Virtual Reality Horror Games and Fear in Gaming `FREE`

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Summary

Fear is a basic human emotion important for survival and for staying alert to potential danger. In psychology, fear is defined as a discrete emotion to help humans adapt to the environment and serves as a signal for potential danger to help humans avoid or prepare for such threats. While fear is typically experienced through real-world threats as a natural response for survival, modern society also exposes us to fear through mediated content like movies and news. Interactive media, such as video games and virtual reality (VR), have emerged as new ways to experience fear because of their immersive environments. Researchers have discovered that people have similar reactions to both real-life and mediated threats. Previous studies have explored the reasons and methods behind how people experience fear through media. With advancements in technology, researchers have also examined the emotional impact of interactive media, such as video games and VR.

This article examines fear elements, fear reactions, and coping reactions in video games and VR. Results indicate that horror games are the most likely to elicit fear responses in video games, and participants often experience greater cognitive than physical reactions. In VR, research has shown that elements that make players feel realistic inside the games, termed plausibility illusion elements, are most effective in eliciting fear. Players' reactions toward the VR horror games include active approach strategies, or a constant reminder that the VR events are not real; directly disengaging physically and mentally; and other self-help coping strategies. In addition to immediate fear during VR-horror gameplay, some players showed residual fear on the day after they finished playing the game, indicating that the Tetris effect is strong in VR-horror games. Overall, the empirical evidence in existing gaming literature show that emotional responses are greater in VR than in non-VR video games. The literature also explores the appeal of horror games, and their mechanisms are reviewed. By understanding the fear responses of audiences in video games and VR, researchers and the industry can design effective intervention and training materials.

Media-elicited fear, mediated fright, is reviewed, followed by the appeal of horror games. Game elements from the design perspective to discuss various elements in horror games that may elicit fear are also reviewed. Fear reactions, negative emotions experienced in horror games and other game-related elements such as music and soundtrack, virtual environment, game characters' appearance, and their facial expressions, all contributed to the fear emotion among players. The discussion of unique affordances and traits of VR and its implications conclude the article.

Fear Elicited From Media

Fear is a negative-valenced emotion that arises when we perceive a significant and personally relevant threat in our surroundings (Easterling & Leventhal, 1989; Lang, 1984; Witte, 1992). Some argue that fear is a psychological concept rather than a biological mechanism that can be scientifically identified (Adolphs, 2013). However, research on the brain suggests that the amygdala, located in the medial temporal lobe, is associated with fear (Davis, 1992). Fear is defined as a complex reaction involving immediate emotional responses and subsequent cognitive reactions to a perceived threatening stimulus in the environment (Lynch & Martins, 2015, p. 299). Verbal self-reports have been established as a sensitive measure to communicate the experience of fear, surpassing physiological data such as heart rate and skin conductance (Rogers, 1983) or facial expressions (Tourangeau & Ellsworth, 1979) as methods to detect fear.

Fear is not limited to real-life situations but can also be experienced in mediated contexts such as watching movies (Cantor, 2002) or consuming news (Cantor & Nathanson, 1996). Several factors in media content contribute to inducing suspense and fear among audiences. These factors include the presence of dangerous characters or monsters in films or victims in news stories (Cantor & Sparks, 1984; Sparks & Cantor, 1986), the perceived likelihood of threats occurring in the real world versus a fictional context (Cantor & Nathanson, 1996; Cantor & Sparks, 1984), the depiction of blood and injuries (Harrison & Cantor, 1999), and abstract threats (Cantor et al., 1986).

Numerous studies have focused on children's developmental differences in their fear responses to these elements in films and news. Cantor (2002) found that younger children were more afraid of fear-inducing stimuli, such as the Hulk, compared to older children. As children grow older, they tend to be more frightened by realistic portrayals of events, whereas younger children are more frightened by fantasy events. Furthermore, depictions of abstract threats, such as a nuclear war, which young children may not fully understand, elicit stronger fear reactions among older children.

In addition to children, adults also experience fear in response to mediated content. Johnson (1980) discovered that adults considered "depicted brutality" in films as the most terrifying element that induces fear and distressing emotions. Furthermore, filmed depictions of bodily injuries lead to higher levels of physiological arousal and self-reported anxiety among adults (Averill et al., 1972; Boyle, 1984).

Interactive media such as video games and VR are different from other forms of media, such as news clips and movies, because they allow audiences to engage with the content in a more active way—known as interactivity. This means that audiences have more control over the narrative and can make decisions continuously while playing these games and in VR environments. As a result, players can experience greater immersion and presence within the game world and VR environments, which may also lead to greater fear in these virtual environments with horror content (Hemenover & Bowman, 2018). In contrast to watching a news story depicting horrific events through the third-person view, horror games allow players to choose what and how to react when facing mediated threats, and horror games in VR further put players as the

protagonists because all threats are directed toward them as if they are actually happening to them. The unique affordances of the technology of digital games and VR have drawn academic attention to both players' fear perpetuated in the game and the various elements in designing these games.

