Application of Big Data and VR Technology in the Treatment of Acrophobia

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Abstract. Under the background of the Internet, the application fields of big data processing technology, artificial intelligence technology and Internet of things technology are becoming more and more extensive. Creating a new form of VRET has become an inevitable trend in the treatment of acrophobia in the future. Through big data and VR online technology, therapists can adjust the exposure level and time in time according to the situation of patients, so as to effectively reduce the anxiety of patients. This paper discusses the application status of big data and virtual reality technology in the treatment of acrophobia, including scene layout, visual immersion, listening and tactile and other multi sensory common perception, and further expands in detail. Finally, it points out the limitations of virtual reality technology in the treatment and the prospect of future treatment. The relevant literature in recent years was searched through the literature method, the exposure experiment was carried out in combination with big data and VR technology, and the results were counted by mathematical statistics. The application of big data and virtual reality technology has great advantages over traditional technology in the treatment of acrophobia, which can greatly reduce patients' pain and anxiety. At the same time, there are also deficiencies at this stage, such as how to break the technical restrictions and integrate different individual differences.

Keywords: Virtual reality technology · Big data · Artificial intelligence · Acrophobia

1 Introduction

Acrophobia is a kind of widespread phobia. At present, its treatment is mainly desensitization technology. Exposure desensitization therapy is the main method used to treat acrophobia in recent years. It is mainly through repeated exposure to the special environment that makes them fear. After repeated adaptation training, patients can produce new associative memory, so as to reproduce new cognition, establish new behavior patterns, and no longer fear such environment.

Big data, as its name suggests, is a huge amount of data resources. Similarly, big data technology has grown rapidly with the revolutionary development of computer industry in recent years. In the field of big data technology, the main research elements include the acquisition of massive data, data storage and management, data content mining and

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application, among which the mining and application of data content is the core of big data engineering.

The emergence and development of virtual reality (VR) technology makes it possible to combine the advantages of reality exposure method and imagination exposure method. Connect VR technology to exposure therapy, expose patients to specific virtual scenes created by VR technology, and then implement treatment. This new method is called VR exposure therapy (VRET). Since the first VRET experiment was conducted in 1992, there has been a sharp increase in relevant studies to evaluate the effectiveness of VRET. VRET allows patients to immerse themselves. Therapists can adjust the level of scene exposure and exposure time in time according to the situation of patients. Each scene can be repeated indefinitely, and VRET will not be dangerous like real exposure therapy. Therefore, VRET will become a new method to replace the traditional exposure therapy in the treatment of acrophobia.

2 Treatment of Acrophobia

2.1 Traditional Treatment

According to a survey, 91% of modern urban people have experienced fear of heights, of which 10% have more serious symptoms. The performance of fear of heights does not mean that people are timid, but a series of physiological reactions that people can't help standing high. Fear of heights is not only a height problem, but also a psychological problem. For them, they are thinking at any time and anywhere and do not want to stand high, so as to eliminate the occurrence of acrophobia. Acrophobia is generally divided into two types. One is the absolute fear of heights at heights, which is physiological fear of heights; The other is the fear of "high" people or things, and the inferiority and retreat when seeing people or things better than themselves, which is psychological fear of heights [11]. Being on the transparent glass plank road, standing on tall buildings and traveling by plane are things that can't be avoided for patients with acrophobia. When a patient with acrophobia is at a certain height, due to changes in physical visual information and psychological unreasonable ideas, a series of physiological symptoms will occur, including rapid heartbeat, chest tightness, chest pain, gastrointestinal discomfort, nausea and vomiting, chills and weakness, hand and foot trembling and so on. Psychologically, there will be inattention, anxiety, always worried that something terrible will happen, feeling particularly helpless and so on, In terms of behavior, it is fear of escape, so you don't want to fly or climb high places [12]. This situation has brought many troubles to people's lives. During treatment, patients should first rank the height of inducing their fear in different degrees from high to low, and then continue to be exposed from the lowest level until the situation at this level does not make patients experience fear, and then enter the next level. The fear experienced during each exposure should be moderate. If it is too light, it will not have the effect of exposure, and if it is too heavy, it may be life-threatening. Protective measures should be taken during treatment. If there is any uneasiness, it should be stopped immediately.

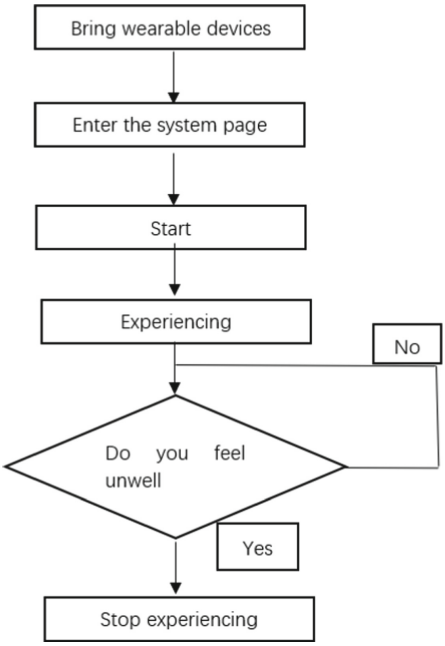

Fig. 1. Wearing process

2.2 Application of Virtual Reality Technology in Acrophobia

2.2.1 Build VR Scene and Platform

The key to using VRET is whether the environment exposed by patients is real enough. Therefore, the construction of VR platform and the layout of scene are very important. Developers generally use some game engines, such as unity3d and ps3d, to develop VRET realistic scenes. Using these game engines can easily rely on their own scenes for special feature design. These game engines also use a wide range of operating system environments on computers, such as windows, IOS, Android, etc. [9] The actual effect largely depends on the immersion of patients in the virtual scene, which requires a good fidelity of the scene. When designing the virtual scene, some unstable factors can also be added, such as being at a high place, so that the patient can enter the sense of fear faster. After establishing a virtual scene, VRET is often used in combination with virtual reality devices, such as virtual helmets [10]. The specific wearing process is shown in Fig. 1, so that people can better enter the scene, achieve the feeling of "immersive" and provide convenient conditions for treatment.

