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RESEARCH ARTICLE

A psychological perspective on the development of a VR exposure therapy application for typhoon-related PTSD

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ABSTRACT

Background: Posttraumatic stress disorder (PTSD) is a condition involving the manifestation of negative biological, behavioral, affective, and cognitive responses to a triggering event or stimulus. In the Philippines, PTSD can be caused by typhoon-related trauma which is borne out of the country's relative proneness to this natural disaster. Research has shown that PTSD can be effectively mitigated through prolonged exposure therapy. Contemporary studies have also shown promise in the utility of virtual reality as a tool for aiding prolonged exposure therapy.

Objectives: To address current research gaps, the study intended to discuss the development of an adjunct virtual reality tool (*Typhoon VRET*) whose elements were mainly derived using data from narrative review and a consultation interview with a Filipino psychotherapy practitioner.

Methodology: The study utilized in-depth literature review and consultation interview with a Filipino trauma response specialist as primary sources of data. Key themes and findings were virtually represented through Unity, Blender, and Cardboard SDK.

Results: The Typhoon VRET features a relaxation scene, a rescue scene, and a typical Filipino house that showcases cultural elements so as to stimulate clients' traumatic reminders and fear structures. Users are given the option to control the environment, including the strength and volume of the flooding, wind, and rain.

Conclusion: Virtual reality could may be an adjunct tool to aid in addressing typhoon-related trauma among Filipinos. Several recommendations are provided in improving the technical features of the tool and integrating it into psychotherapy practice.

Keywords: *virtual reality, typhoon-related trauma, posttraumatic stress disorder*

Introduction

Posttraumatic stress disorder (PTSD) is a psychological condition precipitated by a traumatic event. It is characterized by intrusive memories, dreams, and flashbacks as well as the experience of psychological and physiological distress at any cue related to the traumatic event. It is also marked by avoidance of internal experiences, such as thoughts and feelings, and external stimuli, such as situations or objects, that serve as reminders of the trauma. Other symptoms include amnesia of certain aspects of the event, negative beliefs about self and others, persistent feelings of self-blame and guilt, detachment from people and activities, and inability to experience positive emotions [1]. These symptoms impair an individual's well-being as well as his or her ability to function in many areas of his or her life including social relationships and work. With an estimated 7% of the global population suffering from PTSD, the condition is now considered a global health crisis by the global burden of disease report 2010 [2]. The experience of a traumatic event is one of the most important criteria for the development and diagnosis of PTSD. Such events include experiencing or witnessing death, serious injury, or sexual violence [1]. Disasters, and the associated injury and loss of life that occur in its wake, can also be precipitants of PTSD.

Various therapeutic interventions have been formulated to address the symptoms of PTSD. Exposure therapy is one

such intervention. It involves exposing the client to the stimuli that evoke fear and other forms of psychological distress. It also decreases avoidance, a way of coping that protects the client from distress in the short term but serves to maintain it in the long run. Exposure therapy is done in a safe context and under the guidance of a trained psychotherapist [3]. It is usually done by requesting the client to imagine trauma-associated memory and other stimuli to activate the maladaptive emotion structure. However, some clients find it difficult to engage in imaginal exposure [4]. Studies have shown that a new form of exposure therapy called virtual reality exposure therapy (VRET) takes the burden of imagining from the client by using virtual reality technology to facilitate exposure to trauma reminders. Virtual reality makes use of a software to create a visually and aurally immersive environment that mimics real-life experience [5]. Numerous VRETs have been developed and tested for efficacy, and these have been found to be potentially helpful adjunct exposure therapy tools for treating trauma- and fear-based mental disorders. VRETs offer greater control over the presentation of stimuli, variations in response options, and potentially increased ecological validity [6]. Studies have also shown that a virtual reality-based prolonged exposure therapy can be applied to adult clients and adolescent clients as young as 13 years old [7] with considerations for special therapeutic arrangements among clients falling under the latter age category [8]. Moreover, VRET is also useful for older adults as it overcomes the limit imposed by the decline of vivid mental imagery that occurs with age [9].

