Computers in Human Behavior 72 (2017) 350–361

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Full length article

Fear in virtual reality (VR): Fear elements, coping reactions, immediate and next-day fright responses toward a survival horror zombie virtual reality game

Jih-Hsuan Tammy Lin

College of Communication, National Cheng-Chi University, No. 64, Section 2, Zhinan Road, WenShan District, Taipei, Taiwan

ARTICLE INFO

Article history:
Received 2 November 2016
Received in revised form
23 February 2017
Accepted 25 February 2017
Available online 27 February 2017

Keywords:
Virtual reality game
Survival horror
Fear
Coping strategy
Personality
Plausibility illusion

ABSTRACT

This study explores players' fright reactions and coping strategies in an immersive virtual reality (VR) horror game. Based on Slater's theory of virtual reality, two dimensions of fear elements in the VR game—the fear of place illusion (PI) and the plausibility illusion (PSI) —were identified by playing a virtual reality survival horror game with a sample of 145 students. Participants reported greater fear toward PSI elements than toward PI elements. Fear of PSI elements positively and strongly predicted disengagement coping strategies and overall fear. Among coping strategies, players mainly adopted approach strategies, followed by avoidance (disengagement and denial), and self-help strategies. A "self-talk" strategy, newly identified in this study, has been reported as an effective means to cope with mediated threat in VR games. Regarding individual differences, sensation seeking and neuroticism influenced participants' coping strategies and fear. Additionally, males and females employed different coping strategies. Very few students experienced next-day fright, which consists mostly of cognitive reactions and VR-related reactions, such as the Tetris effect and the fear of being attacked from the back. Theoretical frameworks regarding fear elements and coping reactions are proposed to aid future research. Implications for academia, fear conditioning for training, and marketing campaigns are discussed.

1. Introduction

"Don't come any closer, no! no! … AHH!" followed by terrified screams. This is a common reaction seen in the promotion of horror films. However, in 2016, this response did not come from the characters in a film, but rather from a live audience playing a movie-themed virtual reality (VR) game that was designed to generate interest and promote the film *Paranormal Activity: The Ghost Dimension* (Blum, Peli, & Plotkin, 2016).

The year 2016 has been coined as the year of VR (Cellan-Jones, 2016; Morris, 2015) because of the wide commercialization of VR technology in the video game, entertainment, news and film industries. The horror, first-person shooter (FPS) and survival genres are the most anticipated by the VR community (Painter, 2016). These genres have also become extremely popular in the game streaming community, as many famous streamers have chosen to demonstrate their fear reactions while playing newly released VR horror games (Butler, 2016). For example, famous game streamer Pewdiepie received more than 16 million views on YouTube on his first VR horror game playthrough via Oculus (Butler, 2016).

Researchers have studied the appeal and impact of frightening media content such as horror films (Tamborini, 1991) and news clips (Newhagen, 1998). Regarding the popular video game format, very few studies have used an empirical approach to explore frightening experiences in video games (Lynch & Martins, 2015). The first survey (Lynch & Martins, 2015) to explore this topic showed that more than half (53%) of 269 university students experienced game-inspired fright. Additionally, the survival horror game genre topped the list, having been found to cause more fear than any other genre.

VR and video games have become a booming trend in the entertainment industry (Martins, 2015). The interactivity embedded in video games, defined as "situations where real-time feedback is collected from the receivers of a communications channel and is used by the source to continually modify the message as it is being delivered to the receiver" (Straubhaar & LaRose, 1996, p. 12), allows players to freely control their progress and the way in which they engage with the media content (Lin, 2013a). In addition, interactivity is a prominent factor correlating with fear in

E-mail address: tammylin@nccu.edu.tw.

http://dx.doi.org/10.1016/j.chb.2017.02.057
0747-5632/

video games (Lynch & Martins, 2015). VR is by far the most interactive type of digital games (Steuer, 1992). However, interactivity in VR deals with more than merely being able to respond to the programs or modify content; rather, it is able to provide illusions that a) the audience perceive themselves situated in the game (place illusion, i.e., presence) and b) events happening in the games are really happening (plausibility illusion) (Slater, 2009). The place illusion mechanism in VR games allows players to "be in the game" (Bohil, Owen, Jeong, Alicea, & Biocca, 2009), and the plausibility illusion mechanism (Slater, 2009) allows players to personally face immediate threats such as being surrounded and directly attacked by disfigured humans or anxiously waiting for monsters to suddenly appear. Unlike traditional media, players in a VR horror game must actively decide how they will react to such threats and manage to survive.

The importance of mediated fright in VR has been widely valued and adopted in the area of therapy of various types of phobia (Parsons & Rizzo, 2008), such as spider phobia (Garcia-Palacios, Hoffman, Carlin, Furness, & Botella, 2002), social phobia (Klinger et al., 2005), fear of flying (Rothbaum, Hodges, Watson, Kessler, & Opdyke, 1996), and acrophobia. Theoretically, triggering real fright in a simulated VR environment without actually being hurt (Peng, 2008) is important for treatments. A meta-analysis (Parsons & Rizzo, 2008) showed that VR treatments elicited frights similar to real events and was effective in lessening anxiety and phobia when compared to those who were in the controlled conditions (i.e., delayed treatments). Presence and immersion were found to be important theoretical constructs to elicit mediated frights in order to deliver effective treatments. However, existing studies compared mostly VR and non-VR contexts (Howard, 2017) and overlooked plausibility illusion, an essential theoretical mechanism in VR (Slater, 2009), in designing and testing various elements of VR. Understanding what and how elements elicit effective mediated frights in VR is crucial for theoretical contributions and practical implications for both entertainment and fear conditioning in treatments (Baas, Nugent, Lissek, Pine, & Grillon, 2004). In the entertainment context, the appeal of experiencing fright has received market popularity, and the results of this study could further provide theoretical framework for designers and future research.

The purpose of this study is to explore "what" causes audiences' fright in the VR horror context, "how" audiences with different individual traits cope with these mediated threats, and any potential lingering effects the day after the VR experience. This study employed the two theoretical mechanisms in VR (Slater, 2009) to explore game elements that cause audiences' fright reactions. Theoretically, the results will provide empirical evidence for future VR research in support of manipulating certain game elements to further examine the influence of such mechanisms on audiences' emotions and behavior. Practically, this can provide implications for game designers and marketers for greater entertainment experiences. In addition, understanding "how" various players cope with mediated fright could potentially contribute to gamified treatments for certain phobia or for reflex training in sports, similar to Stanford University's use of VR to train football quarterbacks (Brown, 2015). The results can identify various personality traits that contribute to different reactions. Furthermore, understanding potential lingering effects could provide theoretical and practical guidance for marketing campaigns and implementation.

