

Improving Mood for People with Depressive Disorders: Designing and Developing a VR Game

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Abstract: Mood disorders can have a significant psychological impact on many groups of people. It causes severe disease burden and can lead to many effects that decrease the quality of life of an individual. Video games are popular forms of entertainment which can help improve a person's mood and decrease their depressive symptoms. In the paper, we design and develop a prototype VR game to help people with depressive disorders improve their mood. We have performed preliminary testing showing encouraging results in improving peoples' moods.

1 INTRODUCTION

Mood disorders occur frequently in many groups of people throughout the world. An overwhelming feeling of sadness and hopelessness is the main symptom of mood disorders that can last for long time, usually for months or years. Mood disorders can make people feel that life is meaningless. Depression, which is a mood disorder, is one of the major causes of global disease burden (Vos T et al., 2012). In 2010, it was listed as the second leading medical cause of disease burden that is especially significant in high disability in the working age people, which makes depression particularly costly for society. Major depressive disorder (clinical depression) was also a contributor of burden allocated to suicide and ischemic heart disease. These findings underscore the importance of including depressive disorders as a public-health priority and implementing cost-effective interventions to reduce their burden (Ferrari et al., 2013).

Depressive symptoms and disorders account for more than 40% of the burden of psychiatric disorders. The levels of depressive symptoms increase markedly in adolescence, and nearly 20% of those 12-18 year of age suffer from a depressive disorder (Hankin, 2008). Depression causes a global economic burden of more than USD \$200 billion annually. However, many individuals with depressive symptoms do not receive appropriate services. Even among those who do get treatment, up to two-thirds of those individuals

fail to respond and many drop out of these services prematurely. This shows the need for more potent, accessible interventions (Schleider, Mullarkey, & Weisz, 2019). Depression (major depressive disorder or clinical depression) is a common but serious mood disorder which causes severe symptoms that affect how you feel, think, and handle daily activities. To be diagnosed with depression, the symptoms must be present for at least two weeks (National Institute of Mental Health, 2018).

Depression may come with serious illnesses. Palliative care is often related to improving patients' moods, which is an interdisciplinary person-centered approach to treating patients with serious illnesses through relieving symptoms and improving quality of life for patients and their families (Personal Care Medical Associates, 2019). Palliative care can be incorporated successfully into the treatment regimen for life-threatening diseases. Although palliative care is sometimes used synonymously with end-of-life care, it actually is a broader concept involving care delivered at any stage of illness from diagnosis through the terminal stages of the disease (Kelley & Morrison, 2015).

There are valuable tools for fostering patient participation in health-related activities, which include digital games, such as 2D games, 3D games, virtual realities, computer simulations, and online play. Since regular fitness training is known to improve depression (Kvam, Kleppe, Nordhus, &

Hovland, 2016), it may not be overly surprising that these exergames likewise lead to an alleviation of symptoms (Li, Theng, & Foo, 2016). However, the compliance with physical exercise is generally lower and more patients will enjoy a video game rather than an exercise intervention. This is why gaming is the latest tool in the arsenal to improve health outcomes - gaming makes health-care fun (Hawn, 2009). A survey conducted in the United States reported that over 164 million adults in the United States play video games and three-quarters of all Americans have at least one gamer in their household. Video games are the leading form of entertainment today, which is an integral part of American culture (Entertainment Software Association, 2019). Fast-paced action video games can improve visual attention and task switching. They have also been reported to reduce rumination and enhance subjective cognitive ability. Rumination is a good predictor of depression and may contribute to triggering depression (Kühn, Berna, Lüdtke, Gallinat, & Moritz, 2018).

More and more adolescents and adults around the world are enjoying playing video games. Due to their widespread use, scientists have researched how video games can affect the brain as well as an individual's behavior (Nichols, 2017). Stress-related medical disorders such as cardiovascular disease, diabetes and depression are serious medical issues that can cause disability and death. Strategies to prevent their development are needed. Casual video games (CVGs) are fun, easy to play, spontaneous, and tremendously popular. Studies show that people play CVGs for a multitude of reasons including cognitive exercise, relaxation, and stress relief (Russiello, O'Brien, & Parks, 2009).

VR exercise can have a positive effect on anxiety in addition to depression and other mental disorders based on multiple studies. Anxiety is a disorder with particular features including recurrent intrusive thoughts, increased tension, and physical manifestations such as tachycardia. It is the most common mental health disorder in the US affecting about 18% of the population. Unfortunately, only about 40% of adults receive appropriate mental health services. New and more enjoyable treatments for mental disorders can be used along with more traditional psychotherapy and medications (Kazdin, 2000).