The principles that guide exposure therapies are based on Emotion Processing Theory which is centered around two basic assumptions [10]. The first assumption is the presence of a maladaptive emotion structure. This structure consists of mental representations such as thoughts and memories that are related to the emotion and stimuli that activate it. An adaptive emotion structure is helpful when it matches the objective demands of the situation [10]. For example, anxiety-related thoughts and feelings about an oncoming typhoon can push an individual to prepare. However, in the case of PTSD, the emotion structure turns maladaptive because it is associated with otherwise harmless stimuli and it extends to situations in which it is not required. Thus, any situation, object, thought, or feeling that becomes associated with the traumatic event, even if non-threatening, will activate the emotion structure – particularly the fear structure – and cause the individual to feel psychological distress.

The second assumption of Emotion Processing Theory is that in order to undo this maladaptive emotion structure, the false associations made between the traumatic event and other stimuli must be changed. Hence, the individual learns that not all stimuli pose danger [10]. This change is facilitated by the activation of the emotion structure via exposure to the associated stimuli. By exposing the individual to situations or objects that serve as trauma reminders, he or she learns that the anticipated negative consequences actually do not happen. Its effectivity has been established in numerous studies; in particular, literature has shown the efficacy of prolonged exposure therapy in aiding survivors of sexual abuse, combat veterans, refugees, motor vehicle accident victims, and victims of mixed trauma [11].

In the Philippines, the prevalence of PTSD is observed to significantly increase after major disasters such as after Typhoon Haiyan in 2019 and the Mount Pinatubo eruption in 1991 [12]. Filipinos are particularly vulnerable to trauma after typhoons, which occur at an average of 20 times per year [13]. Some of these cause significant destruction of lives and property. In support of this, previous studies that were focused on flooding hazards and risk factors of PTSD have shown that the prevalence of PTSD among survivors one year after the flood was 9.2 percent [14]. This means that an estimated tenth of natural disaster victims in the Philippines is expected to develop symptoms of the condition after the event. The frequency of typhoons, its widespread effect on a large section of the Filipino population, and its possible influence in the development of PTSD are considerations that warrant the development of tools that augment the current therapeutic interventions.

In the country, however, culturally-appropriate tools that specifically address typhoon-related stressors or trauma are incredibly limited. In the psychotherapeutic perspective, this poses both as a gap and as a challenge, especially because the relative location of the country warrants its natural proneness to natural disasters, hence the relatively higher risk for Filipinos to experience typhoon-related trauma with limited availability of culturally-relevant psychotherapeutic solutions. This limitation can be addressed by a technological solution anchored on the tenets of technology, exposure therapy, and the Emotion Processing Theory.

The main objective of this study was to discuss the development of a virtual reality exposure therapy (VRET) application as guided by relevant psychotherapeutic concepts and mechanisms that address typhoon-related PTSD among Filipinos. In order to achieve this, the study specifically aimed to (1) identify components and symbolisms associated with the Filipino typhoon experience, (2) develop

an application based on these variables, and (3) discuss psychotherapeutic concepts relevant to Filipino PTSD that support the usefulness of the developed VRET application.

Creating a culturally-relevant psychological intervention in the Philippines, tailor-fitted for typhoon victims, should come as a timely opportunity to enhance the status of psychotherapy interventions in the country. This novel virtual reality tool directly addresses limitations on the available interventions for PTSD treatment in the Philippines. In addition, the tool could also promote psychoeducation and disaster response training suitable for Filipinos who reside in typhoon-prone areas. From a larger perspective, the integration of psychological constructs and concepts in tool development, such as this, also provides promise on generating more specialized technologies for other potential socio-environmental precipitators of trauma including climate change and man-made hazards.

Methodology

In this section, the researchers highlight the methodology involved in the conduct of the study, including a brief presentation on the sources of data, data collection and analysis, materials, and tool development – all of which are viewed as relevant steps in accomplishing the study objectives.

Sources of Data

Relevant studies and literature on typhoon and trauma, alongside the Filipino experience of the phenomenon, were used as primary sources of data. In addition, data from a consultation interview with a Filipino practitioner of trauma-related cognitive behavior therapy were also corroborated with data from literature. The involvement of any specific population or sample was not relevant for this study.

Tool Development Process

The study was conducted in two parts. The first part involved the identification of relevant, culture-specific elements using narrative literature review and consultation interview with a trauma-related therapy practitioner informed in cognitive-behavioral techniques. Mainly, a narrative review of literature that identified related elements associated with the Filipino typhoon experience, as well as demonstrated the effectiveness of virtual exposure therapy grounded within the context of typhoons and flooding, was conducted. To corroborate this data, a consultation interview with a Filipino practitioner in the field of trauma-related cognitive behavior therapy was also held. Data on the psychotherapeutic mechanisms to address typhoon-related PTSD were also acquired from this interview. The data that were collected from both literature and the consultation interview were organized into elements related to a Filipino typhoon experience.

