacle-Melendez et al., 2025), and in psychological therapy (e.g. VR exposure therapy; Tian, 2024).

Students of the uniformed services overwhelmingly (91.42%) would like to use horror VR games during emotional training. The above form, according to their opinions, can be helpful in accustoming oneself to the need to work and act in stressful conditions, as well as in an environment that arouses disgust. The above voices coincide with the opinion of Federica Pallavicini’s research team, according to which “survival horror games played in virtual reality can trigger intense fright and anxiety in the players. Such unique characteristics can thus be exploited, not only as a source of entertainment, but also as a tool for both emotion elicitation and emotional training” (2018, p. 87). According to students, the use of VR horror games is not beneficial in the context of rote learning owing to the high level of stress that accompanied them. It sometimes made logical thinking difficult, favouring impulsive actions aimed primarily at survival. As one of the respondents emphasised, “I didn’t remember all the details of the game, it stressed me a bit and at some moments I felt very scared” (V8). This observation proves the high self-awareness of the surveyed students, whose opinions fit into the trend assuming that a high level of stress reduces cognitive abilities (Oei et al., 2006; Bogdanov et al., 2021).

Prior research demonstrates that survival horror titles elicit particularly intense reactions, including fear, disgust, vigilance, and startle responses, which are more pronounced in VR conditions than in traditional PC settings (Susindar et al., 2019; Lin, 2023). For instance, Pallavicini highlight that “survival horror games played in virtual reality can trigger intense fright and anxiety in the players” (Pallavicini et al., 2018, p. 87). This shows that these genres provide unique conditions for stress induction in a safe, controlled environment. Similarly, Sobiepan notes that VR horror amplifies immersion, making “the horror elements definitely scarier and [giving] real goosebumps on the skin” (2021). These findings confirm that Resident Evil, with its

immersive design, audiovisual intensity, and globally recognized gameplay structure, represents a suitable and replicable stimulus for exploring the role of emotional arousal in training scenarios. Its widespread availability and familiarity also minimize novelty effects, enabling researchers to focus on emotional regulation rather than the mechanics of gameplay.

The use of VR horror games in the context of, for example, memory training, theoretical or topographical teaching, etc. is of course possible, provided that appropriate conditions are met. Referring to the Yerkes-Dodson curve, it can be concluded that the appropriate selection of VR horror games will bring the expected educational effects (Nieuwenhuis, 2024). For this purpose, it is necessary to ensure a moderate level of arousal, fear, and tension, which provide increased concentration and mobilization to act.

It cannot be denied that interactive action that includes emotional stimuli and data (e.g. horror scenes) makes the VR environment more interesting and attractive to the recipient's attention than traditional communication (Diemer et al., 2015). Additionally, the use of VR horror games in the educational process is supported by the positive emotions experienced by users, which were recorded in the research. Compared with traditional methods such as lectures, films, or even field simulations, VR horror provides a unique combination of emotional intensity and immersive presence. Unlike biofeedback or smartphone-based applications (Colombo et al., 2019), horror VR directly confronts participants with stress-inducing stimuli, offering a distinctive training scenario. While VR has been applied in exposure therapy (Parsons & Rizzo, 2008) and social skills training (Li et al., 2025), horror-based scenarios focus specifically on rapid decision-making under stress, which is particularly relevant for uniformed services.

Integrating VR into the curriculum of students of the uniformed services enables realistic training in crisis response, operational procedures, and threat simulation without endangering health or life. This technology allows multiple scenarios to be replayed in controlled environments, promoting the development of decision-making skills and mental resilience. VR can also support theoretical learning through interactive models and educational environments tailored to the specific nature of the services' work.

The findings can be interpreted through Kolb's experiential learning cycle (1984). Playing VR horror constitutes a concrete experience, followed by reflective observation during debriefing. This can lead to abstract conceptualization about stress management strategies, and finally to active experimentation in subsequent training scenarios. This process mirrors also Piaget's idea of experiential cognitive development (1954). Furthermore, the results align with the Yerkes-Dodson law (Nieuwenhuis, 2024), which posits that moderate levels of stress enhance learning, while excessive stress may impair cognitive performance.