Players' Appeal to Horror Games

Regarding video games (Kjeldgaard-Christiansen & Clasen, 2019), researchers argue that a combination of evolutionary theory and game studies can explain why players are drawn to horror video games (Lynch, 2018). Horror games allow players to simulate fear scenarios of uncertainty and danger, challenging them to assess and negotiate potential threats. While horror games instill negative emotions, they also offer stimulating challenges that can expand players' emotional and behavioral repertoire, leading to a sense of mastery and explaining the genre's paradoxical appeal. The authors illustrate their evolutionary approach through an analysis of Playdead's puzzle-horror game Limbo.

In addition to the evolutionary mechanism, the excitation transfer theory and model of suspense were employed to examine why players enjoyed horror games. Researchers (Lin et al., 2018) investigated the underlying mechanism of a paradoxical issue: VR-horror game players experienced fear in the game but provided enjoyable appraisals afterward. This study employed the excitation transfer theory (i.e., model of suspense; Zillmann, 1980) as a basis and proposed a three-factor model.

Zillmann's model of suspense shows that the resolution of threats and arousal are two important moderators in the association between fear experienced in movies and the enjoyment outcome after watching the movie. According to this model, audiences become aroused due to suspenseful content and experience negative emotions if a character they like is threatened with victimization. However, if the character has a satisfying ending or successfully overcomes the threats (by resolving them), audiences experience positive emotions, and the accumulated arousal intensifies the enjoyment. The model highlights the role of a satisfying resolution of previously encountered threats as a key factor in enjoyment. If the resolution is unsatisfying or unresolved, the arousal carries over to exacerbate disappointment or dysphoria.

This model being discussed focuses on fear, threat resolution, and arousal as key factors in understanding the enjoyment of frightening media. However, previous studies have not always taken arousal into account when examining the relationship between fear and enjoyment. Arousal is crucial for understanding how fear and threat resolution impact enjoyment because it plays a moderating role in this process. Additionally, while threat resolution has traditionally been viewed as important for explaining the appeal of horror content, research has shown that audiences can still enjoy horror even without resolution because the absence of a happy ending does not necessarily mean that viewers experience cognitive dysphoria.

Revising the excitation transfer theory, Lin et al. (2018) proposed a new three-factor model to explain why players enjoyed the horror game even when they experienced great fear in VR-horror games. Lin et al. (2018) argued that instead of the resolution of threat, horror self-efficacy might be a more precise construct to alter players' negative emotions to enjoyment after the gameplay. In the case of "mediated" fright, self-efficacy is crucial to resolve the threat. Self-efficacy is a belief in one's capacity to accomplish tasks necessary to achieve specific goals. For horror media, a similar concept is "mastering horror," which refers to the ability to withstand horror content. Horror self-efficacy is the belief in one's capacity to confront and endure the challenges presented by media. In video games, successfully coping with suspense and confronting immediate threats can be considered the "resolution" of the challenges posed. If viewers can successfully endure horror content, they experience "cognitive euphoria," and their arousal level transfers the previous intensity of suspense into enjoyment when the game is over, regardless of whether they experience a satisfying conclusion to the threat.

Revising the model of suspense (Zillmann, 1980), Lin et al. (2018) proposed a three-way interaction, including fear, horror self-efficacy, and arousal that affects enjoyment. Specifically, fear and horror self-efficacy have a significant interaction effect on enjoyment among players who experience high arousal, but not among those who experience low arousal. Among high-arousal players, those who have lower horror self-efficacy experience less enjoyment when they also have high levels of fear. However, horror self-efficacy does not affect enjoyment for players who experience low levels of fear.

In this lab study (Lin et al., 2018), the primary factor that influences how individuals perceive negative feelings of fear while experiencing mediated horror content is their level of horror self-efficacy. Horror self-efficacy refers to an individual's belief in their ability to successfully endure and confront frightening situations. The study showed that high levels of horror self-efficacy can transform a negative fear experience into a positive appraisal, leading to enjoyment of the horror content and a desire to play the game again in the future. The study also found that measurements of physiological arousal through skin conductance indicated increased emotional intensity, which further enhanced the experience of enjoyment.