2. Theoretical background

2.1. Fear and mass media content

Fear is a negatively valenced emotion that is induced when we sense or face a significant and personally relevant danger in our environment (Easterling & Leventhal, 1989; Lang, 1984). Fear has been argued to be a psychological construct rather than a biological mechanism that can be identified through scientific investigation (Adolphs, 2013). Nevertheless, neurological studies have suggested that the amygdala, which is located in the medial temporal lobe in the brain, is associated with fear (Davis, 1992). Fear has been defined as "a multidimensional reaction composed of immediate emotional and subsequent cognitive responses to a perceived threat stimulus in the environment" (Lynch & Martins, 2015, p, 299). Among the different ways to detect a person's fear, verbal self-reports have been validated as a sensitive measure that communicates the experience of fear compared to physiological data (such as heart rate and skin conductance) (Rogers, 1983) and facial expressions (Tourangeau & Ellsworth, 1979).

In addition to real environments, people also sense fear in mediated contexts such as watching films (Cantor, 2002) or watching the news (Cantor & Nathanson, 1996). Numerous factors in media content induce suspense and fear among audiences, including the appearance of dangerous characters and/or monsters in films or victims in the news (Sparks & Cantor, 1986), the probability of threats occurring in the real world as opposed to in the fantasy context (Cantor & Nathanson, 1996), blood and injury (Harrison & Cantor, 1999), and abstract threats (Cantor, Wilson, & Hoffner, 1986). Johnson (1980) found that adults referred to "depicted brutality" in films as the scariest element to induce fear and disturbing emotions. In addition, filmed depictions of bodily injuries greatly result in higher levels of physiological arousal and self-reported anxiety among adults (Boyle, 1984).

2.2. Fear in video games and VR

Do video games exhibit different elements to induce fear? A survey (Lynch & Martins, 2015) of 269 undergraduate students indicated that darkness inside of video games, disfigured humans, zombies, interactivity, the unknown, and surprise were the top fright-inducing elements in video games. Among all the reported fear elements, abstract threats (such as biological and/or chemical war), blood and avatar/non-player character death, violence, fantasy, and manifested realism were similar to the fear elements identified in mass media. Audio and music were also two important elements that cause fear in video games.

Although elements in video games may be similar to those in mass media, the way in which audiences engage with media content differs greatly due to the levels of interactivity. According to social learning theory (Bandura, 1986), watching a film and playing a video game can be theorized, respectively, as observational experience and enactive experience in mediated contexts (Lin, 2013a; Peng, 2008). When they watch a film, audiences cannot control any of the depicted characters on the screen, and they must follow the narrative of the story. The suspense that leads to the confrontation or the resolution of the threat in films induces anxiety and fear (Tamborini, 1991). In video games, players actively make decisions to engage in the storyline, which usually leads to different outcomes and resolutions of the threats based on players' previous behavior and decisions (Lin, 2013b). The cognitive efforts that contribute to frightening experiences in video games include playing a character who walks alone along a dark path that leads to a deserted and haunted house, not knowing when monsters will pop up or whether to keep going, run away, or defend oneself.

In VR, players not only actively decide to engage in game content but also directly encounter monsters and threats as if they are facing them in the real environment (Slater, 2009). This technology requires players to see the virtual world through head-tracking goggles that entirely cover their field of vision so that the players

are fully immersed in the simulated environment. A full VR system usually consists of visual, auditory, and haptic displays with a tracking system (Slater, 2009). In the virtual environment, head-tracking technology within goggles separate left and right images so that players experience stereo vision. The audio has directional effects, which help players to identify the sources and directions of events through sound. Using hand controllers, players can touch game objects, grab things, or fire guns to engage in the game.

In addition, advanced VR engines allow players to freely walk around in an enclosed space (such as HTC VIVE or the supporting system Virtuix Omni) (Prasuethsut, 2016). Therefore, players interact with characters and game objects as they perform real actions in the real world (Madsen, 2016). Darkness means that it is totally dark inside the goggles, and when monsters walk toward the player, the changing distance between them with the approach is perceived as being real; players can dodge by lowering their bodies, kneeling down or moving in any way they prefer. A VR environment places players within a totally immersed space and provides them with the greatest degree of freedom to engage in content (Klimmt, Hefner, & Vorderer, 2009).

To further explore elements in VR games that induce fear, this study takes the first stab at employing the theoretical framework of the place illusion (PI) and the plausibility illusion (PSI), two distinct characteristics in VR (Slater, 2009). The so-called PI, which 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), allows players to perceive the virtual environment as reality. In addition to the PI, whereby the VR environment is perceived as being real, the PSI focuses on the depicted events as being real; the PSI can be described as "the illusion that what is happening is real even though you know that is it not real." (Slater, 2009, p. 3561). For example, in a survival horror VR game, we know that the zombies are not real, but when they walk up to us, our bodies and brains respond as if they were (Pan & Slater, 2007). PI and PSI are closely related to self-location and to possible action dimensions in the spatial presence scale (Vorderer et al., 2004). In this study, the theoretical framework of PI and PSI was employed because possible actions in the traditional presence scale emphasize whether the audience can interact with the environment, which lacks the "real happening" central focus of PSI. Therefore, several distinctive elements in VR games would induce players' fear, depending upon the PI or the PSI. Examples include zombies approaching players (PSI), zombies appearing suddenly behind players (PSI), or hearing the directional footsteps of zombies walking (PI). The author categorizes environment-related factors as the PI dimension to include the visual and aural depictions of game elements, and game events and activities are categorized as the PSI dimension. Thus, the following research questions are proposed to explore fear elements in VR games.

RQ1a. What elements cause fear in a VR survival horror game?

RQ1b. What dimension of elements (PI or PSI related) do players fear most in a VR survival horror game?

2.3. Coping strategies

When people encounter media-induced fear, they employ different coping strategies to alleviate negative emotions. The existing research has mainly considered how children effectively cope with frightening media content (Cantor, 2002). Generally speaking, empirical studies have indicated that noncognitive strategies are more effective for pre-school children than for older children, whereas both noncognitive and cognitive strategies are beneficial for elementary school-aged children. Noncognitive strategies include physical activities such as grabbing an attachment object, leaning on significant others, walking out of the situation, becoming involved in another activity, or eating and drinking. Another effective strategy is to directly cover one's eyes to avoid the frightening depictions of the media content (Cantor, 2006). However, Wilson (1989) reported that covering one's eyes is effective for younger children but is of limited benefit for older children. Older children found that the continuous audio from a program still made them feel less in control and more vulnerable when they covered their eyes, thus providing limited ability to distract them and to help them to reduce their fear.

While noncognitive strategies are mainly behavioral, cognitive strategies center on players' thoughts and verbal information, which alter the perception of a threat and the danger depicted in media content (Cantor, 2006). Common strategies include focusing on the "not real" part of a situation. Other strategies include providing an explanation to minimize the perceived severity of threats and danger, focusing on the happy ending of the depicted story, and employing expressive communication, such as talking with somebody else about the experience or writing about it afterwards to reduce it.