Analyzing research results need consideration several limitations must be acknowledged. The study relied on a relatively small and homogeneous sample ($N=140$), consisting predominantly of young Polish male students of uniformed services. This restricts the generalizability of the findings to broader or more diverse populations. A commercial-off-the-shelf (COTS) game, Resident Evil, was selected as the experimental tool. Its advantages include accessibility, established popularity,

and its proven ability to elicit strong emotional reactions, as documented in prior studies (Pallavicini et al., 2018). Importantly, using a well-known game reduced the novelty effect and allowed focus on emotional responses. However, limitations arise from the fact that the game was not designed as an educational tool, which restricts the researcher's control over content, difficulty levels, and specific learning objectives. COTS games are developed primarily for commercial purposes and lack explicit pedagogical objectives, limiting the instructor's ability to tailor scenarios to specific training needs (Radianti et al., 2020). Additionally a large number of stimuli (when horror scenarios are too intense) it raises the risk of cognitive overload and reducing the educational value of the exercise. Ethical considerations must also be noted: horror VR involves high stress levels, and although no participants withdrew, such exposure may not be suitable for all individuals (Lavoie et al., 2021). Finally, COTS horror games prioritize dramatic and fictional narratives rather than fidelity to real-world operational environments, which may lowering validity as professional training tools.

Future research should explore larger and more diverse samples, include female participants more proportionally, and test a wider range of horror subgenres. Comparative studies between commercial games and purpose-built VR training applications would further clarify the educational potential of horror VR. Finally, longitudinal studies are needed to determine whether the emotional regulation skills acquired during VR horror training translate into real-world professional performance.

The integration of VR technology into the education of uniformed services students involves initial investment costs, including hardware, software, and the training of teaching staff (Radianti et al., 2020). However, long-term benefits – such as enhanced teaching efficiency, realistic threat simulations, and the development of decision-making skills in controlled environments – significantly outweigh the initial expenses (Jerald, 2015). Challenges related to technology accessibility can be addressed by implementing affordable VR headsets and utilizing open-source educational platforms (Cruz-Neira et al., 2002).

8 Conclusion

The presented research analysed the level of eight emotions distinguished by Plutchik in the context of PC horror and VR horror games. The study also aimed to determine whether students of uniformed services consider horror VR games to be valuable in the context of their educational process. This study was undertaken because of the few results available in this area. Meanwhile, analyses combining the VR space and human emotions are extremely important, because, as Jeroen S. Lemmens, Monika Simon, and Sindy R. Sumter note, “despite the relative commercial success of VR gaming systems, research on players’ emotional response to headmounted VR systems is scarce” (Lemmens et al., 2022, p. 223). In addition, it should be made clear that there is still some ambiguity as to whether emotions experienced in the VR space can be stronger than those experienced in a natural or computer-based environment (Marin-Morales et al., 2021). The use of VR horror games in the context of theoretical learning also raises a number of doubts. On the one hand, emotions stimulate

cognitive activity, but on the other, too high a level of fear and stress can paralyze the user. In this context, students' feelings and opinions are extremely important. Emotionally stimulating VR horror games require attention, also from the point of view of the broadly understood education sector, which is constantly looking for effective solutions adapted to modern audiences.

During the quantitative and qualitative analyses, it was found that there are statistically significant differences in the level of emotions experienced, including: fear, disgust, vigilance, ecstasy, and admiration between VR and PC players. It was found that VR players felt these emotions more strongly than PC players. Meanwhile, no statistically significant difference was found between PC horror and VR horror players in terms of feelings of amazement, sadness, and rage. The above experiment outlines a certain trend regarding emotions and their intensity occurring during PC horror and VR horror games. Obtained findings, about emotion, align with evidence that immersive VR elicits both stronger negative and positive emotional responses than non-immersive formats, due to heightened sense of presence (Lie et al., 2023; Yang et al., 2023; Lemmens et al., 2022). Intensified emotional arousal in VR is known to enhance attention, memory encoding, and motivational engagement. This suggests that VR horror could be adapted as a high-impact pedagogical tool that fosters deeper cognitive processing. However, VR horror games must be carefully selected to avoid excessive stress. For instance, students of the uniformed services rated Resident Evil game as too stressful for use in theoretical education.

The collected data show that students of the uniformed services are interested in including horror VR games in their education process. They recognize a specific role for VR horror games in emotional training. Of course, the presented experiment should be repeated, taking into account both a larger research group and types of horror other than Survival horror (e.g. Action horror, Jump scare games, Psychological horror games, Reverse horror games). Perhaps if users played a different game (with a different plot) or the game they played was not familiar to them before, the values regarding the analysed emotions would be different. It's worth recommending further research into the benefits and risks of using VR horror games in theoretical educating students of the uniformed services. In this context, it is also necessary to examine VR horror games' role in curriculum design or cognitive skill development.