Horror Video Games and Fear: Stimulus Characteristics

Horror Game Design: Emotion and Agency

Scholars explored the design of horror game environment (Habel & Kooyman, 2014; Vachiratamporn et al., 2013) that elicit fear from players. Scary events, fear elements, and interactivity are dimensions scholars explored in this area (Habel & Kooyman, 2014; Lin, 2017; Lynch & Martins, 2015). Survival horror games have received attention in the literature because the genre is designed to induce players' intense emotions such as fear. Affective gaming, incorporating a player's emotional state to manipulate gameplay, has become a trend in early 2010s. Vachiratamporn et al. (2013) focused on players' affective states prior to and after a scary event in a survival horror game. In this study, the researchers used an affect annotation tool to gather self-reported player affective states before (i.e., neutral, anxiety, suspense) and after (i.e.,

low-fear, mid-fear, high-fear) a scary event in a survival horror game. They also collected physiological data, such as brainwave signals, heart rate, and keyboard and mouse activity, to determine the potential for automatically detecting horror-related affect. The results showed that players were more likely to experience fear when they were in a suspense state compared to when they were in a neutral state, and heart rate data was the most effective in classifying player affect, which achieved up to 90% overall accuracy. This suggests that player affect can be used to adapt a scary event in survival horror games to evoke more fear from players.

Habel and Kooyman (2014) proposed a construct of "agency mechanics" as an innovative design element of survival horror video games. The authors argue that agency, or the player's ability to make meaningful choices, is a key element in creating an immersive and engaging gameplay experience in the survival horror genre. They provide an overview of the history and evolution of survival horror games, as well as a discussion of the different types of agency mechanics that can be used in game design. These include player-controlled actions, environmental interactivity, and narrative choice. The authors also examine the psychological effects of agency on the player and how it contributes to the horror experience. Overall, the article provides insights into the importance of agency mechanics in the design of survival horror video games and offers practical guidance for game developers looking to create effective and engaging gameplay experiences.

Indeed, the agency mechanics reflect the game design to offer more interactivity for players to feel that they are the ones making all the decisions and choices in the game. Similar game design elements in the exercise context illustrated in Peng et al. (2012) also correspond to the agency. Guided by self-determination theory (Ryan & Deci, 2006), agency is closely linked to the construct of autonomy. The need for autonomy, defined as the need to feel in control and make decisions, is an intrinsic need for human well-being. Narration choices, which is being able to select the character growth or the environment interactivity, are elements in game design to increase satisfaction of autonomy, which further leads to increased game enjoyment.

However, in horror games, games often "revel in the denial of agency provided to players, and it is precisely the abandonment of control that produces the pleasure of horror gaming's "bounded experience of "fear"" (Habel & Kooyman, 2014, p. 11; Pinedo, 1997, p. 38). Therefore, in order to produce frightening emotions, depriving their autonomy in the "survival context" is a core design element. Habel and Kooyman (2014) also raised the question of the dichotomy of game categories of "survival" (i.e., players being controlled by the game world) and "action" (i.e., players having control and power over the environment). These mechanics not only intensify the gaming experience but also heighten the survival horror elements, including action games. A good example of this is the Dead Space franchise, a very successful survival horror game that has sold more than 2 million copies, and the game effectively uses agency mechanics to elicit horror responses from players. For example, in the game series, the player is allowed conventional movement within a third-person perspective, which involves walking and running. One notable feature is the absence of controllable vehicles, preventing faster locomotion through the game world, and notably, there are no weaponized vehicles that would enable the player to deliver massive firepower. As a result, the basic opportunities for movement are limited compared to, for example, a first-person military shooter. Therefore, game design, particularly in horror games, would benefit greatly from more explicit attention to agency mechanics, which could improve

player experience and enhance the overall quality of game design (Habel & Kooyman, 2014). The authors also called upon the designers to break free from the dilemma of choosing between creating games for action or survival by focusing on player interactivity. This indicated that by adding agency mechanics of action games in survival games can enhance the fear induction process. For example, survival games limit one's agency but by adding movements and agency in limited realms from the action games to survival scenes, a designer can create dynamic environments inducing fear through these two mechanisms. This approach is not limited by the popularity of action games or the niche audience of survival horror games, and allows for a more nuanced design focus.

This agency mechanic may be also related to an underlying mechanism of gameplay: character identification (Klimmt et al., 2009). Character identification in video games is defined as the degree to which a player feels like the character in the game as well as a change of self conpcet mering the player's self and the character. Game design elements such as interactivity contribute to character identification, and further leads to game enjoyment (Hefner et al., 2007). Other literature (Lin, 2013b) also showed that interactivity (playing a game as high interactivity vs. watching a gameplay as low interactivity) led to greater character identification, which leads to greater player emotions and cognition to the game context. These mechanics are closely linked to the agency mechanic illustrated by Habel and Kooyman (2014).

