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Theorizing Gamified Virtual Reality Approach to Overcome Fear of Height

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Summary. *The use of virtual reality as a form of exposure therapy for people who suffer from acrophobia (fear of height) has been proved and tested by multiple studies. In this paper, we initiate gamified virtual reality approach to overcome fear of height by providing a design implementation theory. We call this theory High Engagement and Low Intensity-Low Engagement and High Intensity. This theory adds a gamified element to the virtual environment. The idea here is to have game engagement at its highest and intensity of the acrophobia at its minimum in the virtual environment at the start of the treatment. As the treatment progresses, the engagement in the game starts decreasing and the intensity of the phobia starts increasing. The implementation provides two parameters (engagement and intensity) that could be adjusted independently according to the patient needs. We also evaluate the base of our theory through a pilot study.*

Key words: Acrophobia, fear of height, gamification, treatment, virtual reality.

1.1 Introduction

Acrophobia, or more commonly known as the fear of heights, is a debilitating anxiety order that many people suffer from. Between two to five percent of the world population is afflicted by this mental disorder with twice as many females as males affected [1]. Acrophobic people are afraid to be in high places, though "high" is a relative term. Some people are fearful of being on a three story balcony with no railings. However, in the more extreme cases, simple standing on a single chair on the ground is high enough to bring about a phobic reaction. According to [2], the fear of heights would need to be overpowering and inhibiting to term as a phobia. In [3], Stanley Rachman created a model called the *pathways of fear* where he has identified three ways fear acquisition. They are (1) Learning by direct experience, (2) Learning by observing others, and (3) Learning through information/instruction. In addition to the Stanley Rachman model, in [4], fourth pathway called *non-associated perspective* is identified that cause fear. Acrophobia, like many other phobias, has symptoms that relate to panic and anxiety attacks. These symptoms are often followed by other more physical signs including sweating, abnormal breathing, accelerated heartbeat, trembling, disorientation, nausea, and even dizziness [5]. In acute cases, sufferers can become so overwhelmed with their fear that their bodies seize up and they are unable to function or move [1]. The author of the book, “Diseases of the Human Body”, mentions that the phobics are often aware that their fear is irrational. However even knowing this, they are unable to confront or control their fears [6]. Estimates from the study [7] on refusal and acceptance of treatments for phobias showed that 60-80% of people with specific phobias are reluctant to pursue help or treatment. Acrophobics can be coached to develop mechanisms for dealing with their fear through the help of therapists. Therapists use different types of behaviour therapies to achieve results. Such therapies are build upon the assumption that the sufferer has learned this response to being in particular environments or situation and hence can be treated as if one can learn a reaction then it can be unlearn too. One such therapy is called cognitive-behaviour therapy (CBT). The CBT involves introducing a patient to their fears while trying to inspire them to alter their thought processes about their fear. A common process of CBT is *system desensitization* in which a patient is gradually exposed to the stimuli. This treatment is administered in two stages, the first relaxation training and imagined situations going from least to most fearful. The second stage is actual exposure to the feared situation from the least threatening to the most. Though it can take a long time for these treatments to be effective, taking months or even years in some cases. Some medications, such as tranquilizers, anti-depressants, anti-anxiety, beta blockers and sedatives, can also be utilised in the treatment of acrophobia. These medications will not cure the condition by themselves however. They are used to help minimise or relieve some of the symptoms of acrophobia, especially anxiety, in order to allow patients to cope better.

1.1.1 VR Exposure Therapy

There have been multiple studies concerning treatment of phobias using Virtual Reality (VR). The first of these studies were done in 1993 as referenced in [8]. Research projects around the world were sparked by the encouraging results of this venture such as fear of public speaking [9], fear of driving and claustrophobia [10], agoraphobia [11]. VR treatment works by creating a computer generated simulation that would mimic an in-vivo situation where the user is exposed to their fear. The VR has advantages over in-vivo such as VR is less expensive and less time consuming; VR provides safer environment; VR removes the risk of any possible public humiliation for the patient. Taking into account these various studies [12], [13], [14], [15] done on using VR in acrophobia treatment and their results, there is now a considerable amount of evidence to support the use of VR exposure as an effective means of treating acrophobia.