The results obtained may be helpful for designers of educational PC and VR games, university lecturers, members of the uniformed services, and professionals involved in emotional training (Majewska, 2025).

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Data availability Research data is saved in SPSS program.

Declarations

Ethics approval and consent to participate All participants provided informed consent prior to inclusion in the study. The research was conducted in accordance with ethical standards and was approved by the Ethics Committee of the Faculty of Philosophy and Social Sciences at Nicolaus Copernicus University in Toruń.

Consent for publication I declare that the article "Horror VR as a tool supporting the emotional training of students of the uniformed services. Results of a research experiment" has not been published before. I consent to its publication in the journal "Education and Information Technologies".

Competing interests Not applicable.

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References

- Bailenson, J. (2018). *Experience on demand: What virtual reality is, how it Works, and what it can do*. W. Norton & Company.
- Bailenson, J. N., Patel, K., Nielsen, A., Bajcsy, R., Jung, S., & Kurillo, G. (2008). The effect of interactivity on learning physical actions in virtual reality. *Media Psychology, 11*(3), 354–376. <https://doi.org/10.1080/15213260802285214>
- Barrett, L. F., Mesquita, B., Ochsner, K. N., & Gross, J. J. (2007). The experience of emotion. *Annual Review of Psychology, 58*, 373–403. <https://doi.org/10.1146/annurev.psych.58.110405.085709>
- BBC News. (2018). VR helping police tackle domestic abuse. <https://www.bbc.co.uk/news/av/uk-wales-43121253>
- Binsch, O., Bottenheft, C., Landman, A., Roijendijk, L., & Vermetten, E. H. G. J. M. (2021). Testing the applicability of a virtual reality simulation platform for stress training of first responders. *Military Psychology: The Official Journal of the Division of Military Psychology American Psychological Association, 33*(3), 182–196. <https://doi.org/10.1080/08995605.2021.1897494>
- Bogdanov, M., Nitschke, J. P., LoParco, S., Bartz, J. A., & Otto, A. R. (2021). Acute psychosocial stress increases cognitive-effort avoidance. *Psychological Science, 32*(9), 1463–1475. <https://doi.org/10.1177/09567976211005465>
- Bucăța, G., Popescu, V. F., Cioacă, C., & Comșa, O. (2023). Virtual reality and its applications in the process of leading military troops. *Romanian Journal of Information Technology and Automatic Control, 33*(2), 7–22.
- Chirico, A., & Gaggioli, A. (2019). When virtual feels real: Comparing emotional responses and presence in virtual and natural environments. *Cyberpsychology, Behavior, and Social Networking, 22*(3), 220–226. <https://doi.org/10.1089/cyber.2018.0393>
- Citron, F. M., Gray, M. A., Critchley, H. D., Weekes, B. S., & Ferstl, E. C. (2014). Emotional Valence and arousal affect reading in an interactive way: Neuroimaging evidence for an approach-withdrawal framework. *Neuropsychologia, 56*(100), 79–89. <https://doi.org/10.1016/j.neuropsychologia.2014.01.002>
- Colombo, D., Fernández-Álvarez, J., García Palacios, A., Cipresso, P., Botella, C., & Riva, G. (2019). New technologies for the understanding, assessment, and intervention of emotion regulation. *Frontiers in Psychology, 10*, 1261. <https://doi.org/10.3389/fpsyg.2019.01261>