Existing studies focused mainly on children's reactions to media frights, and the current literature has not established any theoretical framework regarding audiences' responses to mediated frights and aversive events. Whereas preferred coping styles categorize individual personality traits into blunters and monitors (Miller, 1987), Zuckerman and Gagne (2003) proposed the approach-avoidance categorization of an individual's coping reactions. The closest theoretical framework focusing on "reactions" is the revised COPE scale, which focuses on coping reactions to daily stress (Zuckerman & Gagne, 2003). Zuckerman and Gagne (2003) conceptually categorized humans' responses to stress into cognitive and behavioral coping methods within the approach and avoidance framework. For example, cognitive and behavioral *approach* methods refer to planning and active coping dimensions, respectively. In the *avoidance* method, the cognitive dimension refers to denial and behavioral dimensions, focusing on behavioral disengagement. In the revised and enlarged COPE scale, Zuckerman and Gagne (2003) also included self-help (such as expression emotion and emotional support-seeking), accommodation (such as maintaining optimism and acceptance of what happened) and self-punishment dimensions (such as self-blame and self-focused rumination).

Do people employ different coping strategies when playing VR games than when watching a film? The technological design in VR affords players the opportunity to perceive "response-as-if-real, RAIR" (de la Peña et al., 2010). The RAIR is largely dependent upon the sensorimotor contingencies, which are defined as "the actions that we know to carry out in order to perceive," in VR (Slater, 2009, p. 3551). For example, through the head-tracking device goggles, players move their heads and eyes to change the direction of their gaze or lean forward and bend to see something at a low height (Noë, 2004; O'Regan & Noe, 2001). Therefore, in a survival zombie game, players can dodge by lowering their bodies or kneeling down or in any other way they prefer to avoid or defend an attack.

In addition, a game requires players to actively defend themselves to survive (as the resolution of the threat). They must monitor the environment while controlling and performing in-game actions to defend or attack zombies and eliminate threats. In conjunction with all of the affordances in VR games (PI and PSI), players can employ any coping strategy to cope with the approaching danger as if the aversive event were real and respond to it realistically. For example, players can adopt *monitoring strategies* to maintain personal security in the case of sudden attacks and firing weapons. They can also directly close their eyes or purposefully turn their heads to *avoid* seeing the zombies (while still

being exposed to their voices), or they can keep telling themselves "*this isn't real*". In addition, they may employ an expressive communication strategy such as self-talk as a means of *self-help* (Zuckerman & Gagne, 2003).

In the VR context, this study employs the revised COPE framework to further categorize media-related coping strategies in the following ways and proposes a theoretical framework of how players react to VR horror content. The cognitive and behavioral dimensions of *approach* method includes a monitoring reaction (i.e., planning) and active actions to confront and shoot zombies (i.e., active coping). The cognitive and behavioral dimensions of the *avoidance* method includes a "this isn't real" (denial) strategy and behavioral disengagement, such as turning one's head the other way or closing one's eyes. Regarding the expressive communication strategy found in reactions to mediated fright, this corresponds to the *self-help* method in the revised COPE framework. Traditional self-help focuses on talking to friends or writing about the experience later. In the VR horror game context, this study argues that players can self-talk to remind themselves of the reality outside the virtual world and to create verbal cues as a means of distraction. This self-help method includes the cognitive dimension, which is emotional support seeking (talk to self) and the behavioral dimension, which is expressing emotion, such as yelling, shouting or swearing.

To understand how players cope with "real" threats in VR, the following question is proposed:

RQ2. What coping strategies do players employ in a VR survival horror game?

2.4. Factors that influence the employment of coping strategies

Previous literature has found that certain personality traits were important factors influencing how audiences react to mediated fright. For example, sensation seeking (Hoffner & Levine, 2005; Lynch & Martins, 2015) and neuroticism (Tamborini, 1991) were significant predictors of enjoyment of horror content and subsequent emotional reactions, such as feeling anxious or frightened. However, much remains unknown about how these individual differences affect players' coping strategies, especially in the context of VR games. In addition, game-related experiences, novelty, and the characteristics of VR may also influence how players employ various coping styles when encountering vivid and surrounding threats. Understanding how these factors influence users' coping strategies and fear is important for future guidance of designing VR training and treatment programs for different types of audiences. Therefore, the following section will discuss these potential factors in the following order: the individual personality level, the game experience level, and the VR level.

2.4.1. Individual differences

Neuroticism. Neuroticism is a well-established factor that correlates with coping strategies in people's daily lives (McCrae & Costa, 1986; Parkes, 1984; Scheier, Weintraub, & Carver, 1986). It is one of the so-called Big Five personality traits and is related to fear, anxiety, and stress (Thompson, 2008). Neuroticism results from a neural system that detects a mismatch between actual and expected situations (Eisenberger, Lieberman, & Satpute, 2005; Laricchiuta & Petrosini, 2014. Individuals with high-neuroticism traits are highly sensitive to negative stimuli and tend to be worrisome, insecure, and emotionally unstable (Costa & McCrae, 1992; Eysenck, 1981). They respond poorly to threats, and they perceive common situations as threatening.

How does neuroticism predict players' coping strategies when they are faced with the vivid threats and danger in VR games? The existing literature correlating neuroticism and coping strategies focuses on real-life contexts such as daily stress (Gunthert, Cohen, & Armeli, 1999) or marital conflict (Bouchard, 2003). Research has found that high-neuroticism individuals employ more distancing and avoidance strategies when they are confronted with marital conflicts (Bouchard, 2003). However, is this real-life pattern transferrable to the VR horror context? In VR, the PI and PSI may exacerbate the perception of threats for high-neuroticism individuals. Therefore, these individuals may directly adopt avoidance strategies (in both the disengagement and denial dimensions) instead of employing approaching strategies because their cognitive and emotional appraisal may exceed their optimal level of information processing and arousal **(H1).** Much remains unknown about the influence of neuroticism on players' coping strategies in such a novel context, and this area is worth exploring.

Sensation seeking (SS). SS is another well-established factor predicting audiences' appeal and responses to frightening and violent media content (Hoffner & Levine, 2005). It refers to the characteristic exhibited by an individual to purposefully seek novel, exciting, and intense experiences to satisfy their need for sensation (Zuckerman, 1994). High sensation seekers are willing to take risks to gain sensations through activities such as bungee jumping or extreme sports (Zuckerman, 1994). SS has been found to be positively related to the enjoyment of frightening films (Hoffner & Levine, 2005) and scary video games (Lynch & Martins, 2015), and subjects with this trait recalled fewer frightened reactions during gameplay.