1.2 Gamification Theory

Our purpose is to take the idea of using VR in the treatment of acrophobia and gamify it. The term *Gamification* is an umbrella term used when video game elements are added to a non-gaming system [16]. The purpose of gamifying a non-gaming system is to motivate and engage the participants. Our main purpose of gamifying virtual reality treatment for acrophobia is to draw patient's attention away from thoughts associated with heights. This is achieved by engaging the patient in playing a virtual reality game. As many studies have proved that a person can be distracted from pain and the associated fear by involving in some fun activity. This distraction is effectively achieved through the use of virtual reality environment as proved by various studies [17], [18], [19], [20]. We propose a design implementation theory of how to design the gamified virtual reality environment for treating acrophobia. We call this theory High Engagement and Low Intensity - Low Engagement and High Intensity. In short, we use HELI-LEHI for High Engagement and Low Intensity - Low Engagement and High Intensity. The HELI-LEHI theory is twofold: first is the high to low game engagement and second, low to high phobia intensity. The high to low gameplay engagement idea is to have the engagement at its highest at the start of the treatment. As the treatment progresses, the game engagement decreases to the point that it is very minimal (or non-existent). The purpose of engaging a participant in the game is to distract the participant from her fear while she is still subconsciously going through it. The more engaging the game is, the less the participant will notice the height stimuli at the time. Though, this may sound counterproductive as the point of the virtual reality treatment is exposure. It is not, because as the treatment progresses the engagement is lessened to the point where it is almost non-existent. This leaves the participant to be fully exposed to the height without any distraction. It is important to remember not to distract the participant entirely to the extent that these stimuli no longer induce the phobia. The participant needs to be exposed to the height stimuli and know about it, however, not primarily focused on it. This distraction goes hand in hand with the idea of low phobia intensity to high phobia intensity part of the theory. We suggest that participant is to be exposed to the least fear evoking situation and gradually moved to a more serious situations as the treatment progresses - following similar approach to systematic desensitization in [21]. In our case the phobia is about height, so the participant can start close to ground level and as the treatment progresses the participant moves to higher and higher environments. The HELI-LEHI theory introduces participants to their phobia more gradually using the two parameters - engagement and intensity, allowing the participants to conquer their phobia one step at a time.

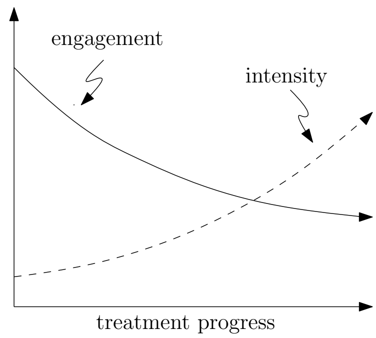

Fig. 1.1. HELI-LEHI

Our HELI-LEHI theory has three benefits: (1) the game element adds fun to the treatment procedure which provides motivation to the patient who now becomes a player. (2) the game engagement distracts patient's mind temporarily from not thinking about the height. This way it provides extra level of ease, for the benefit of the patient, in the treatment. (3) it provides two independent parameters, engagement and intensity, that makes the treatment more adjustable to the needs of each individual patient.

1.3 Virtual Reality Game

For the purpose of this study - the idea of "crossing a bridge" and "dodging incoming projectiles" at different floors was chosen. The reason for this was largely because the idea is easily scalable. Crossing a bridge allows both the intensity and engagement to be scaled up or down mutually exclusive of each other. The intensity of the phobic stimuli is generated via the current height that the player (the patient is now becomes a player) has achieved. Engagement is created by the projectile system which has multiple variables (projectile speed, fire rate, amount of projectiles) to increase or decrease how much attention is required by the player. Re-playability is also a factor as this experience is designed for players to partake in multiple times. Puzzles once solved do not offer the same interaction in a subsequent play through.