- Cruz-Neira, C., Bierbaum, A., Hartling, P., Just, C., & Meinert, K. (2002). VR Juggler - An Open Source Platform for Virtual Reality Applications In *Virtual Reality. Proceedings. IEEE*. IEEE, pp 89–96. <https://doi.org/10.2514/6.2002-754>
- Culbert, T. (2017). Perspectives on technology-assisted relaxation approaches to support mind-body skills practice in children and teens: Clinical experience and commentary. *Children*, 4(4), 20. <https://doi.org/10.3390/children4040020>
- Dede, C. (2009). Immersive interfaces for engagement and learning. *Science*, 323(5910), 66–69. <https://doi.org/10.1126/science.1167311>
- Desjardins, C. (2016). New research: Feeling bad has academic benefits, https://www.concordia.ca/cunew/main/stories/2016/11/30/psychologia-occasional-negative-moods-can-positively-impact-student-success.html?utm_source=chatgpt.com
- Diemer, J., Alpers, G. W., Peperkor, H. M., Shiban, Y., & Mühlberger, A. (2015). The impact of perception and presence on emotional reactions: A review of research in virtual reality. *Frontiers in Psychology*, 6, Article 26.
- Dozio, N., Marcolin, F., Scurati, G. W., Nonis, F., Ulrich, L., Vezzetti, E., & Ferrise, F. (2021). Development of an affective database made of interactive virtual environments. *Scientific Reports*, 11(1), 102791. <https://doi.org/10.1038/s41598-021-03380-y>
- Dróżka, W. (2020). *Disgust: Some people feel this emotion more strongly. What does it depend on?* <https://zdrowie.radiozet.pl/psychologia/psychoterapia/Obrzydzenie-niektorzy-odczuwaja-te-emocje-silniej.-Od-czego-to-zalezy>
- Du, Y. (2025). Research on police physical training based on virtual reality technology. *Quality in Sport*, 38, 58534. <https://doi.org/10.12775/QS.2025.38.58534>
- Francová, A., Jablonská, M. K., Lhotská, L., Husák, J., & Fajnerová, I. (2025). Efficacy of exposure scenario in virtual reality for the treatment of acrophobia: A randomized controlled trial. *Journal of Behavior Therapy and Experimental Psychiatry*, 88, 102035. <https://doi.org/10.1016/j.jbtep.2025.102035>
- Galuszka, A. (2022). Emotion - their meaning and tasks. *Journal of education. Health and Sport*, 12(1), 147–159. <https://doi.org/10.12775/JEHS.2022.12.01.012>
- Gamito, P., Oliveira, J., Silva, J., Rosa, J., Mendes, M. L. R., Dias, F., Mansuklal, S. A., Cartaxo, J., António, H., & Salvador, Á. (2024). Stress inoculation in police officers using virtual reality: A controlled study. *Cyberpsychology, Behavior, and Social Networking*, 27(4), 253–260. <https://doi.org/10.1089/cyber.2023.0385>
- Gilpin, G., Gain, J., & Lipinska, G. (2021). The physiological signature of sadness: A comparison between text, film and virtual reality. *Brain and Cognition*, 152, 105734. <https://doi.org/10.1016/j.bandc.2021.105734>
- Henderson, J. V. (2005). The virtual terrorism response academy: Training for high-risk, low-frequency threats. *Studies in Health Technology and Informatics*, 111, 185–190.
- Herrera, F., Bailenson, J., Weisz, E., Ogle, E., & Zaki, J. (2018). Building long-term empathy: A large-scale comparison of traditional and virtual reality perspective-taking. *PLoS One*, 13(10), e0204494. <https://doi.org/10.1371/journal.pone.0204494>
- Houck, C., Modrowski, C. A., Hadley, W., Barker, D., Myers, V., Bala, K., Wickham, B., & Jerrod, T. (2022). A pilot study of a tablet-based emotion regulation intervention for early adolescents. *Journal of Developmental and Behavioral Pediatrics*, 43(8), e505–e514. <https://doi.org/10.1097/DBP.0000000000001094>
- Immordino-Yang, M. H., & Damasio, A. (2007). We feel, therefore we learn: The relevance of affective and social neuroscience to education. *Mind, Brain, and Education*, 1(1), 3–10. <https://doi.org/10.1111/j.1751-228X.2007.00004.x>
- Jerald, J. (2015). *The VR book: Human-Centered design for virtual reality*. Morgan & Claypool.
- Juszczyk, S. (2001). *Statistics for educators: Lecture outline*. Adam Marszałek Publishing House.
- Klein, C. (2024). *Using virtual reality to support social and emotional learning*. National Education Association. <https://www.nea.org/professional-excellence/student-engagement/tools-tips/using-virtual-reality-support-social-and-emotional-learning>
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice-Hall.
- Konarzewski, K. (2000). *How to do educational research*. School and Educational Publishing House.
- Kotyśko, M. (2020). Youth and computer games – motives, emotions and problems related to playing. *Pedagogical Annals*, 12(48), 3, 95–110. <https://doi.org/10.18290/rped20123-5>