The second part of the study saw the development of the VRET based on findings from the previous step. In particular, the elements and culture-specific components that were identified during the first part were directly integrated into the application, paving the way for a tool whose functions and features have empirical and theoretical bases.

Materials

The virtual reality application, Typhoon VRET, was created using Unity. Blender was used to model the house and some of the fixtures inside the house. Meanwhile, Cardboard SDK was used to create the virtual reality scenes.

Tool Development

The mobile application has two users, the client and the therapist. As a therapist, the individual can set the time per stage. The two stages that will be time-limited are relaxation exercises and the typhoon simulation. The therapist can also toggle settings for the virtual environment and type of simulation. As for the client, the client can move and interact inside the virtual environment. They can also stop the simulation if they are not feeling well or cannot finish the objective.

Therapist Activity

The therapist is in charge of setting the parameters for the virtual system. The settings that are modifiable are the time allotted for the typhoon simulation and the type of stimuli and simulation to be used. The therapist may toggle settings to simulate storm by controlling the following parameters: thunder/wind breeze sound, wind effect, flood and rain. Furthermore, the therapist may choose between the types of simulation: (1) Gradual simulation, where the client is exposed to a trigger one at a time; and (2) Flooding, where the client is exposed to 2 or more types of triggers at the same time.

Client Activity

The client is given a set of instructions displayed in the virtual environment, particularly, (1) Pack up specified

objects (few clothes, flashlight, canned goods, radio, phone); (2) Power down the main supply of electricity (inside the house, the fuse box); and then (3) Go to the designated highlighted area (for simulation closure). The client follows the objectives of the safety training part of the simulation (to "escape" the flooded environment) and proceeds to closure (relaxation exercises). The client also has the option to stop the simulation if they do not feel well.

Results and Discussion

The study mainly aimed to discuss the development of a virtual reality exposure therapy (VRET) application as guided by relevant psychotherapeutic concepts and mechanisms that address typhoon-related PTSD among Filipinos. Psychotherapeutic features and thematic elements of the Typhoon VRET were supported by principles of cognitive-behavioral and prolonged exposure therapy as well as aspects of Filipino cultural and environmental contexts found in review of literature and validated by a practitioner in trauma-related therapy.

Psychotherapeutic Mechanisms of Thematic Elements in Typhoon VRET

Posttraumatic stress disorder is caused by pathological fear structures found in memory, which then promote the development of anxiety and trauma-related symptoms. Therefore, alleviating trauma symptoms requires components of the fear structure to be destabilized. Using data from the narrative review and the consultation interview, the Typhoon VRET was designed to specifically address components of the fear structure, including the stimuli, verbal, physiological, and behavioral responses, and the meaning associated with the first two components. In this section, the specific findings from the narrative review and consultation interview are presented, and along with this is a discussion of how these components were specifically applied or integrated onto the Typhoon VRET.

As prior studies suggested that posttraumatic presentations can be triggered by objects and environmental conditions [15], the researchers found it necessary to integrate scenarios, objects, and situations that can elicit the activation of fear structures, so that in vivo exposure can be facilitated.

The relaxation scene was designed to imitate a psychotherapy room with an ongoing psychotherapy session. The two chairs represent the client and the therapist, and the face-to-face direction of these chairs promotes direct interaction between the two. The direction of the chairs was also developed to symbolize an open and supportive client-therapist relationship that is crucial in facilitating the effectiveness of a therapeutic technique [16]. Transferring real-life elements of psychotherapy into the virtual world is found to aid in maximizing therapeutic opportunities, even in the relaxation scene where the client is given more opportunity to successfully utilize other cognitive-behavioral interventions to be utilized in the prolonged exposure exercise, specifically breathing exercises and mindfulness.