A review article by Zeng et al. found four studies that reported significant physical and psychological improvements including reduced tiredness and tension as well as increased energy and enjoyment as a result of VR use (Zeng, Pope, Lee, & Gao, 2018). The latest VR exercise systems have the capability to

allow for precise control of stimuli in a multi-sensory three-dimensional computer-generated environment while promoting a motivating exercise regimen. At the same time, there is a lower risk of physical injuries that may be associated with real-life exercise.

One of the fastest-growing industries is the video game industry. About two thirds of American households own at least one device which is capable of playing video games. Similar usage data can also be found in Europe, Asia and other parts of the world (Roettl & Terlutter, 2018). Video game technology is changing from 2D to 3D and virtual reality (VR) graphics.

VR games are becoming increasingly more prevalent in our daily lives due to its immersive and interactive nature. They are a new milestone in the way we interact with our environment, and even how we conceive new approaches in our relationship with reality (Kitson, Prpa, & Riecke, 2018). VR and other immersive information and communication technologies have a high potential for transforming the real world and the way in which we interact with it (Rubio-Tamayo, Barrio, & García, 2017). VR is a computing technology that generates an artificially simulated three dimensional (3D) environment that imitates reality. VR presents a convincing interface that allows the user to engage with the computer-generated environment in a naturalistic way. Through 3D computer graphics via advanced input and output devices, users believe they actually perceive sensory information that is similar to that of the real world. In very simple terms, virtual reality can be defined as a synthetic or virtual environment which gives a person a sense of reality (Ma & Zheng, 2011). There are many kinds of VR devices available, including Oculus Rift, PlayStation VR, and Samsung Gear VR. Some VR Personality Projects were designed to systematically target and increase adolescents' perceived control by offering a more immersive, engaging, user-directed intervention experience than the Web-based intervention. By targeting an identified predictor of intervention response, the VR Personality Project may lead to larger reductions in depressive symptoms than existing Web-based mindset interventions (Schleider et al., 2019).

2 METHODS

People used to think that VR would damage our brains. However, VR seems more likely to develop the gray matter in the brain. A new wave of research is pioneering VR to diagnose and treat medical conditions from social anxiety to chronic pain to

Alzheimer's disease. Many of these solutions are still undergoing testing, but some are already making their way onto the market (Martin, 2019). With VR, players will have an immersive experience, which is an illusory environment that completely surrounds the players such that the players feel that they are inside it. Due to the immersive nature, VR games are more powerful than regular video games in affecting players' feelings. Bad mood is so common for everyone and video games are effective in improving mood. It is necessary to design and develop VR games to effectively improve mood for people with depressive disorders. We use Unity as the game engine for designing and developing the VR game. Our VR game is a multiplayer game. The VR game can be played by one or more persons in the same game environment at the same time, either locally or over the Internet. It allows players to have interactions with other individuals in partnership, competition or rivalry, providing them with social communication. Players may compete against two (or more) human contestants or work cooperatively with a human partner to achieve a common goal. Players can choose avatars or create their own avatars in the virtual world.

We use nature scenes as the background environment in our VR game. With head tracking and head mounted displays (HMD), players can reach out and feel that they are really there. The built-in microphone makes it easy to communicate with teammates. Due to the lack of physical activity in many individuals with depressive disorders, it is necessary for us to integrate some exercise components into our game. We can add bicycling, canoeing, swimming, and skiing to our VR game to make the game rich in choices (see Fig. 1.).

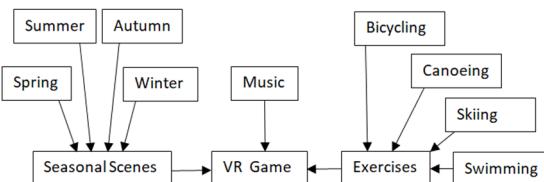


Figure 1: Components of the VR game.

We created four separate groups for the seasonal scenes, with each group of scenes representing a particular season. For each season, there will be multiple themes and landscapes such as mountains, islands, and bodies of water. The players can choose which season they want and which themes they would like. The VR game will have multiple difficulty levels of exercise to suit different players. The players may choose easy levels to start with, and then progressively go to more difficult levels. They can also jump to

certain levels if they want. Additional challenges are provided in each new level, and when a level is successfully completed, the player will get a new score.

For the game to be attractive, we also need computer-generated non-player characters (NPCs) to be populated at a certain level. If the player chooses not to play with other human players, NPCs will be the main source of competition during gameplay based on different levels that the players choose. NPCs are one of the elements we will develop to craft the pacing, challenge, and tension of a level. We can control not only where the NPCs are placed, but also the NPCs' scripted behavior, how they are equipped, and other variables (Rivera, Hullett, & Whitehead, 2012).