The gamified experience that is created for the experiment starts at ground floor. Movement is controlled with an Xbox 360 controller. The viewport is created with an Oculus Rift Head Mounted Display (HMD). The player begins on a sidewalk of a city street surrounded in all directions by tall high rise buildings and cars driving along the road.The player is not permitted to roam the streets and is limited to the sidewalk in front of the main building only. This ground floor stage has no real interaction with either the fear itself or the gamified elements of the simulation - it is more of an adjustment area for the player to enter and get acquainted with the simulated world. Background sounds are played that emulate basic city streets including car noises and also player's footsteps sounds. These sounds are played at ground floor so, the higher the player goes in the simulation the quieter these noises become. Once, the player has adjusted to the simulated world and are ready to proceed, there is an elevator waiting on the sidewalk ready to take them to the first real part of the simulation. Entering the elevator automatically triggers the doors to close and the elevator starts its slow ascent. The elevator has two glass windowed sides, so that the player is gradually introduced to the height as they can see the movement occurring. This version of the virtual reality game contains three levels only. It is meant to serve as the prototype.

1.3.1 Game Levels

When the elevator reaches the third floor of the main building the elevator stops and the player can move out onto a balcony. The balcony allows the player to move around and start to feel the sensation of height. There is an opening in the middle with a small platform that the player can stand on. This is the first part of the gamified experience. The small platform is part of the bridge and will start moving across a wire to the other side of the road to another building. At this stage the player can actually walk off the platform completely. This is intentionally allowed so that the player does not fall prey to knowing that they cannot. However, the aim of this experiment is not to terrify the player, if the player character (not the player herself) starts to fall, the simulation fades to black very quickly and then the game needs to be restart. When the player first steps onto the platform a door from the opposite building opens up and an installation of three projectile launchers are shown. On a short interval, two of the projectile launchers will fire creating a gap that the player needs to maneuver their 'head' into, in order to dodge the projectiles (blue in color) as seen in Figure 1.2. Oculus Rift head motion tracking is used in order to achieve this. The Oculus HMD allows the camera to be moved relative to the player, creating a balancing act for the player (the projectiles are rigged to collide with the camera position only). This movement of the head affects the camera only and causes no movement so the player cannot trigger a fall in the simulated world via this. Once the player crossed the bridge, the door with the launcher installation closes and the launchers stop firing. Stepping off the platform puts the player on another balcony with another glass elevator to take them to the next level.

The setup of this second bridge is almost identical to the first one. The interaction takes place on the seventh floor of the building raising the intensity of the acrophobia stimuli. In order to bring more attention to the height factor, the game is lessened so that the player is less engaged. The launcher installation is triggered in the same way except the fire rate is decreased so there is less projectiles to dodge. The launcher placement also only selects one launcher to fire rather than two making the dodging easier and less attention consuming.This is the intermediate stage of HELI-LEHI - medium intensity and medium engagement. The player gets time in between the projectiles to notice their height and take in their surroundings. Again, there is an elevator available to transport the player to the next level. For this study, the next level is the final level.

In the final level, the engagement is at its minimum and intensity is at its highest point. We removed the game engagement at all so that to expose the player to the maximum intensity of the phobia. There is no projectiles to dodge, and the bridge is no longer a platform that automatically moves when the player is on it, this can be seen in Figure 1.3. A glass bridge extends across the gap allowing the player to move across it at their own pace and really be able to see to interact with the high intensity of the height. The player upon reaching the opposing side is greeted by a door opening up with a victory message displaying that the simulation is over. This is the Low Engagement, High Intensity (LEHI) stage of the proposed theory. The assumption here is that the player is now at her final stage of the treatment and ready to be exposed to the maximum intensity of the height.