Stimulus Characteristics in *Resident Evil* and Negative Emotions

In addition to fear induction through game design, negative emotions in horror games have received attention in the literature. Lin et al. (2017) explored negative emotions including fear, anger, worry, disgust, and frustration in the violent horror game *Resident Evil*. They focus on the perspective of gamers and aims to examine and construct a detailed structure of their emotions. This structure includes the network of events triggered by the game and the personal beliefs and feelings of negative emotions experienced by the gamer. The study also investigates the correlation and level of interinfluence between the various factors. The results of the study indicate that the hierarchical value map, a visual representation of emotional network structure of gamers using different layers to show connected clusters of gamers' emotions, provides a comprehensive understanding of the gamer emotional network structure. The key game-activating events, such as enemies, stage missions, boss-level monsters, horror atmosphere, and third-person view, lead to the formation of personal beliefs of character death, high difficulty, negative emotions, fear, being frightened, enemy ambush, and tough enemies, ultimately leading to negative emotions such as fear, worry, anger, disgust, and frustration. Additionally, the study found that the clusters of fear and anger had the greatest impact on gamers, and there were varying degrees of correlation and influence between the different factors.

Building on this work, Lin et al. (2017) identified the specific activating events and beliefs that caused negative emotions in players of *Resident Evil*. To achieve this, the study isolated the negative emotions and grouped them into emotional clusters, which included fear, worry, anger,

disgust, and frustration. By doing this, the study provided a clear understanding of how the different variables interacted with each other to produce the negative emotions experienced by the players.

Among the emotion clusters, the worry cluster was associated with negative emotions caused by specific game plot and game-activating events such as stage missions in *Resident Evil*. Previous research has shown that games with high difficulty levels or time constraints can induce anxiety or worry in players (Liu et al., 2009). In the case of *Resident Evil*, the study participants perceived the stage missions to be difficult, leading to the belief in high difficulty, which ultimately resulted in the negative emotion of worry when they were unable to overcome the challenges. Furthermore, participants noted that the game featured a continuous story plot with recurring themes of viral infection and killing, which caused negative emotions such as paranoia and made them worried about their own mental well-being.

The disgust cluster in *Resident Evil* players was associated with negative emotions caused by the third-person camera view and team cooperation. The constantly rotating camera view in the game made some players feel sick or dizzy, leading to a feeling of disgust. Additionally, poor support or wasteful actions from teammates in the game could also cause players to feel disgusted.

The fear cluster was found to be the most predominant negative emotion experienced by players in *Resident Evil* games. Previous studies have suggested that these games can create intense fear for players (Zagalo et al., 2005). Zagalo et al. (2005) found that the emotion of fear had three components in *Resident Evil*. The plot of the game, which includes realistic and plausible storylines, could lead to depression or nightmares, triggering negative emotions and ultimately resulting in fear. The presence of zombies with weapons, concealed in the game's horror atmosphere and soundtracks, which are designed to create tension and stress, could also cause players to feel frightened and trigger fear. Additionally, the realistic and creepy images in the game, including dimly lit tunnels, dilapidated houses, and vast forests, could stimulate players and lead to feelings of fear.

Stimulus Characteristics: Interactivity, Sounds, and Visual

The study regarding *Resident Evil (Capcom)*, provided an in-depth examination into the elements causing fear in a single game. Other literature explored the general elements in different games, in which the survival horror game genre was reported the most. Among this literature, interactivity, scary soundtracks in horror games, visual presentation, and environment were key elements causing fear in various horror games. Regarding these horror games, a study conducted by Lynch and Martins (2015) surveyed 269 university students and discovered that over half (53%) of the sample reported experiencing fear while playing games. Among 53 game titles, the participants listed the games that made them frightened, and the survival horror genre, including the *Resident Evil* and *Silent Hill* series, was at the top of the list and had a significant proportion of all games. In addition, first-person shooters, such as the *Call of Duty* and *Halo* series, also led to experiences of fear.

What elements caused players to fear in these horror games? Lynch and Martins (2015) asked participants to identify the elements that caused fear in video games. The participants ranked interactivity as the top element that caused fear, as they played an active role in the game's narrative and content. Other elements that caused fear included game mechanisms like surprise and game environment elements like audio, darkness, and zombies. Participants reported that interactivity was a major factor in their fear responses and that they differentiated between two types of realism: graphic realism and manifest realism. Graphic realism, which refers to the immersive elements' vivid sensory detail, was more often described as contributing to fright responses than manifest realism, which relates to the plausibility of game events in the real world. Additionally, participants described their responses to the types of fear-inducing elements commonly identified in research on traditional media, including abstract threats like biological and chemical hazards, violence, and death.