Little research has studied the relationship between SS and copying strategies. In the context of sports, research has indicated that individuals with low SS reported poorer coping skills in stress management (Smith, Ptacek, & Smoll, 1992). In the war context (Solomon, Ginzburg, Neria, & Ohry, 1995), findings have indicated that high-SS subjects showed better adjustment than low-SS subjects to the stress of captivity 18 years after their participation in the Yom Kippur War. In VR games, it is likely that high-SS subjects will be more adaptive to this novel context than low-SS subjects, and they will employ more active strategies to face the mediated danger, such as approach strategies, after controlling other personality factors **(H2).**

Sex. Past research have shown that adult men and women employ different coping strategies when they are faced with stress. For example, Brougham, Zail, Mendoza, and Miller (2009) found that college women reported using more emotion-focused coping strategies than college men. Research on recalling frightening experiences in video games (Lynch & Martins, 2015) indicated that sex did not influence frightened reactions in video games. An evolutionary perspective (Darwin, 1872) may support sex as a predictor of coping strategies, as men may employ active strategies to approach and eliminate threats, whereas women may tactically avoid the attack or danger. VR games provide an excellent mediated stimulus because players can freely decide whether to confront zombies and shoot them or to kneel down and avoid the attack.

A meta-analysis (Tamres, Janicki, & Helgeson, 2002) on sex differences and coping showed that women were more likely to employ expressive communication strategies to verbally express emotions and thoughts to others or to themselves in the process of seeking emotional support, positive self-talk, or ruminating upon encountered problems than men. Therefore, it is likely that there will be sex differences in coping strategies, in that women will employ more self-help strategies to express emotions and more avoidance strategies than men, controlling for other personality factors **(H3).**

2.4.2. Game-related factors

VR is a novel experience for most people, especially because

advanced VR gear and technology were not widely commercialized to the general public until 2016 (Cellan-Jones, 2016, p. 2016; Morris, 2015). Therefore, a first-time VR player may focus more on employing the "denial" strategy – that is, taking an "it isn't real" attitude – than non-first-time players **(H4).**

Other game-related factors include players' preferences for shooting games or horror games. These preferences may influence how players cope, as those who prefer shooting and horror games tend to be experienced players and would be more likely to employ approach strategies than avoidance strategies.

2.4.3. Fear generated by the PI and PSI elements

Finally, the PI affordance in VR provides players with the illusion of "being there," which is a core dimension of presence. A higher level of presence creates an illusion of reality that causes players to think that they are actually inside the virtual environment, even though they know that it is not real. VR games provide a higher degree of presence than other video games (Steuer, 1992). This study further distinguishes fear toward PI and PSI elements. How does fear toward these two dimensions affect players' coping strategies?

RQ3. How do individual differences, game-related experiences, and fear toward PI and PSI elements affect players' employment of coping strategies in a survival horror game?

RQ4. How do individual differences, game-related experiences, and PI and PSI elements affect players' immediate fear?

2.5. Next-day fright reactions

Mediated fright induced not only an immediate fright reaction but also lingering effects, which could be life-long memories (Cantor, 2006). For example, media content affects children's sleep or thoughts and causes enduring and life-lasting traumatic experiences (Cantor, 2006). College students (Lynch & Martins, 2015) have also reported mostly cognitive responses (such as hyper-awareness of strange sounds and shadows) and few physical responses (such as headache or stomachache) after encountering frightening content in video games. Do VR fright experiences cause enduring feelings or even behavioral and physical symptoms?

As previously theorized with social cognitive theory, video games provide mediated enactive experiences as opposed to the mediated observational experiences gained by watching movies or novels (Peng, 2008). Studies have shown that greater level of identification in mediated enactive experiences resulted in greater effects emotionally, cognitively, and physiologically compared to enactive observational experiences (Lin, 2013a; Peng, 2008). In VR games, both PI and PSI elements provide players illusions that the events were happening to "them", cues from these events are stored in amygdala in the brain as implicit memory and serve as signals for future defense against potential harm (LeDoux, 1996). Fear conditioning is a process in which humans implicitly associate certain cues from a frightening experience, such as the sound, the color or the shape of the dangerous object. Whereas LeDoux (1996) referred to fear conditioning in the context of real lives, Cantor (2006) argued that mediated frights also induce strong and enduring effects to disrupt audiences' lives.

Therefore, the last focus of this study is to explore the next-day fright reactions toward the VR horror experience. Since VR horror games provide a "real" environment for players to experience threats as their personal encounters, whether there are lasting effects overnight is an important and meaningful question to explore for future design of fear conditioning.

RQ5. What are the fright reactions the next day after playing a VR survival horror game?

3. Method

3.1. Participants

One hundred and forty-five students (53 male, 92 female) from a university participated in this experiment. The mean age of these participants is 22.57 years old (SD = 2.97, ranging from 19 to 36). Most of the participants are Taiwanese (97.93%), and the remainder included one Korean, one Malaysian, and one US-born Taiwanese, who are all proficient in Chinese.

3.2. Stimulus

Participants played the demo[1] of The Brookhaven Experiment (2016) in a lab that simulates a home living room and kitchen. The space for this experiment was set as 3 × 2 m. This game is particularly suitable for this experiment because it features a survival mode of five waves of disfigured zombies approaching the player from every angle in a deserted town hall. The environment is dark, with several trees in the distance. Players have one gun with limited bullets and one flashlight with a limited battery. When the game begins, players can hear footsteps approaching, but it is difficult to kill zombies when they are distant. The easiest way to kill zombies is to fire at their heads up close. Therefore, players are able to see the visual depictions of the zombies regardless of their shooting ability. This design also ensures that players experience both PI and PSI elements, and it engages the core elements of the horror survival game genre. The game was played in HTC VIVE with a high-end PC that was equipped with the latest GTX1080 graphic card. The HTC VIVE VR engine provides a room-scale play mode (players can freely set the room size) in which players can freely walk around in a pre-set space to engage in game content.

3.3. Procedure

A screening questionnaire was sent out to determine a player's willingness to play different types of games in VR. The author excluded those who indicated complete unwillingness (rated 1 on a 7-point Likert scale) to play horror games. The qualified participants arrived in the lab and signed a consent form to voluntarily participate in the experiment. The participants then filled out a questionnaire, indicating their demographic information along with SS and neuroticism scales, and subsequently watched a trailer of the VR game (as a forewarning). The instructions for the VR game controller were then provided.

After being fitted with the VR goggles, participants were instructed to practice aiming, firing, and reloading the gun and turning the flashlight on and off. After a brief practice round (wave 1), the participants played the VR game continuously for 4 min. They then filled out a questionnaire asking about their fear elements, coping strategies, and level of fear. The participants also received a very brief survey the next day to determine their overnight fright reactions. Each participant was rewarded with snacks and a drink as incentives[2].

[1] HTC VIVE was released in April 2016. The experiment was held in June 2016. At that time, only the demo of this game was available. The complete game was officially released on July 12. This demo featured one ("Town Hall") of the survival modes of the complete game.

[2] This study is part of a bigger project regarding fear in virtual reality games.