The mood and depression assessment is a self-reported measurement. It is similar to Klein et al.'s work for evidence-based assessment of depression in children and adolescents (Klein, Dougherty, & Olino, 2005). The measurement is most commonly used in assessing depressive symptoms among adolescents, but could also be used for other age groups.

3 RESULTS

Table 1: Volunteers' mood net change.

		Play time (minutes)	Net mood change
male	#5	10	2
	#9	15	2
	#1	15	3
	#10	16	3
	#6	18	3
	#8	25	4
	#2	32	4
	#4	30	5
	#7	38	5
	#3	45	6
female	#2	12	2
	#7	14	2
	#10	17	3
	#3	20	3
	#5	22	3
	#9	28	4
	#6	30	4
	#1	34	4
#4	33	5	
	42	6	

Based on our purposes and the above design, we developed a prototype of VR game to improve mood for people with depressive disorders. The game theme

is a magical world where the inhabitants are falling ill and being attacked by enemy characters. The only way to save them is to find the Magical Healing Potion. Fig. 2 - 4 show some scenes from the game.

The players are exposed to many natural scenes throughout the course of the game. If the players choose to exercise, he or she can also choose the kind of exercise they prefer, such as walking, jogging, biking, and canoeing. They can also choose the difficulty level. For players who are physically limited or less mobile, they can choose levels that promote more walking. For players who are more physically able, they may choose more strenuous activities such as biking and canoeing.

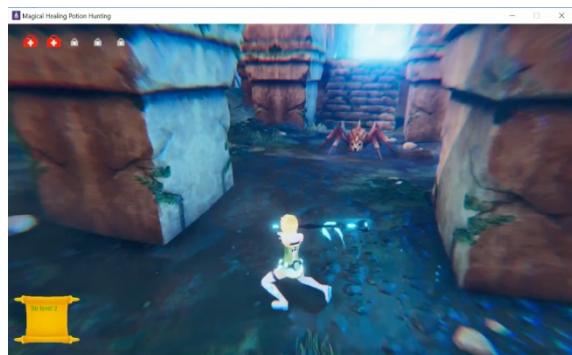


Figure 2: Battling with enemies.

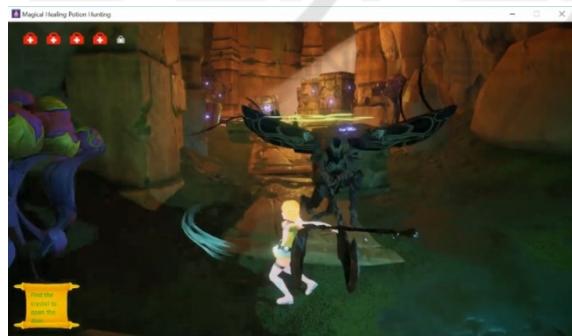


Figure 3: Battling with enemies.



Figure 4: The player is near a cabin in the hill.

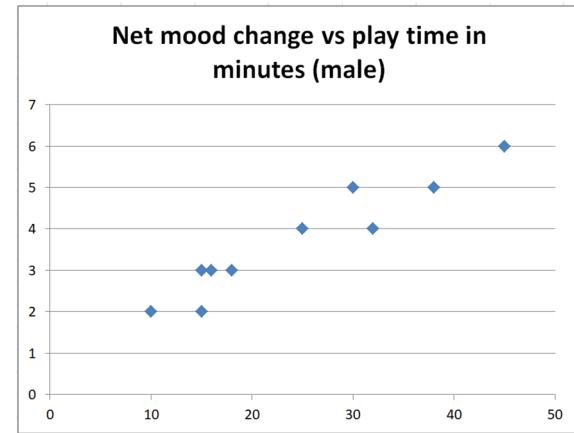


Figure 5: Mood change for men.

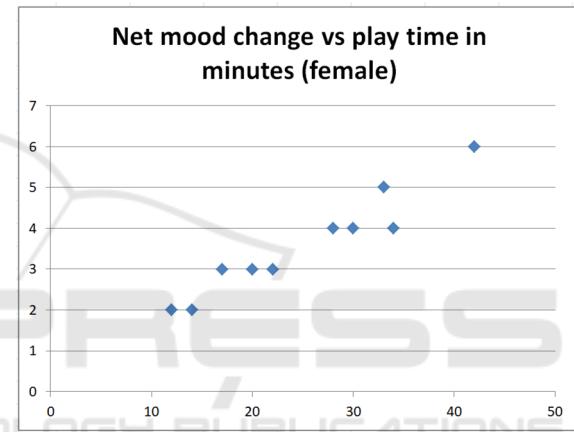


Figure 6: Mood change for women.