- Krzystanek, M., Surma, S., Stokrocka, M., Romańczyk, M., Przybyło, J., Krzystanek, N., & Borkowski, M. (2021). Tips for effective implementation of virtual reality exposure therapy in phobias – A systematic review. *Frontiers in Psychiatry*, *12*, 737351. <https://doi.org/10.3389/fpsy.2021.737351>
- Kurdziel, M. (2025). The Decalogue of difficult interventions, Part 2. *Gazeta policyjna*, *50*. <https://gazeta.policja.pl/997/archiwum-1/2025/numer-50-022025-r/257003,Dekalog-trudnych-interwencji-cz-2.html>
- LaBar, K. S., & Cabeza, R. (2006). Cognitive neuroscience of emotional memory. *Nature Reviews Neuroscience*, *7*(1), 54–64.
- Lacle-Melendez, J., Silva-Medina, S., & Bacca-Acosta, J. (2025). Virtual and augmented reality to develop empathy: A systematic literature review. *Multimedia Tools and Application*, *84*, 8893–8927. <https://doi.org/10.1007/s11042-024-19191-y>
- Lavoie, R., Main, K., King, C., & King, D. (2021). Virtual experience, real consequences: The potential negative emotional consequences of virtual reality gameplay. *Virtual Reality*, *25*, 69–81. <https://doi.org/10.1007/s10055-020-00440-y>
- Lemmens, J. S., Simon, M., & Sumter, S. R. (2022). Fear and loathing in VR: The emotional and physiological effects of immersive games. *Virtual Reality*, *26*, 223–234. <https://doi.org/10.1007/s10055-021-00555>
- Li, X., Hu, Y., Yang, X., Bi, X., Zhang, J., & Tao, P. (2025). The effectiveness of virtual reality training on social skills in education: A meta-analysis. *Education and Information Technologies*, *30*, 89–105. <https://doi.org/10.1007/s10639-024-12941-3>
- Liao, D., Zhang, W., Liang, G., Li, Y., Xie, J., Zhu, L., Xu, X., & Shu, L. (2019). Arousal Evaluation of VR Affective Scenes Based on HR and SAM. In: *2019 IEEE MTT-S International Microwave Biomedical Conference (IMBioC)*, Nanjing, China, pp. 1–4. <https://doi.org/10.1109/IMBIOC.2019.8777844>
- Lie, S. S., Røykenes, K., Sæheim, A., & Groven, K. S. (2023). Developing a virtual reality educational tool to stimulate emotions for learning: Focus group study. *JMIR Form Res*, *20*, 7, e41829. <https://doi.org/10.2196/41829>
- Lin, T. (2023). *Virtual reality horror games and fear in gaming*. Oxford Research Encyclopedia of Communication. <https://oxfordre.com/communication/view/10.1093/acrefore/9780190228613.001.0001/acrefore-9780190228613-e-1478>
- Lindner, P., Rozental, A., Jurell, A., Reuterskiöld, L., Andersson, G., Hamilton, W., Miloff, A., & Carlbring, P. (2020). Experiences of gamified and automated virtual reality exposure therapy for spider phobia: Qualitative study. *JMIR Serious Games*, *8*(2), e17807. <https://doi.org/10.2196/17807>
- Liu, R., Wang, L., Lei, J., Wang, Q., & Ren, Y. (2020). Effects of an immersive virtual reality-based classroom on students' learning performance in science lessons. *British Journal of Educational Technology*, *51*(6), 2034–2049. <https://doi.org/10.1111/bjet.13028>
- Majewska, K. (2021). *Teaching and learning in the virtual media space. Virtual reality in early school education*. Adam Marszałek Publishing House. (Nauczanie i uczenie się w przestrzeni mediów wirtualnych. Rzeczywistość wirtualna w edukacji wczesnoszkolnej. Wydawnictwo Adam Marszałek).
- Majewska, K. (2023). Experiencing virtual reality and visual memory. *E-Mentor*, *3*(100), 61–69. <https://doi.org/10.15219/em100.1620>
- Majewska, K. (2025). Virtual reality in the context of opinions and preparation of teachers for its use in the educational process. A large-scale survey. *International Journal of Pedagogy Innovation and New Technologies*, *12*(1), 2–13. <https://doi.org/10.71358/ijpint.2267>
- Marin-Morales, J., Higuera-Trujillo, J. L., Guixeres, J., Llinares, C., Alcañiz, M., & Valenza, G. (2021). Heart rate variability analysis for the assessment of immersive emotional arousal using virtual reality: Comparing real and virtual scenarios. *PLoS One*, *16*(7), e0254098. <https://doi.org/10.1371/journal.pone.0254098>
- Markocki, M. (2016). Horror and digital games. In D. Brzostek, A. Kobus, & M. Markocki (Eds.), *Monster Knowledge: Horror in cultural studies*. Nicolaus Copernicus University Publishing House.
- Masi, L., Abadie, P., Herba, C., Emond, M., Gingras, M.-P., & Amor, L. B. (2021). Video games in ADHD and non-ADHD children: Modalities of use and association with ADHD symptoms. *Frontiers in Pediatrics*, *9*, 632272. <https://doi.org/10.3389/fped.2021.632272>
- Matsunobu, K., Davidson, R., & Lo, K. Y. (2023). The role of negative emotions in learning music: Qualitative understanding of Australian undergraduate students' listening experience of unfamiliar music. *British Journal of Music Education*, *40*(2), 204–219. <https://doi.org/10.1017/S0265051722000250>
- Meehan, M., Insko, B., Whitton, M., & Brooks, F. P. (2002). Physiological measures of presence in stressful virtual environments. *ACM Transactions on Graphics*, *21*(3), 645–652. <https://doi.org/10.1145/566654.566663>