Graja et al. (2020) examined the visuals and sounds in horror games and explored how those elements cause arousal and tension. They hypothesize that modifying game elements such as visuals and sounds can enhance the gaming experience. The researchers conducted an experiment to investigate the players' emotional reactions toward context alteration through an adapted version of the game *P.T.* (by Konami, 2014), which altered contexts including light effects, sounds, and in-game events. The experiment measured the participants' physiological data through the galvanic skin response and their perceived emotion. The study found that the order in which the effects were presented had a significant impact on the emotional responses of the players. Furthermore, the study suggests that the psychological impact of the game can be enhanced not only by the visual horror but also by the gradual build-up of sounds.

These two elements of visual and sound in horror games were examined in-depth by other scholars. Klimmt et al. (2019) focused on examining the role of the soundtrack in two games for players' enjoyment and horror emotions. In their second study focusing on a horror game, 59 young males played an episode of *Alien: Isolation* with or without the soundtrack music and reported their horror experience, spatial presence, and character identification. Results indicated that the presence of shocking soundtrack music has an effect on players' horror experience. Presence or identification are not the underlying mechanisms of the effects of soundtrack on players' horror experience.

In addition to emotions, arousal was also examined in horror games. In another study, Ballard et al. (2021) investigated the effects of frightening sound effects in a survival horror video game on cardiovascular and affective arousal and whether these factors were linked to a bias toward shooting people of color (POCs) first in a shooter task. They predicted that participants who played the horror game with scary sound effects would experience higher levels of cardiovascular arousal and fear compared to those who played without sound effects. Additionally, it was expected that an increase in cardiovascular arousal would result in a higher likelihood of participants shooting a POC first during the shooter task. The results supported the hypothesis that playing the survival horror game with scary sound effects leads to higher cardiovascular arousal. However, the study did not find any correlation between first-shot bias and cardiovascular arousal. Instead, the study found that first-shot bias was positively correlated with enjoyment of the shooter game. An exploratory analysis indicated that participants who

played the game with scary sound effects were slightly more likely to shoot a POC first in the shooter task, but only when enjoyment of the game was included as a covariate. Although this effect was small, it indicated that the first-shot bias occurred when the scary sound effects were present after controlling one's enjoyment of the game. These evidences indicated that sound element is an important factor contributing players' fear emotion, through self-recalled questionnaire (Lynch & Martins, 2015), self-reported emotion (Klimmt et al., 2019), and through physiological signals (Ballard et al., 2021).

Regarding virtual environment, McCall et al. (2022) explored types of virtual environments that elicit ambiguous threats. Previous studies have shown that feeling uncertain about when or where a threat may occur can cause anxiety. In this study, McCall et al. (2022) wanted to investigate other aspects of ambiguous threats by creating a virtual environment that did not contain any concrete threats but still induced a feeling of danger. By incorporating psychological research and principles of emotional game design, the authors developed a virtual world and tested its effects in three studies. Participants reported feeling uneasy and uncertain in the virtual environment, and their subjective and physiological responses were affected by the presentation of ambiguous cues that could be perceived as threatening. The results also suggest that this experience had an impact on participants' memory of the virtual world and its storyline. Overall, this study shows that immersive virtual worlds can effectively create a complex experience of ambiguous threat that has both subjective and cognitive effects.

Stimulus Characteristics: Character's Appearance and Facial Expressions

Research suggests that when playing video games, fear is more likely to be experienced from a first-person perspective, where the player interacts with the game environment directly. A study by Hofer et al. (2017) found that when an avatar expressed fear, it reduced the player's sense of embodiment of the avatar and decreased their fear reactions. This suggests that the emotions expressed by an avatar may interfere with the player's identification with the avatar and alter their self-concept. Therefore, first-person perspectives are likely to elicit greater fear in players than third-person perspectives in video games because the player cannot see the facial expressions of their own avatars. The same study also found that this effect only occurred during active gameplay and not while watching recorded gameplay. This suggests that the mechanisms by which video games induce fear may differ depending on how the audience engages with the content: playing versus watching.

The objective of this study (Hofer et al., 2017) was to examine how an avatar's emotional expressions affect players' fear reactions during horror gameplay. In Study 1, the results showed that the emotional expressions of an avatar reduced players' fear reactions. This effect was mediated by the level of embodiment that players experienced with their avatars. Specifically, avatar emotional expressions reduced the level of avatar embodiment, which, in turn, positively predicted players' fear reactions. In Study 2, the findings of Study 1 were replicated. Additionally, it was discovered that the effects observed in Study 1 only occurred during interactive gameplay

and not when players watched prerecorded footage of the game. This suggests that the effects of an avatar's emotional expressions on players' fear reactions are moderated by interactivity, through avatar embodiment. A moderated mediation model was supported by these results.