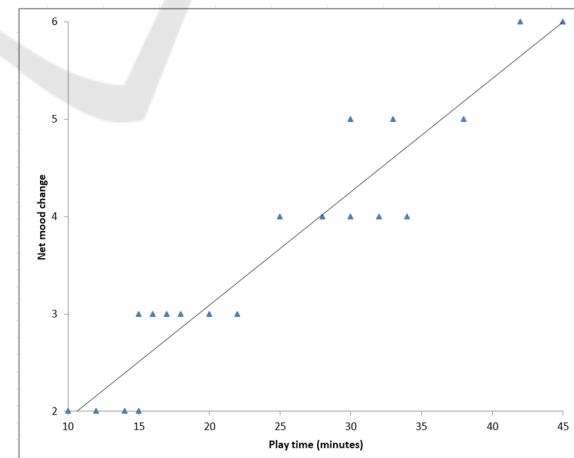


Figure 7: Correlation between mood change and playing time, combined for all male and female data.

For the current preliminary research, we recruited a total of 20 healthy, young volunteers (10 males and 10 females, age range of 18 - 21) for testing our VR

game on the effect of improving people's mood. We collected the volunteers' mood change data (see table 1). Figure 5 and Figure 6 show that the VR game has a positive effect for mood improving for all the men and women tested.

It seems obvious that the longer the players played the game, the more effective it would be on the change of players' mood. Figure 7 shows the correlation between the time played and the net mood change. The improvement seems universal. For males and females, young or old, all of the players' subjective reports showed that the game helped to improve their mood after playing the game.

4 DISCUSSION

Exercising in VR games has multiple mental and physical benefits. VR has been praised by people who had trouble making other exercise habits last (Brewster, 2019). CVGs have effects on improving people's moods (Russoniello et al., 2009). Nowadays, VR and its related technology has been a research focus with its applications in various fields, from entertainment to education. Research has shown that video games have numerous therapeutic benefits for individuals living with chronic diseases (University of Utah, 2012). As the players with depressive disorders are often not motivated enough to perform exercise activities, it is beneficial that exercise components be integrated into the game. Based on current research, it appears that VR games can help to both increase physical activity and decrease symptoms of anxiety and depression.

Because of its growing appeal amongst both gamers and non-gamers alike, VR can be used to promote a wide range of beneficial activities in addition to physical activity. The wide capabilities of VR systems indicate that they have the potential to serve as an important adjunct therapy for depression and anxiety in addition to mainstream treatments. As technological improvements are made, one could potentially see VR being incorporated into various medical services.

VR allows the player to have complete control, as the provider can control the exact aspects of the exposure environment (Maples-Keller, Bunnell, Kim, & Rothbaum, 2017). The method by which VR promotes mental health and improves anxiety and depression is multifactorial. There is evidence suggesting that VR can help to create a virtual environment that modulates the triggers that lead to an individual's anxiety or depression. VR also allows individuals to manipulate exposures in ways that

might not be realistic, such as performing certain physical feats that they may not be able to accomplish in real life.

Among many advantages with the use of VR, it is relatively safe and there are few negative effects from using the technology. The main limitations including physical effects such as eye strain, nausea, and headache. Although many individuals are able to tolerate these adverse effects, some people such as those with epilepsy may be at higher risk of developing symptoms from VR use. Finally, as with other types of games, there may also be an element of gaming addiction, especially in those who use VR extensively.

Further research is needed to provide guidelines and treatment techniques for video game players who suffer depressive disorders. Our research is preliminary. We need to do further to determine the optimal intensity, duration, and frequency of VR exercise and physical activity (Zeng et al., 2018). As much of VR research is still in its infancy, further research into the physical and mental benefits of VR exercise is warranted. For the next step in our current project, we plan to test the VR game on people with clinically diagnosed depressive and anxiety disorders. We aim to perform this next study in a hospital environment, with the goal of comparing VR therapy with more traditional methods of rehabilitation such as physical and occupational therapy. We also seek to qualitatively and quantitatively determine how much improvement the game can achieve in improving mood.

5 CONCLUSIONS

Playing VR games can help individuals with depressive disorders to engage in a different environment, which may offer numerous physical and psychological benefits. The results suggest that VR games can be an efficient strategy for reducing depressive symptoms. VR equipment is relatively affordable and its price is getting lower as the time goes. VR is potentially engaging to adolescents experiencing mood-related distress. This especially helps the player to temporarily get rid of their physical limitations. Therefore, playing VR games can positively affect the mood of people with depressive and anxiety disorders. The elements of the game, such as natural scenes and music, also play an important role. When these elements meet or exceed the expectations of the player, this will provide a boost to the player's mood and help to provide the intended therapeutic effect.

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