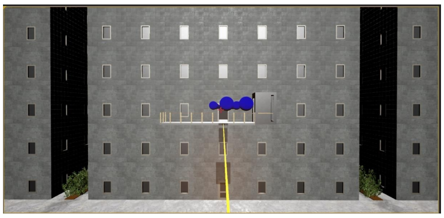

Fig. 1.2. First Bridge

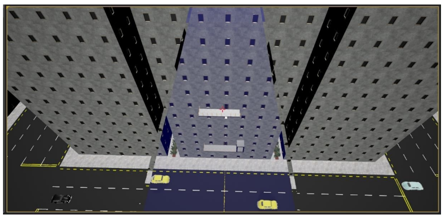

Fig. 1.3. Final Bridge

1.4 Method

In order to start the process of testing the HELI-LEHI theory, a small pilot study is the first logical step. There are two goals that we want to achieve in the pilot study. The first goal is to create a virtual environment that stimulates a sense of height. The second goal is to prove that the participants awareness level about their surroundings will decrease with the increase of the game engagement. The HELI-LEHI theory mainly bases on the second goal. Here, it should be noted that this is not the purpose of the pilot study to test how effective the gamified virtual reality approach is in the treatment of fear of height. We will conduct such experiment on acrophobia patients under the supervision of a qualified medical professional in a clinical environment in future. For the pilot study, we conducted two experiments to test the two goals. The results and related analysis are given below. A total of 15 volunteers, 4 females and 11 males aged between 18 to 38, were recruited from the Media Design School. Most of them were students. For our experiments, the participants are not required to be acrophobia patients.

1.4.1 Results and Analysis

Experiment 1: The purpose of the experiment is to make sure that our developed virtual world does stimulate a sense of height. To begin the experiment, we let the participants one by one to have a walk-through of all three bridges. In this experiment, the participants are not required to play the game (dodging projectiles) during crossing the bridges. The first bridge is at 3rd floor, the second bridge is at 7th floor, and the third bridge is at 12th floor. The participants started their journeys by entering the building, then went up to the third floor through elevator and crossed the first bridge. Similarly, the participants experienced the other two bridges. After finishing the final bridge, the participants came straight back to the ground floor, through elevator, to exit the building. The walk-through finished by exiting the building and hence, the experiment ended. Once the experiment became over, we recorded their responses about the following two statements: (1) I felt a sense of high up being in the virtual world, (2) I felt fear of height being in the virtual world. For each statement, we provided a 5-point scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree) to record their responses. The participants' responses about the first statement are provided in the Figure 1.4. The participants' responses about the second statement are provided in the Figure 1.5.

Experiment 1 Results Analysis: In Figure 1.4, we can see that 13 out of 15 participants felt high up in the virtual world. It shows that the developed virtual world is good enough to carry on with. Figure 1.5 captures participants' fear of height. In Figure 1.5, it is shown that, 11 out of 15 participants have felt fear of height when they were in the virtual environment. From the results, it is evident that the developed virtual world is effective and hence, our first goal is successfully achieved.

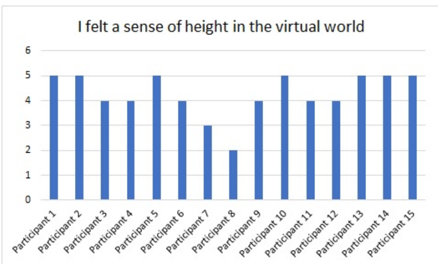

Fig. 1.4.

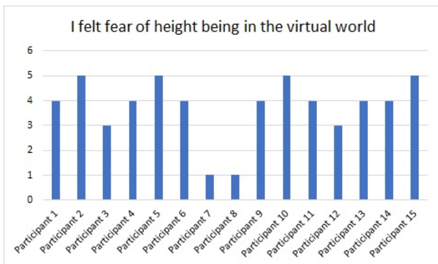

Fig. 1.5.