- Nieuwenhuis, S. (2024). Arousal and performance: Revisiting the famous inverted-U-shaped curve. *Trends in Cognitive Sciences*, 28(5), 394–396. <https://doi.org/10.1016/j.tics.2024.03.011>
- Oei, N. Y., Everaerd, W. T., Elzinga, B. M., van Well, S., & Bermond, B. (2006). Psychosocial stress impairs working memory at high loads: An association with cortisol levels And memory retrieval. *Stress (Amsterdam Netherlands)*, 9(3), 133–141. <https://doi.org/10.1080/10253890600965773>
- Pallavicini, F., Ferrari, A., Pepe, A., Garcea, G., Znacchi, A., & Mantovani, F. (2018). Effectiveness of virtual reality survivalhorror games for emotional elicitation: preliminary insightsusing Resident Evil 7: Biohazard. In *Universal Access in Human–Computer Interaction. Virtual, Augmented, and IntelligentEnvironments: 12th International Conference, UAHCI 2018*, (pp 87–101). Springer International Publishing.
- Parsons, T. D., & Rizzo, A. A. (2008). Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: A meta-analysis. *Journal of Behavior Therapy and Experimental Psychiatry*, 39(3), 250–261. <https://doi.org/10.1016/j.jbtep.2007.07.007>
- Persky, S., & Blascovich, J. (2008). Immersive virtual video game play and presence: Influences on aggressive feelings and behavior. *Presence Teleoperators and Virtual Environments*, 17(1), 57–72. <https://doi.org/10.1162/pres.17.1.57>
- Piaget, J. (1954). *The Construction of Reality in the Child*. Basic Books.
- Plutchik, R. (1980). *Emotion: A Psychoevolutionary Synthesis*. Harper and Row.
- Police Professional. (2020). *Derbyshire debuts virtual reality training system for taser*. <https://policeprofessional.com/news/derbyshire-debuts-virtual-reality-training-system-for-taser/>
- Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education*, 147, 103778. <https://doi.org/10.1016/j.compedu.2019.103778>
- Repetto, C., Germagnoli, S., Triberti, S., & Riva, G. (2018). Learning into the wild: A protocol for the use of 360° video for foreign language learning. In G. Riva, B. K. Wiederhold, & E. Molinari (Eds.), *Pervasive computing paradigms for mental health* (pp. 56–63). Springer. https://doi.org/10.1007/978-3-319-67684-5_7
- Riva, G., Wiederhold, B. K., Chirico, A., di Lernia, D., Mantovani, F., & Gaggioli, A. (2018). Brain and virtual reality: What do they have in common and how to exploit their potential. *Annual Review of CyberTherapy and Telemedicine*, 16, 3–7. <http://hdl.handle.net/10807/144968>
- Rivu, R., Jiang, R., Mäkelä, V., Hassib, M., & Alt, F. (2021). Emotion elicitation techniques in virtual reality, Human-Computer Interaction – INTERACT 2021 In *18th IFIP TC 13 International Conference, Bari, Italy, August 30 – September 3, 2021, Proceedings, Part I*.
- Rubacha, K. (2008). *Metodologia badań Nad edukacją*. Wydawnictwa akademickie i Profesjonalne.
- Seth, A. K., Suzuki, K., & Critchley, H. D. (2012). An interoceptive predictive coding model of conscious presence. *Frontiers in Psychology*, 2, 395. <https://doi.org/10.3389/fpsyg.2011.00395>
- Slater, M. (2009). Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1535), 3549–3557. <https://doi.org/10.1098/rstb.2009.0138>
- Slater, M., & Sanchez-Vives, M. V. (2016). Enhancing our lives with immersive virtual reality. *Frontiers in Robotics and AI*, 3, Article 74. <https://doi.org/10.3389/frobt.2016.00074>
- Slater, M., & Wilbur, S. (1997). A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments. *Presence: Teleoperators and Virtual Environments*, 6(6), 603–616. <https://doi.org/10.1162/pres.1997.6.6.603>
- Sobiepan, K. (2021). *Blood and guts in your living room: How does virtual reality affect the body and mind?* <https://innpoland.pl/170946.jak-wirtualna-rzeczywistosc-wplywa-na-umysl-i-cialo-deweloper-vr-o-medium>
- Spyridonis, F., Daylamani-Zad, D., & Nightingale, J. (2024). PublicVR: A virtual reality exposuretherapy intervention for adults with speech anxiety. *Virtual Reality*, 28(105), 1–19. <https://doi.org/10.1007/s10055-024-00998-x>
- Susindar, S., Sadeghi, M., Huntington, L., Singer, A., & Ferris, T. K. (2019). The feeling is real: Emotion elicitation in virtual reality. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 63(1), 252–256. <https://doi.org/10.1177/1071181319631509>
- Tasnim, R., Heldal, I., Frøland, T. H., Székely-Keresztes, O., Székely, Z., & Kon, E. (2024). Emergency preparedness training using virtual reality games: Allowing knowledge transfer in the digital age. *European Conference on Knowledge Management*, 25(1), 369–378. <https://doi.org/10.34190/ECKM.25.1.2890>