The literature review and consultation interview highlighted physical environmental elements as significant components of trauma reminders. As a response to this finding, each of the rooms in the Typhoon VRET was also designed in a way that a typical Filipino household was represented, even during the typhoon and flooding simulation. For example, one study found that only a multi-story house was a good fit for disaster mitigation in the Philippines [17], and so the design that was implemented in the Typhoon VRET was a single-story house that was more prone to flooding. To add more realism into the virtual environment, the walls were made of nipa and the lighting was intentionally made dim. These elements can be translated into diminished sensory awareness, which can in turn affect emotional responses and behaviors [18]. Limited resources were also viewed as relevant triggers to fear as these items were viewed by Filipino typhoon victims as impediments to survival [19]. Applying this to the Typhoon VRET, the house was purposely only filled with minimal essentials including canned goods, a flashlight, and a radio, plus some appliances and furniture found in a typical Filipino home. The inclusion of the radio in the tool was also deemed relevant as studies have shown that media and technology could be associated with both fear responses and move to action among Filipino typhoon victims [18].

Meanwhile, the flooding and rescue scenes were also designed in consideration of the Filipino experience, as derived from the literature review and consultation interview. The researchers found that strength, frequency, and volume of natural trauma reminders, including flooding, wind, and rain, influence the emergence of fear and anxiety symptoms among Filipino PTSD clients. This is supported by an earlier study which found that Filipinos' level of anxiety during typhoons was directly correlated with worsening rainfall [20]. To materialize this in the Typhoon VRET would be to imply that necessary fears can be triggered only when the tool was designed with a flooding feature. As a result, the Typhoon VRET was developed in such a way that continuous flooding emerged in various areas of the house, and the threat to safety and well-being, which are significant elements of the

Figure 1. *Stop button*

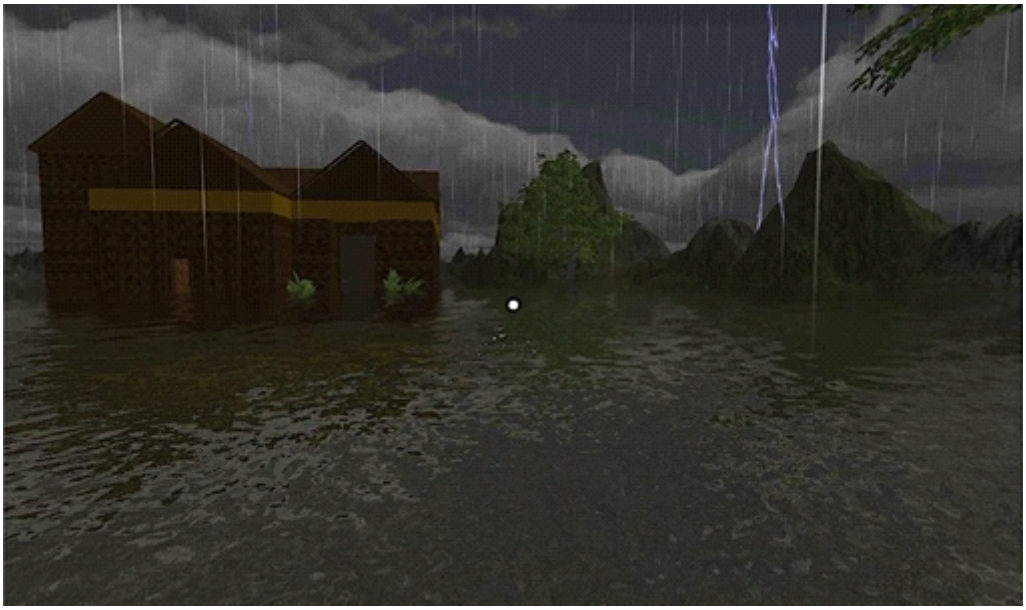

Figure 2. *Outside view with flood and typhoon*

Figure 3. *Relaxation Scene*

Figure 4. *Living room with objectives*

Figure 5. *Rescue truck*

fear structure, were triggered. In addition, the rescue scene was developed to represent physiological aid from the government. This is because previous studies have found that disaster risk reduction management (DRRM) activities in the Philippines were typically focused on physical preparedness and not on any other form of response [21]. In the Typhoon VRET, the use of an army truck was intended to symbolize a typical government response to a typhoon, which can make clients' virtual reality experiences more realistic and relatable.

Typhoon VRET Mobile Application Environment

When the mobile application is started, the Start Menu appears. Once the Start Simulation button is selected, the next scene will be the setup screen for the relaxation and exposure scene. In this scene, the therapist can specify the duration for both environments. For the relaxation scene (both opening and closing scene), the available options for duration are two minutes, three minutes, and five minutes (max). For the exposure scene, the available options for duration are three minutes, five minutes, and seven minutes. Clicking 'Next' will lead to the scene where the therapist can choose what type of simulation the client will be exposed to. Gradual Simulation is where the client is exposed to a trigger one at a time, while Flooding Simulation is where the client is exposed to two or more types of triggers at the same time.