3.4. Measurements

3.4.1. Individual differences

Sensation seeking ($\alpha = 0.78$; $M = 4.33$; $SD = 0.96$) was measured using a brief SS scale (Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002). The participants rated seven statements such as "I like to do frightening things" on a 7-point scale that was anchored by 1 (completely disagree) and 7 (completely agree). The bungee jumping item was deleted because it did not predict well in the pilot testing. Neuroticism ($\alpha = 0.78$; $M = 4.08$; $SD = 0.92$) was measured through the subscale of neuroticism from the Big Five (John & Srivastava, 1999). The participants rated six adjectives such as self-consciousness and anxiety on a 7-point scale that was anchored by 1 (completely disagree) and 7 (completely agree).

3.4.2. Game-related differences

The participants indicated whether this was their *first time* playing a VR game (using VR goggles) by answering "yes" or "no" (18.6% indicated not first time). They also rated questions about their *familiarity with first-person shooter (FPS) games* ($M = 3.30$, $SD = 1.93$, single item) and their *preference for the horror game genre* ($M = 3.54$, $SD = 2.23$, single item) on a 7-point scale that was anchored by 1 (completely disagree) and 7 (completely agree).

3.4.3. Fear elements

The participants rated their level of fear using 13 elements on a 7-point scale ranging from 1 (very low) to 7 (very high); this scale was designed by the author and made reference to the previous literature and to PI and PSI in the horror genre. An exploratory factor analysis using the maximum likelihood extraction method with direct oblimin rotation (Table 1) was employed following the recommendation from Costello and Osborne (2005). The scree plot showed that there were two factors and that these two dimensions explained 69.36% of the variance. The details of the PI dimension ($\alpha = 0.88$, $M = 4.48$, $SD = 1.32$) and the PSI dimension ($\alpha = 0.93$, $M = 4.83$, $SD = 1.41$) are described in Table 1.

The participants also answered open-ended questions regarding what element caused the most fear for them and why. Two independent coders first reviewed all the answers individually and grouped similar responses. For example, "the sound of zombie footsteps" and "zombies' growling" were both grouped as "sound effect"; "I aimed but the zombies did not die", "out of ammunition", and "the gun was loaded too slow" were grouped as "not competent". The first group round resulted in 10 and 11 categories from two coders (one coder combined "uncertainty" and "zombies from every direction", and the other separated this two). The author reviewed all the answers and the categories, then developed the codebook using the 11 categories and provided clear instruction and examples. Two coders then categorized the open-ended questions based on the codebook (see Table 2) and achieved excellent agreement, Cohen's $k = 0.98$ (Landis & Koch, 1977).

3.4.4. Coping strategies

Using the well-established COPE scale (Zuckerman & Gagne, 2003) for coping with daily stress, relevant sub-scales were revised and tailored to the VR game. Regarding the *self-help* dimension, strategies of verbal communication such as emotional expression (e.g., swearing, screaming) and self-talk were included. The approach dimension included items for monitoring the environment and actively confronting threats. In the avoidance dimension, the disengagement sub-dimension consisted of physical disengagement (i.e., closed eyes) and mental disengagement (i.e., thinking of something else) during the experience. The denial sub-dimension was measured using a single item, "this isn't real." In virtual reality, players cannot "pretend that it isn't really happening" or "refuse to believe that is happening" (two other items from the original COPE scale), in contrast to dealing with real-life stress. In addition, "this isn't real" is sufficient to capture the idea. Scholars have advocated the employment of a single-item approach for some clear and simple concepts, and no significant differences were found between measuring through a single item or through multi-item scales (Bergkvist & Rossiter, 2007). The participants rated these statements on an 8-point scale that was represented by 1 (none), 2 (very few times), to 7 (always).

3.4.5. Fear and fright reactions

Immediate fear was measured using a three-item scale ($\alpha = 0.88$, $M = 3.93$, $SD = 1.47$). The participants rated statements including "the degree to which I feel afraid," "the degree to which I was frightened," and "the degree to which I do not want to recall the experience," on a 7-point scale represented by 1 (very low) and 7 (very high). An exploratory factor analysis (maximum likelihood extraction) showed that these three items loaded onto a single factor, explaining 79.48% of the variances. All items had community scores higher than 0.40 and factor loading higher than 0.60, indicating the structure and items are valid (Costello & Osborne, 2005).

The fright reactions that were reported from the next day consist of statements that are referenced from Lynch and Martins (2015), such as "I was too scared to sleep" and "I was afraid to walk alone at night", as well as statements that were tailored to the VR horror game, including "I was afraid to be in the dark" and "I was afraid that something might attack me from behind." The participants rated eight statements on a 7-point scale represented as 1 (completely disagree) and 7 (completely agree), and they indicated

Table 1
Pattern Matrix of the exploratory factor analysis and descriptive data of fear elements based on PSI and PI dimensions.

	N	Mini-mum	Maxi-mum	*M*	*SD*	Factor loading	
PSI elements (58.23% variance, ($\alpha = 0.93$, $M = 4.83$, $SD = 1.41$)							
When I cannot control my weapons	145	1	7	5.14	1.55	**0.66**	0.18
When zombies are really close to me	145	1	7	5.10	1.61	**0.89**	0.03
When zombies attack me	145	1	7	4.59	1.77	**0.93**	-0.08
When I feel vulnerable	145	1	7	4.53	1.77	**0.81**	0.08
When zombies attack me, and the screen turns red	145	1	7	4.20	1.88	**0.76**	-0.08
When zombies approach	145	1	7	4.78	1.65	**0.71**	0.13
PI elements (11.23% variance, $\alpha = 0.88$, $M = 4.48$, $SD = 1.32$)							
Darkness	145	1	7	4.07	1.59	0.31	**0.44**
Environment sounds	145	1	7	4.25	1.75	-0.15	**0.91**
Growls from zombies	145	1	7	4.30	1.74	0.20	**0.61**
Sound of zombie steps	145	1	7	4.63	1.73	0.05	**0.77**
Not knowing where the zombies will come from	145	1	7	5.37	1.58	0.29	**0.45**

Numbers in bold indicate that factor loadings over .40 were categorized into one factor.

Table 2
Open-ended fear elements in a VR survival horror game.

	Frequency	Valid Percent	Cumulative percent
0. Not at all	1	0.7	0.7
1. Not competent	48	33.1	33.8
2. Zombies being very close	27	18.6	52.4
3. Sound	17	11.7	64.1
4. Suddenly found out that the zombies are in the back	20	13.8	77.9
5. Uncertainty	15	10.3	88.3
6. Darkness	2	1.4	89.7
7. Environment	3	2.1	91.7
8. Being attacked	5	3.4	95.2
9. Others	2	1.4	96.6
10. Number of zombies from all directions	5	3.4	100.0
Total	145	100.0	

"yes" or "no" regarding whether they had nightmares or dreamt of game-related content. An open-ended question was also provided for the participants to report other fright reactions.