- Tian, C. (2024). Research on the therapeutic effects of virtual reality (VR) technology on psychological disorders. *Lecture Notes in Education Psychology and Public Media*, 54, 292–298. <https://doi.org/10.54254/2753-7048/54/20241593>
- Tyng, C. M., Amin, H. U., Saad, M. N. M., & Malik, A. S. (2017). The influences of emotion on learning and memory. *Frontiers in Psychology*, 8, 1454, 1–22. <https://doi.org/10.3389/fpsyg.2017.01454>
- UNIMERSIV. (2015). *Virtual reality as a learning tool*. <https://unimersiv.com/virtual-reality-as-a-learning-tool/>
- Vesisenaho, M., Juntunen, M., Häkkinen, P., Pöysä-Tarhonen, J., Fagerlund, J., Miakush, I., & Parviainen, T. (2019). Virtual reality in education: Focus on the role of emotions and physiological reactivity. *Journal for Virtual Worlds Research*, 12(1), 1–15. <https://doi.org/10.4101/jvwr.v12i1.7329>
- Wang, J., & Wang, L. (2020). Influence of affective priming effect of immersive virtual reality horror games on cognitive processing of college students. *Revista Argentina de Clínica Psicológica*, 29(2), 1213–1222.
- Wu, J., Guo, R., Wang, Z., & Zeng, R. I. (2021). Integrating spherical video-based virtual reality into elementary school students' scientific inquiry instruction: Effects on their problem-solving performance. *Interactive Learning Environments*, 29(3), 496–509. <https://doi.org/10.1080/10494820.2019.1587469>
- Yang, H., Cai, M., Diao, Y., Liu, R., Liu, L., & Xiang, Q. (2023). How does interactive virtual reality enhance learning outcomes via emotional experiences? A structural equation modeling approach. *Frontiers in Psychology*, 13, 1081372. <https://doi.org/10.3389/fpsyg.2022.1081372>
- Zhang, H., Li, X., Qiu, C., & Fu, X. (2023). Decoding fear: Exploring user experiences in virtual reality horror games. *Chinese CHI 2023 (CHCHI 2023)*, November 13–16, 2023, Denpasar, Bali, Indonesia. ACM. <https://doi.org/10.1145/3629606.3629646>
- Zlomuzica, A., Preusser, F., Totzeck, C., Dere, E., & Margraf, J. (2016). The impact of different emotional states on the memory for what, where and when features of specific events. *Behavioural Brain Research*, 298(B), 181–187.

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