Choosing either Gradual Simulation or Flooding Simulation will lead to a scene containing the same set of parameters. The parameters can be toggled on and off by the therapist. When “Gradual Simulation” is chosen, gazing at a setting will

automatically lead us to the relaxation scene since it exposes the client to only one trigger at a time. When "Flooding Simulation" is chosen, the therapist has the option to expose the client to one or more triggers at the same time.

Relaxation Scene. When the parameters are chosen, the next scene loaded is the relaxation scene. The relaxation scene is composed of a simple room (with an orange skybox) and jazz music in the background. There is also an on-screen breathing exercise shown in the camera screen. The same relaxation scene is shown on the closure part of the Typhoon VRET. The relaxation scene serves as a necessary premise to the conduct of the actual exposure therapy. Entering the relaxation scene allows clients to engage in emotion regulation strategies that foster the unpairing of the established associations and trauma reminders. Through behavioral techniques including mindfulness and breathing techniques, and with the continued guidance of the therapist, the client is guided to take part in exposure therapy [22].

Exposure Scene. When the timer runs out, the exposure scene will be loaded. The purpose of this scene is to expose the participants to triggers that have been associated with the fear structure related to that elicits distressing emotional responses. The scene starts with the player's spawn inside the house. The game objectives are displayed on the camera screen. Upon completing the objective, the completed objective will be removed from the camera screen. The objectives can be found in the following places: living room, kitchen, and bedroom.

Once the following objectives are completed, the last objective is located outside the house area. The last objective is to go to the designated area where the rescue truck is located. The on-screen instruction and the randomly-spawned designated area will only appear after finishing the first six objectives displayed on the camera screen. Throughout the exposure process, the therapist is expected to guide the client using therapeutic techniques that aim to neutralize the fear response. The exposure of the client to typhoon-related stimuli that are otherwise harmless in most settings within the safety of the therapist's guidance will undo the association that the client has made between such stimuli and the emotional structure of fear.

Conclusion and Future Directions

The Typhoon VRET is a mobile application that provides virtual environments modeled after the therapist's choice of parameters for each client and serves as an adjunct tool for typhoon-related prolonged exposure therapy. It offers a start and closure relaxation scene and the exposure environment containing the house and the outside environment. Each scene provides on-screen instructions for objectives that dynamically changes after an objective is done. The end of the simulation is at the relaxation closure scene where the client has the choice to quit the game.

This application was developed as an adjunct to traditional exposure therapy treatment and its elements were based on findings from a narrative literature review and a consultation interview conducted by the researchers. The Typhoon VRET could expose clients to stimuli that are difficult to access, eliminating the need for intense imaginal skills for clients. The virtual reality exposure therapy program was developed in consideration of the existing assessment protocols, facilitation techniques, and ethical principles associated with cognitive-behavioral therapy in the Philippine context.

At its current stage, the Typhoon VRET was developed on the basis of psychotherapeutic frameworks and expert opinions on neutralizing trauma-related fear responses. In the future, the application must be tested by participants in order to empirically validate its usefulness in addressing typhoon-related PTSD.

It is also important to note that the facilitation of the Typhoon VRET should be done with several considerations in mind. First, therapist skills and qualifications are critical in the success of the intervention. While prolonged exposure therapy is empirically-proven to promote good therapeutic outcomes, training and mastery of this skill can be challenging. Nowadays, certificate courses and intensive training programs are offered to psychologists seeking to specialize in this treatment modality. As such, practitioners who intend to use this method without sufficient training should efficiently assess their capabilities prior to proceeding. Second, the Typhoon VRET that was specifically designed in this study was based on local life in the Philippines; therefore, the use of this tool in other nations may pose cultural barriers that could lead to issues on treatment effectiveness. Even when the Typhoon VRET provides promise in uplifting the cognitive-behavioral approaches in the Philippines, therapists should proceed with care in fully utilizing it in their practice.

One direction that this study may take is the utilization of personalized relaxation scenes which can help foster better emotional regulation exercises among clients. Psychological assessment battery and pre- and post-therapy activities may be further evaluated in the context of Philippine culture and the Typhoon VRET. In addition, the role of further training and needs evaluation of psychologists facilitating prolonged exposure therapy could be done to improve the facilitation of the intervention.

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