4. Results

4.1. Fear elements

RQ1a explores types of fear elements in the subject VR game. As described in the method section, two factors, PI and PSI elements, were extracted (Table 1). PI elements consisted of environmental cues, such as sound effects and darkness, whereas PSI elements consisted of perceived plausible actions, such as zombies approaching. In addition to the forced-choice answers, open-ended questions were also provided for the participants to indicate the element that caused the most fear during their VR game experience. The answers were coded into 11 categories, which are shown in Table 2. Forty-eight percent of the participants rated "not competent at effectively employing their weapons" as the most feared element, while 27% reported zombies being very close to them; 20% indicated zombies suddenly appearing; 17% reported the sound effects (especially the steps of zombies); and 15% indicated the uncertainty element.

A within-subject repetitive measure general linear modeling (GLM) was employed to compare PSI- and PI-related fear elements. The results indicated that the participants rated PSI-related elements ($M = 4.83$, $SD = 1.41$) as causing significantly more fear than PI-related elements ($M = 4.47$, $SD = 1.32$), $F(1, 144) = 20.22$ ($p < 0.001$), answering RQ1b.

4.2. Coping strategies

RQ2 explores the types of coping strategies that players employ in a VR survival horror game. A within-subject repeated measure GLM was conducted to compare these coping strategies. As shown in Table 3, the players employed approach, self-help, and avoidance strategies (including the sub-dimensions of disengagement and denial). Among these, the within-subject GLM showed that the contrasts between these strategies were significant ($p < 0.001$). The approach strategies were employed the most often, followed by the cognitive avoidance strategy (not real), stressing the nonreality of the fright experience. Self-help strategies and behavioral disengagement strategies were employed similarly (with no significant statistically differences between these two).

RQ3 investigated how individual differences, game-related experiences, and fear regarding PI and PSI elements influence players' coping strategies (Table 4). Due to the VR context, this study treated the cognitive dimension of avoidance strategies as a standalone strategy to explore factors of this specific strategy. Four hierarchical linear regressions were conducted to examine the associations by entering individual differences in the first step, game-related experiences in the second step, and the fear of PI and PSI in the last step. As shown in Table 4, all tolerance values were above 0.20 and all VIF values were lower than 2.52, indicating no issues of multicollinearity (O'Brien, 2007). Durbon-Watson tests also indicated no signs of auto-correlations. The following results were organized by coping strategies.

Regarding the self-help coping strategy, in which the participants talked to themselves or expressed their emotion through verbal communication, female (supporting H3), SS and neuroticism are all positive individual predictors of this strategy. In addition, greater familiarity with FPS games negatively predicted employment of this strategy, controlling for individual differences. A preference for horror games had a close-to-significant negative relationship with this strategy ($p = 0.055$). Fear regarding the PI and the PSI were not associated with the self-help strategy.

Regarding the approach strategy (i.e., monitor surrounding environment and approach threats), male participants and those with high SS (supporting H2) employed more of this strategy than female participants and those with low SS. Controlling for these individual differences, familiarity with the FPS genre and preference for horror games positively predict the employment of the approach strategy. Fear of the PSI and the PI did not influence the participants' approach strategy.

As for the disengagement avoidance strategy (i.e., distracting oneself or closing one's eyes), the female participants were more likely to report using this strategy than the male participants. Neuroticism had a close-to-significant positive relationship with this strategy ($p = 0.055$, not supporting H1). In addition, after controlling for individual differences, the preference for horror games negatively predicted the employment of a mental disengagement strategy. Fear of the PSI positively predicted a disengagement strategy, controlling for the effects of individual differences and game-related experience.

Last, regarding the cognitive avoidance strategy (i.e., "this isn't real"), female participants reported a higher frequency of using this strategy than male participants. First time using VR was also a positive predictor of this strategy (supporting H4), after controlling for individual differences. Fear of the PI and fear of the PSI were not significant factors.

4.3. Immediate fear and next-day fright

RQ4 explored how individual differences, game-related experiences and fear of the PI and the PSI influence the participants' immediate fear. A hierarchical linear regression with the same steps used for RQ3 was conducted (shown in Table 4). All three individual differences were significant factors for immediate fear. Female

Table 3
Types of coping strategies in a VR survival horror game ($N = 145$).

	Minimum	Maximum	*Mean*	*SD*
Approach (monitoring) strategies ($\alpha = 0.65$, $M = 6.10$, $SD = 1.49$)				
Cognitive (planning)				
I constantly monitored my surroundings for potential zombies	2	8	7.19	1.14
Behavioral (active coping)				
I approached zombies for more precise shooting	1	8	4.78	2.61
I aimed at zombies more precisely	1	8	6.34	1.76
Self-help strategies ($\alpha = .71$, $M = 2.05$, $SD = 1.38$)				
Cognitive (self emotional support seeking)				
I kept talking to myself to remind myself of the context	1	8	1.72	1.46
Behavioral (expressing emotion)				
I swore (foul language)	1	8	1.97	1.91
I screamed or yelled	1	8	3.01	2.62
I loudly shouted at zombies to tell them "go away and don't come near me"	1	8	1.48	1.24
Avoidance strategies: physical and mental disengagement ($\alpha = .69$, $M = 2.15$, $SD = 1.31$)				
Behavioral disengagement				
I turned my head and did not look at zombies	1	8	2.59	2.17
I took off my earphones	1	8	1.31	1.02
I closed my eyes	1	8	1.96	1.95
I distracted myself by thinking of other things	1	8	1.43	1.06
I intuitively crouched down	1	8	1.88	1.95
I intuitively backed off	1	8	3.78	2.28
Avoidance strategies: Denial *(cognitive)*				
I said to myself "this isn't real"	1	8	3.44	2.45

Table 4
Standardized coefficients of hierarchical linear regressions regarding effects of individual differences, game experiences, and fear elements on coping strategies and fear.

	Self-help	Disengagement	Approach	Not-real	Fear	Tolerance/VIF	
Step 1: Individual difference							
Sex (male = 1)	−0.20*	−0.31***	0.33***	−0.21*	−0.25**	0.98	1.02
Sensation seeking	0.18*	−0.11	0.29***	−0.03	−0.16*	0.99	1.02
Neuroticism	0.22**	0.15[a]	−0.07	0.13	0.19*	0.996	1.00
R^2 changes	0.12**	0.14***	0.22***	0.07*	0.14***		
Step 2: Game-related experiences							
Sex (male = 1)	−0.08	−0.18*	0.19*	−0.14	−0.06	0.78	1.29
Sensation seeking	0.24**	−0.02	0.22**	0.01	−0.06	0.91	1.10
Neuroticism	0.20*	0.13	−0.05	0.14	0.16*	0.98	1.02
First-time VR	−0.01	0.13	−0.01	0.17*	0.11	0.96	1.04
FPS familiarity	−0.21*	−0.13	0.25**	−0.14	−0.30***	0.80	1.25
Liking horror games	−0.16	−0.26*	0.19*	0.01	−0.26**	0.87	1.15
R^2 changes	0.18*	0.23**	0.31**	0.11	0.28***		
Step 3: Fear elements							
Sex (male = 1)	−0.06	−0.15[a]	0.17*	−0.12	−0.001	0.77	1.30
Sensation seeking	0.24**	−0.01	0.21**	0.01	−0.04	0.91	1.10
Neuroticism	0.14	0.04	−0.01	0.09	0.02	0.92	1.09
First-time VR	−0.06	0.06	0.02	0.13	−0.003	0.92	1.08
FPS familiarity	−0.17	−0.04	0.22**	−0.11	−0.15**	0.76	1.31
Liking horror games	−0.13[a]	−0.20**	0.17*	0.04	−0.16**	0.86	1.17
Fear of PSI	0.11	0.35***	−0.08	0.08	0.61***	0.40	2.52
Fear of PI	0.17	0.12	−0.11	0.15	0.17*	0.40	2.50
R^2 changes	0.23**	0.40***	0.33	0.15*	0.75***		
Durbin-Watson	2.20	2.11	1.94	2.21	2.06		