In another study, Tinwell et al. (2010) examined the relationship between the perceived strangeness of virtual characters and the perception of human likeness based on attributes of motion and sound among 100 participants. Thirteen video clips of virtual characters and one of a human were rated. The results showed that the uncanny phenomenon and the perceived fright of a character were exaggerated by attributes of motion and sound. The perceived strangeness of a character had strong correlations with how humanlike the voice sounded, how humanlike the facial expression appeared, and how synchronized the character's sound was with lip movement. The least synchronized characters were perceived to be the most frightening. These findings provide an initial set of hypotheses for character facial rendering and vocalization in survival horror games that game designers can use to increase the fear factor. These empirical data showed that game characters' appearance and their facial expressions are factors affecting players' fear.

Technological Affordance: Interactivity

Interactivity was also explored as a dimension to examine audiences' emotions toward a horror-themed video game. Interactivity in existing literature is often operationalized as playing (high interactivity) versus watching (low interactivity) a video game (Lin, 2013a, 2013b). Related literature has shown that greater level of interactivity in digital games leads to greater emotional responses such as aggression. In horror games, Madsen (2016) employed this play versus watch a video game to explore the direct or authentic versus indirect or passive fear. In this study, Madsen explored and compared the impact of interactivity or agency on the physiological responses of participants as a measure of direct fear while playing or watching a horror-themed video game. Madsen (2016) hypothesized that players, who have greater agency, would exhibit a higher physiological response, indicating a greater fear reaction. Change scores by subtracting baseline mean values from exposure mean values for each participant were calculated in measures of electrodermal activity (EDA), respiratory rate (RR), and heart rate (HR). Self-reported fear data from each participant were also collected. The results showed that players had significantly greater increases in EDA, RR, and HR change scores compared to watchers. However, there was no significant difference in self-reported fear between players and watchers. The researchers also reported change score t-tests for specific events that occur in the video game. Overall, the results suggest that agency had the effect of inducing a greater fear response and may be useful for researchers looking to ethically induce direct fear. This study also corresponded to other literature regarding interactivity on emotions.

Players' Fright Reactions in Horror Games

In a survey conducted by Lynch and Martins (2015) asking university students to recall their horror game playing experiences, they reported experiencing greater cognitive than physical reactions to playing video games that induce fright. More specifically, over half of players (55%) were acutely aware of strange sounds, while more than one-third (33.6%) were similarly aware of strange shadows. Furthermore, players often experienced cognitive reactions, such as not being able to stop thinking about the game (28%), feeling afraid to be alone at home (19.6%), and being worried about the game (32.9%). Only a small number of university students reported physical reactions, such as nightmares (12.6%), headaches (2.8%), stomachaches (5.6%), or shaking (9.8%). Despite these negative reactions, nearly half of the participants (44.1%) enjoyed the experience of feeling scared.

Regarding potential individual differences, the survey results (Lynch & Martins, 2015) showed that no gender differences were found regarding fear responses. However, male players enjoyed playing these games more than female players. The study also found that individuals with higher levels of sensation seeking were less likely to be scared by horror games. Meanwhile, trait empathy was found to only have a negative correlation with the enjoyment of horror games, but not with fear frequency or playing frequency.

The above sections focus on existing literature exploring elements in video games causing fear among players and their fright responses. Before moving on to the literature on VR horror games, the characteristics in VR are first reviewed for basic understanding of VR.

Technological Characteristics and Core Elements in VR

The distinguishing features of VR that set it apart from other media and video games are its head-mounted device, which presents two separate images to create a stereo virtual environment that users can explore. Additionally, users wear goggles that completely cover their field of vision, immersing them fully in the simulated environment. A complete VR system also includes an auditory and haptic controlling device with a tracking system, which allows users to identify the direction of events and interact with the environment through various actions, such as grabbing objects or firing guns. Advanced haptic devices provide feedback, enabling users to sense vibrations as real feedback.

The second feature that distinguishes VR from other media is its ability to offer room-scale experiences through high-end VR engines such as HTC Vive and Oculus Rift. This feature allows users to move around freely in a designated space and interact with the virtual environment through real-world actions, inducing the response-as-if-real phenomenon (Slater, 2009). This means that users respond with genuine emotions and reactions to the VR environment, similar to their reactions in the real world. For instance, in a VR simulation, users may feel afraid to walk outside on a narrow plank after taking an elevator to the top of a building. Similarly, in a VR

game, users may scream, step back, and fire their guns when they encounter zombies attacking them from behind (Slater, 2009; VR simulation-"Plank"). These reactions are similar to real responses in the real world.