Experiment 2: In this experiment, we want to test the awareness level of our participants while playing the game. Our claim is that the more engaging the game is the less the participants will be aware of their surroundings. We chose first and second bridge to carry out the experiment. We set, at first bridge, the game engagement at its highest and at final bridge, we reduced the game engagement drastically. We want to have a clear difference between game engagements at the two bridges. The participants first brought up to the first bridge, and let the participants to start playing the game. Once the participant played the game for a while, then we started moving the virtual platform upon which the participant is standing in the virtual world. As we started moving the virtual platform, at the same time we started recording time using a digital timer. We stop the timer as the player shouts to indicate us that he/she realized the movement of the virtual platform. We then move the participant to the second bridge to perform the same experiment. The participants' time at first bridge and final bridge are provided in the Figure 1.6. The time of the participants recorded at the first bridge are represented in blue in colour and the time recorded at the second bridge are represented in orange in colour in the Figure 1.6. It should be noted that for the sake of drawing the graph, we allocated 5 points to the participants who did not notice the movement of the virtual platform at all and crossed the bridge. In the Figure 1.6, participants 1 and 7 failed to notice the movement during the entire time and hence 5 points were allocated. Moreover, we allocate 0 to the participants who noticed the movement of the virtual platform immediately or took less than a second.

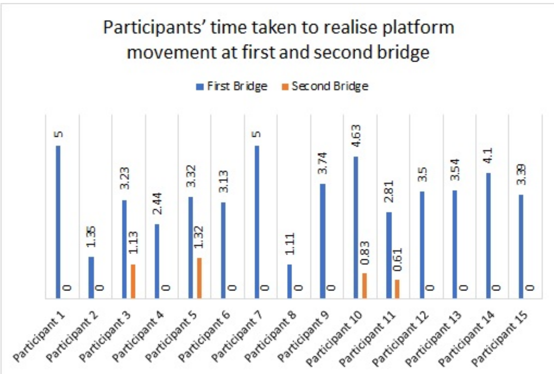

Fig. 1.6.

Experiment 2 Results Analysis: At first bridge, when the engagement of the game was set at its highest, none of the participants realized the movement of the virtual platform immediately. All participants took more than 1 second to realize the movement of the virtual platform. Two of the participants (1 and 7) were fully immersed in the game during crossing the bridge and did not notice the movement of the virtual platform at all. At second bridge, when the engagement of the game was reduced drastically, 11 out of 15 participants were immediately noticed the movement of the virtual platform. The remaining 4 participants took time at most a little more than a second (1.32 seconds) to realize the movement of the virtual platform. Hence, we concluded that the more the participants were engaged in the game, the longer they took to notice the movement of the virtual platform, and hence, the less time their mind spent thinking about the height.

1.5 Conclusion

We initiated gamified virtual reality approach to overcome fear of height by providing a design implementation theory. We called this theory High Engagement and Low Intensity-Low Engagement and High Intensity. This theory provides two parameters independent of each other, intensity and engagement, to a medical professional. We implement the intensity parameter through bridges at different floors. The higher the bridge is, the more intense the fear of height will be. The engagement parameter is provided through the game (dodging projectiles). The engagement parameter is additional parameter that our theory provides. This engagement parameter is what makes our gamified virtual therapy differentiated from other virtual reality exposure therapies. The benefits of our gamified virtual reality approach is three folds. One, the game element adds fun to the treatment procedure which provides motivation to the patient who now becomes a player. Second, the game engagement distracts patient's mind temporarily from not thinking about the height. This way it provides extra level of ease, for the benefit of the patient, in the treatment. Third, having two independent parameters (engagement and intensity) in the hand of a medical professional makes the treatment more adjustable to the needs of each individual patient. We also evaluated the base of our theory by conducting a pilot study. The results of the pilot study mentioned above are in favour of our theory. For future work, we will test our theory by conducting a full user study in a clinical environment under the supervision of a qualified medical professional.

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