Note. $^{***}p < 0.01$, $^{**}p < 0.01$, $^{*}p < 0.05$, a indicated borderline p values ($p < 0.055$).

participants, low sensation seekers, and high-neuroticism participants reported a higher degree of fear from playing a VR survival horror game. Controlling for individual differences, lower familiarity with the FPS genre and a lower preference for horror games predicted higher fear. Fear of the PSI strongly and positively predicted immediate overall fear, whereas fear of the PI had a moderate association with fear, controlling for individual differences and game experiences.

The participants also reported their overnight and next-day fright reactions after playing this survival horror game in VR (RQ5, Table 5). Only one or two people experienced nightmares or dreamed about the game. In addition, fewer than 5% of the participants experienced negative reactions, such as being too scared to sleep, constantly hearing zombie voices, or being afraid to walk alone at night. Fewer than 10% were afraid that someone would attack them from behind, which would indicate the enduring effects of PSI. The participants also indicated other reactions through open-ended options, such as the Tetris effect (seeing the game environment when closing one's eyes; Ackerman, 2016), feeling as if living inside the game, or relief and enjoyment after leaving the game ("So nice to actually be alive").

5. Discussion

This study provides the first examination of coping strategies and fright reactions in the most recent and the most immersive VR horror game. Building on the survey of students recalling fright experiences in video games (Lynch & Martins, 2015), this study

Table 5
Frequency and descriptive data of next-day fright reactions ($N = 144$).

1(completely disagree)/7(completely agree)	1	2	3	4	5	6	7	M/SD
I don't want to hear anything related to it.	82	36	13	8	1	4	0	1.76 (1.16)
I was afraid to walk alone at night.	100	23	10	6	4	0	1	1.58 (1.09)
I was afraid that something would attack me from behind.	95	29	2	8	6	2	2	1.72 (1.33)
I felt that I constantly heard zombie voices.	103	25	6	3	7	0	0	1.51 (1.02)
I felt depressed.	95	24	12	8	2	3	0	1.66 (1.15)
I never want to play a VR survival horror game again.	88	14	13	5	8	7	9	2.22 (1.91)
I was afraid to be in the dark.	91	19	13	11	4	4	2	1.88 (1.44)
I was too scared to sleep at night.	114	22	3	4	1	0	0	1.31 (0.71)
	Yes	No						
Had nightmares (yes 1/no 2)	3	141						
Dreamed about the game (yes/no)	1	143						

further categorized fear elements based on the affordances of VR games and explored their influence on players' coping strategies through an empirical approach. Moreover, several important individual traits and game-related experiences were also examined to inform future research on how players sense fear and cope in VR games. Theoretical frameworks regarding fear elements and coping reactions were proposed for future research.

Fear that is induced by immediate danger or in-sight threat (such as facing a direct attack) is not commonly experienced in our daily lives. We usually worry about stress, fear of the unknown and our future, or we are anxious about relationships. In ancient times, humans faced mortal threats, such as predators or natural disasters. Currently, humans exercise our natural instincts and fear emotions through a mediated approach, such as by watching movies, news clips, documentaries and video games (Lynch & Martins, 2015). However, these media have limited affordances to provide a realistic simulation of immediate danger to audiences. How we cope with such immediate threats still remains unknown.

This study showed that VR games provide an excellent means to simulate close-range physical threats that stimulate our fear and to determine how we react to and cope with such stimuli. VR games allow us to experience vivid and "real" threats that move toward us in a manner that can feel identical to reality (Parsons & Rizzo, 2008). Specifically, in addition to the elements that construct the seems-to-be-real environment (PI), VR games allow events to "really" happen through the illusion of plausibility mechanisms (PSI).

This study identified PI and PSI elements in VR games based on Slater's (2009)' theoretical mechanisms. The results indicated that players perceived PSI elements as causing more fear than PI elements. PSI is a mechanism that distinguishes VR games from other media, including interactive video games. For example, PSI allows zombies and other threatening entities to exist behind a player (or at any angle), something that is only currently possible in VR technology. In video games, players experience emotions by identifying with characters (Klimmt et al., 2009; Lin, 2013b); thus, there is still a distance between a player and an avatar. In VR, players directly experience game events without merging the self and the avatar because, in VR games, the "self" is the protagonist. Therefore, PSI has a greater capacity to cause fear than PI.

PSI refers to what happens in the game is perceived as actually happening; it can be further divided into what players can do to objects and events (such as intuitive body movements to avoid bullets or throwing grenades to explode buildings) and what events and enemies in the game can do to players (such as endless zombies approaching from every direction and attacking). The exploratory factor analysis loaded PSI into one dimension, including both directions of interactivity between events and/or objects and players. However, theoretically, it would be interesting to further examine how variations of both directions of interactivity in VR games influence players' fear and other emotions. Current marketing campaigns and VR games have already employed these tactics, for example, presenting a player who only holds a flashlight (low in player interactivity) to explore a haunted house (high in event interactivity because ghosts can suddenly appear close by or from behind). Will players rate this type of design as the most vulnerable and scariest experience? Future studies should examine the subdimensions of PSI on players' emotions and actions.

The second focus of this study dealt with "how" we cope with such simulated immediate threat situations. Approach strategies were shown to be a common way to manage the immense stress of VR games. It is likely that the participants attempted to "play" the game by aiming at zombies more precisely and looking around for potential threats. These could be game-induced behaviors. Specifically, male participants, those who are high-SS, and those with higher familiarity and preference for horror games employ the approach dimension more than others. One would argue that it might be that male participants are more likely to have experiences with shooting games, and their schema has been trained to confront the enemies in games. However, as shown in the analysis, after controlling for game-related experience, the sex difference is still significant. This study could not provide support for an evolutionary argument, but sex differences may be derived from the approaches to survival that were developed in ancient times.