Slater (2009) identified three fundamental mechanisms in VR: place illusion (PI), plausibility illusion (PSI), and body ownership. PI is defined as "the strong illusion of being in a place in spite of the sure knowledge that you are not there" (Slater, 2009, p. 3553). It refers to the convincing illusion of being in a specific location despite knowing that one is not physically present there. Whereas PI focuses on the environment, PSI emphasizes the perception that the depicted events seem real. On the other hand, PSI pertains to the perception that the events being depicted in VR seem real even though one is aware that they are not. It is defined as "the illusion that what is happening is real even though you know that it is not real" (Slater, 2009, p. 3561). For instance, in a VR-horror game, one may realize that zombies do not exist in the real world, but still feel as if they are genuinely battling with them. Finally, body ownership is defined as "some degree of ownership over this virtual body—it comes to really seem to be your body (even though you know it cannot be)" (Slater, 2009, p. 3554). It refers to the feeling of possessing a virtual body in the VR environment, even though one knows that it is not real. While some VR experiences do not provide users with a virtual body, certain games and social VR applications such as Rec Room and Horizon World allow users to customize their avatar, including their virtual body and facial features.

Immersion in VR

To examine the key affordance of immersion in VR-horror games, researchers examine whether the immersion, operationalized as horror games in VR (high immersion) and horror video games (nonimmersive), influence players' emotions and reactions. Some studies (Pallavicini et al., 2019) compared emotional responses in VR games and nonimmersive video games and found that both types of games elicit fear responses. Those who played VR games indicated greater enjoyment and presence than regular digital games. Participants also displayed more intense emotional responses both in a self-reported questionnaire and a physiological index (heart rate and skin conductance). This finding corresponds to other studies (Hemenover & Bowman, 2018; Lin, 2017), which find that the immersion in VR games elicits a greater degree of emotions than non-VR games.

In addition to emotions, immersion also affects players' physiological response. Lemmens et al. (2022) investigated whether VR games elicited a stronger sense of presence and affected players' emotional and physiological responses compared to playing on a traditional TV screen. Two experiments were conducted with a total of 128 students, in which the effects of playing a survival horror game or a first-person shooter (FPS) on a TV or in VR were compared. The results indicated that playing games in VR led to a stronger sense of presence, lower heart rate variability, and stronger subjective feelings of fear. Moreover, the feeling of presence mediated the effects of VR on fear. The impact of playing an FPS in VR on hostility was inconsistent, and VR gaming was not found to be more enjoyable than playing on TV. Regardless of the game or display

medium, hostility levels increased significantly after playing. This study highlights that commercial VR games have the potential to influence players' feelings of presence, emotional, and physiological states.

Due to these different findings, future research should continue exploring whether technological affordances such as immersion lead to different affective and physiological outcomes comparing VR and non-VR games. From this section, horror self-efficacy is an important mechanism to explain why players enjoy the horror games. This horror self-efficacy can be affected by the design of horror games by various elements which can effectively elicit fear.

Audience Response: Fear in VRHorror Games

Since the commercialization of VR in 2016, scholars have studied players' fear emotions and their coping strategies when playing VR-horror games. Lin (2017) conducted a study to investigate the immediate and next-day fear responses of university students to VR-horror games. The participants were asked to play a VR-horror game for four minutes in a laboratory, but 17 participants quit the game due to extreme fear after watching a video trailer and a VR trial. The study found that the fear responses were caused by two elements: PI elements, such as darkness, environmental sounds, and the sound of zombie steps, and PSI elements, such as when zombies were close to the participants and when they attacked the participants. The participants reported being more afraid of the PSI elements than the PI elements.

In another study (Bender & Sung, 2021), the authors employed facial electromyography and skin conductance response to explore players' affective responses such as fear and arousal through the physiological signals. They explored whether different levels of immersion in different gameplay modes may elicit greater affective responses and whether these heightened affective responses would significantly correlate with players' enjoyment at the precise point of the affective response. Using a popular VR zombie game, Arizona Sunshine (from Vertigo Games), three specific scenarios were chosen as the experimental stimuli in this study: (a) an onboarding scenario (i.e., following the game plot in the beginning), (b) a dark abandoned mine (i.e., dark environment), and (c) a survival-based horde mode (i.e., when a herd of zombies swarm into the player, overrun, and kill). Each mode requires different gameplay from the players and the virtual environments are different in terms of their visual and audio aesthetic. The results showed that all three modes elicited significant heightened fear, arousal, and joy than the baseline.

This study (Bender & Sung, 2021) also found that among all the game modes, the average amplitude of fear was significantly higher in Horde Mode (i.e., survival mode with unlimited zombies coming toward the player) compared to Onboarding Mode (i.e., the usual game plot mode), but there was no significant difference between Abandoned Mine Mode (i.e., dark environment) and Onboarding Mode. Moreover, both Horde Mode and Abandoned Mine Mode induced significantly higher levels of arousal compared to Onboarding Mode. Participants experienced a higher average amplitude of joy in Horde Mode than in Onboarding Mode and Abandoned Mine Mode, but there was no significant difference in the average amplitude of joy between Abandoned Mine Mode and Onboarding Mode. Among all events in the game,

participants reported significantly higher fear when entering the dark room in the Abandoned Mine Mode. This event evoked approximately seven times higher levels of arousal than all other events in the game. Similarly, for joy, participants experienced significantly higher levels of joy when entering the dark room in the Abandoned Mine Mode than in all other events except for "over-run by zombie" and "over-run and die" in Horde Mode.