The results also showed that immediate verbal communication such as self-talk or the expression of emotions by swearing and screaming is also a valid coping strategy in VR horror games. As one participant indicated in the open-ended option regarding thoughts about the experiment, talking to himself helped remind him that it was only a game, and he could also use the talking as a buffer to lessen fear: at least he could hear his voice instead of being alone in a dark wilderness being attacked by approaching zombies from unknown directions. Unlike other modes of expressive communication, such as writing about it or talking to others to "wrap up" one's emotions, self-help strategies focus on the simultaneous expression of emotions and self-talk *during* the exposure rather than *after* the exposure. The participants indicated that by screaming and swearing, they felt relief by expressing their fear. Based on the results, we can further hypothesize that self-help strategies will be an effective means to lessen fear. In addition, those who are high in SS and neuroticism employ this strategy more often. To be able to cope with the frightening situation in VR, perhaps monitoring the environment, the confrontation approach, and self-help are effective and should be examined in future studies.

Who tends to adopt avoidance strategies? The female participants adopted more disengagement and "not-real" strategies than the male participants. One female student shared that this was the

only way to get her through the entire experience. These strategies provide players with expectations for safety and an appreciation of reality after the VR game is over. "Once getting out of the goggles, it is so good to be alive, in reality." From the observations of the research team, the participants employed the sheer avoidance strategy (closing eyes and turning heads) the most when they lost control of their game actions (such as not being able to load guns or running out of ammunition) and when zombies closely surrounded the participants. They simply chose to "die" as a way to exit the experience. Specifically, those who were more afraid of the PSI elements reported a higher degree of using a disengagement strategy. Those who were first-time VR players also employed a "this isn't real" strategy more frequently. VR games provide us with an excellent situation in which to explore people's most intuitive responses to immense physical threats.

This study also explored players' next-day fright reactions to determine potential lingering effects. The results showed that, for most of the university students, the fright emotions did not last overnight. Of those who did experience next-day fright, they were more affected by the PI and PSI mechanisms in VR games, as some people perceived strange sounds, fear of sudden attack from behind, or even the so-called Tetris effect (Ackerman, 2016). Still, very few people reported lingering fright reactions. The implication of the rare overnight lingering effect is particularly encouraging for researchers and clinics to use VR contexts for treatment of various types of phobia or performance trainings, such as military training. Future research could closely manipulate PI and PSI dimensions of elements for different levels of fear induction, fear conditioning, and intuitive coping strategy training.

5.1. Contributions and limitations

This study makes theoretical and practical contributions. Methodologically, this study explored during, immediate, and lingering fright experiences by asking participants to actually play a VR game. Theoretically, this study empirically categorized fear elements into PI and PSI dimensions, thereby providing a theoretical framework future research can employ to further examine the interactions of these two dimensions. Whereas previous literature (Howard, 2017) mainly compared VR and traditional non-VR contexts, this study addressed this issue and empirically examined elements that effectively induced different levels of fear and provided this theoretical framework. In addition, the previous literature operationalized media interactivity as playing versus watching (Lin, 2013a, 2013b; Peng, 2008). The current categorization of VR games based on theoretical constructs provided researchers opportunities to further test "interactivity" in detail, such as the levels of plausibility of the player affecting events or the levels of plausibility of events affecting players.

Second, this study organized coping strategies that the existing literature mostly employed among children and proposed a theoretical framework for coping strategies in VR contexts among adults. The self-help expressive communication coping strategy was first identified in the context of VR horror games. This is a distinctive strategy that has not been identified for media-induced coping strategies. In addition, "this isn't real" is a common strategy employed in VR games to cope with threats. Pan and Slater (2007) has indicated that, although the participants know that the game is not real, the brain still sends signals for danger and threats (such as height, the edge of a cliff) and the participants still react as they would in reality. Future studies can further examine, given a sensory-contingent fear element such as crossing a narrow wood plank to rescue a cat, whether a self-help expressive communication or a "this isn't real" avoidance strategy would be more effective than other strategies.

Third, individual differences and game experiences are important factors in the VR context. SS and neuroticism were two significant individual traits that influence the participants' coping strategies and fear. Males and females behaved significantly differently in the VR games and employed different coping strategies.

The results provide rich practical implications. For game designers and marketing campaign organizers, understanding how PSI and PI interact could help in the design of more emotion-arousing experiences. Understanding *what* elements cause fear, *who* is more afraid, *how* audiences cope, and levels of *lingering* effects helps us to design VR content that is tailored to various types of conditions. For example, for VR football trainings, it may be the best to first employ PI elements (field setting and sound) for those players who are high in neuroticism and low in SS to accommodate the fear, then adding PSI elements (opponent's moves or interception) to train players' coping reactions and reflecting skills. For VR public-speaking trainings, manipulating PI (i.e., number of crowd and stage setting) and PSI elements (i.e., reactions and clapping from the crowd) could provide various contexts for people to train their stage-fright and reactions.

Some limitations exist. First, no factors were manipulated (only screening low- and high-SS participants in the screening questionnaire). As an exploratory study, a fixed approach was adopted so that everyone experienced the same game content (no difficulty options or levels). This can provide us with insights into how dimensions of fear elements and individual differences influence fear and coping strategies. Second, the author only measured the next-day fright reaction and did not follow up after a longer period. The "lingering effect" may not only be limited to the next day but also could be longer or perhaps exhibit a boomerang effect. Furthermore, the sample came from Taiwan, which should be kept in mind when interpreting the results. Future studies could explore potential cultural differences in players' coping behavior. Methodologically, the PI elements have relatively low loadings and the factor had low variances, which should be interpreted with caution. Last, 81% of the participants experienced this game as their first VR experience. Although this was included as a covariate in the analysis, it is possible that the participants will evolve and adopt different coping strategies as they become more familiar with the VR environment and game controls. Nevertheless, first-time experiences provide us with rare data to understand how humans act when faced with immediate threats in novel situations, even if they are not real.

For future research, perhaps the next questions are as follows: Why are we so afraid of playing VR horror games for ourselves but enjoy others' fright reactions so much? What is the appeal of seeing someone frightened to death in a VR horror exploration, as has been featured in movie marketing activities? Will different age groups cope differently with VR environments (such as the "elders react to HTC VIVE" video on YouTube)?

6. Conclusion

Through the first examination of VR horror games, this study identified PI and PSI elements that cause fear. Participants reported higher fear toward PSI elements than toward PI elements. Three coping strategies were identified, including the distinctive self-help strategy by talking to the self, approach, and avoidance (behavioral disengagement and denial, "this is not real") dimensions. Personality traits such as SS and narcissism, sex differences, and game-related factors influenced how university students employed various coping strategies. Very few students experienced next-day fright, and most of the fright is cognitive. VR horror games serve as an excellent means to induce fear, and this implies that the VR

context is suitable for future training, treatment, entertainment, and for marketing campaigns. A theoretical framework of fear elements and coping strategies was provided for future research.

Funding

This work was supported by the Ministry of Science and Technology in Taiwan [grant numbers# 103-2628-H-009 -002 -SS4].

Acknowledgement

The author thanks Dai-Yun Wu, Cheng-I Liu, Ching-Ting Chang, Yu-Fan Chen, Huai-Chuan Chen, and Hai-Bei Liao for assisting with the data collection The author also thanks God for everything.

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