This study (Bender & Sung, 2021) compared the immersion level in the same game, and showed that both "immersive gameplay modes" elicited significantly higher fear and arousal than the "less immersive gameplay mode." This indicated that immersion is an important antecedent of users' emotions in VR games. They also showed that fear and arousal were correlated significantly with users' enjoyment, corresponding with results from Lin et al. (2018).

In terms of fear and arousal, Voigt-Antons et al. (2021) employed another approach to study horror games. They investigated how the level of interactivity affects the sense of presence in natural environments and its impact on arousal and valence. Participants were first induced with fear using a VR-horror game, and then played a VR-nature game with no, limited, or extensive interaction to see how they recovered. The horror game successfully induced high arousal and low valence, as confirmed by a manipulation check. Scores on the Igroup Presence Questionnaire showed that more interaction with the virtual environment increased spatial presence. The experience of nature also had a beneficial effect. Scores on the Self-Assessment Manikin questionnaire for valence showed a significant increase in positive emotions in the conditions with extensive and limited interaction compared to the control group. The VR nature experience significantly reduced arousal and increased positive valence compared to the posthorror game ratings. Physiological responses supported these findings. The study suggests that health-related VR applications can improve mood levels by implementing plenty of interactions and increasing spatial presence, or leaving out any interactions altogether.

Audience Response: Players' Coping Reaction in Horror Games

Regarding how players cope in VR-horror games, according to Lin's (2017) study, four coping strategies were identified among players of VR-horror games. The first category is the approach strategy, which involves actively monitoring the environment and approaching threats. This strategy was more commonly used by male participants and those with high levels of sensation seeking, as well as players who were familiar with the FPS genre and enjoyed playing horror games. Female participants and those with low levels of sensation seeking were less likely to employ this strategy.

The second coping strategy is the disengagement avoidance strategy, which involves distracting oneself or closing one's eyes. This strategy is more commonly used by females and those who are afraid of PSI elements. As expected, a preference for horror games negatively predicts the use of this strategy. In other words, those who prefer horror games would less likely adopted the disengagement avoidance strategy. Rather, they adopted the approach strategy.

The third strategy is the self-help coping strategy, which involves verbal communication such as talking to oneself, swearing, or screaming. This strategy is more commonly used by females, those who are sensation seeking and neurotic. However, familiarity with FPS games predicts less use of this strategy.

The fourth and final strategy is the cognitive avoidance strategy, which involves telling oneself that "this isn't real." This strategy is more commonly used by females and those who are experiencing VR content for the first time. Among these strategies, the approach strategy was used most frequently, followed by cognitive avoidance, physical and mental disengagement, and self-help coping strategies.

Regarding the overall immediate fear while playing the VR-horror game, Lin's (2017) lab study showed that female players and individuals who have lower levels of sensation seeking, higher levels of neuroticism, low familiarity with FPS games, and a low preference for horror games experience greater fear while playing VR-horror games. The study also examined the participants' fear reactions overnight and the following day. One participant reported having a dream related to the game, and three had nightmares. Some participants experienced the Tetris effect, where they feared being attacked from behind (just as in the game) and were afraid of darkness.

Conclusion

Horror games have become the significant and important game genre in the entertainment industry. VR Horror games can even be adopted as training content because the immersion allows players to feel as if they are the ones trying to survive and facing all the challenges. Horror games provide a unique platform to explore the human psyche, particularly how individuals respond to fear and anxiety. Understanding how players react to frightening situations in a safe and controlled virtual environment can offer valuable insights into human emotions and behavior. Moreover, understanding how individuals react to fear while playing video games and experiencing VR can help researchers and the industry create successful intervention and training materials. Studying horror games offers a multidisciplinary perspective, ranging from cultural and societal aspects to psychological and design considerations. By delving into this genre, researchers can gain a deeper understanding of human behavior, media effects, and interactive storytelling, benefiting various fields and industries. Fear elements, fright reactions, and coping reactions, as well as game design elements are reviewed in video games and in VR. VR has been widely used to elicit phobias in a safe virtual environment and as a means to address various phobias, including social phobias and arachnophobia. VR also provides immersive environment to train players' coping reactions when facing threats. Developing programs through video games and VR that encourage the development of coping strategies for fear responses is crucial in present and future research efforts.

Acknowledgments

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