2.2.2 VR Helmet Increases Immersion

VR helmet (head mounted display, HMD) can effectively improve the immersion feeling of acrophobia patients in virtual reality. HMD has integrated screen, loudspeaker and gyroscope. The patient's line of sight can focus on the image generated by the screen,

Table 1. Survey results of high response questionnaire

Content	Quantity
5-10 floors	1
10-20 floors	5
20-30 floors	5
Above 30 floors	2
No fear	7

and the image can be changed accordingly, which makes the real world isolated from it and no longer perceived [8].

2.2.3 Gesture Capture Devices Increase Tactile Immersion

The gesture capture device uses the rubber hand illusion of acrophobia patients, that is, when you see your hand grasping something in virtual reality, you will think that you have "really" grasped such a thing in the real world, realizing the perceptual interaction between virtual and reality, increasing the immersion of patients and improving the therapeutic effect of exposure therapy [5].

2.3 Experiment and Discussion

Relevant experiments are quoted from "research of virtual reality and physical signal characteristics" by Cheng jiangxue of Tianjin University [2].

2.3.1 Experimental Object

The selection of experimental subjects is through field measurement. 30 experimental volunteers are taken to the fourth floor, then let them look at the ground, judge them according to their fear of heights and behavior, and then select 20 students with fear of heights as the experimenters of this study. The experimenters were students of Tianjin University aged 22–24. Before the experiment, we first experienced the virtual scene, and conducted a questionnaire survey on the experimenter's fear of heights (assuming that each floor is 3 m high) to obtain his psychological "height tolerance". The results are shown in Table 1.

In the test, the experimenter experiences the virtual scene. The virtual scene entered by the experimenter is the same, and the location and environment of the test are the same. The staff monitored the heart rate changes of the participants in real time and calculated the peak heart rate as the evaluation index of the experience effect. The test results were divided into group A, group B and group C. The results are shown in Table 2 [6].

Table 2. Comparison of heart rate changes among participants

Group	Quantity	Heart rate at rest	Peak heart rate
A	4	66±4	[90,100]
B	11	66±4	[80,90]
C	5	66±4	[70,80]

2.3.2 Experimental Steps

There are three virtual fear of heights scenes, which are divided into Scene 1, scene 2 and Scene 3. Scene 1 is a single wooden bridge in the air. The experimenter walks from one side of the single wooden bridge to the other. Scene 2 is a cliff. The experimenter walks on the edge of the cliff; Scene 3 is a tall building. The experimenter falls from a high altitude. The experimenter took the brain wave instrument and VR helmet and conducted the experiment in Scene 1 for 3 min. Then, the experimental group should carry out the following training in Scene 2 and Scene 3: once every three days, twice a day, each training time is 3 min, and the interval between the two experiments is 5 min. When the experimenter is basically stable in Scene 2, change the experimenter to scene 3 to do the experiment of the same steps. When the experimenter is basically stable in Scene 3, change the experimenter to Scene 1 for 3 min.

2.3.3 Data Collection

The data of the whole experiment is divided into two parts. One part is the data of training classifier, which comes from the experimenter in Scene 2 and Scene 3; The other part is the control data, which is the brain wave data of the two experimental groups in Scene 1. Among them, the data of training classifier needs the corresponding fear of heights label, which is divided into three categories: low, medium and high. In order to make the collected data have high quality, before the experiment, we should give some guidance to the experimenters, let them concentrate during the experiment, immerse themselves in the scene as much as possible, and give corresponding gestures at different levels of fear of heights, so as to label our data accordingly. However, our comparison data do not need labels. They are classified by our classification model. The brain wave data we collected is one record per second, and each record is divided into five frequency bands. Because there are four electrode pairs on the brain wave instrument, there are four electrode position data in each frequency band, that is, each record is 20-dimensional data.

2.3.4 Experimental Result

Different features: in order to find the best brain wave features that can represent fear of heights, we compared the best classification of four different features. Table 3 shows the accuracy of different features in different brain wave bands. From Table 4-2, we

Table 3. Accuracy of different features in different brain wave bands

Features	Brain wave channel					
	Delta	Theta	Alpha	Beta	Gamma	All
De fluctuation analysis	59.57%	66.13%	68.39%	80.23%	81.97%	86.87%
Hurst index	43.19%	45.46%	53.10%	62.74%	66.79%	75.06%
Square difference	61.76%	64.69%	67.78%	69.76%	70.79%	80.09%
Approximate entropy	72.89%	73.68%	75.38%	74.12%	73.82%	82.65%

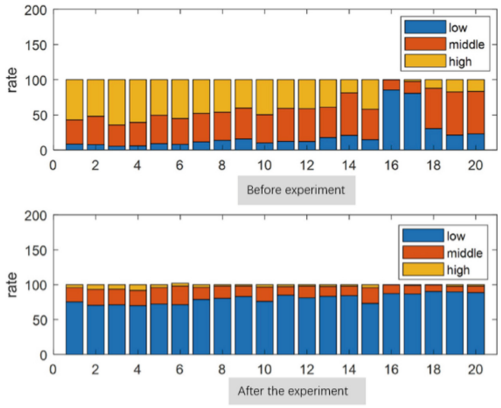

Fig. 2. Comparison before and after the experimenter's fear of heights

can see that de volatility analysis can achieve the best accuracy of 86.87% in the whole frequency band. Waves with high frequency (alpha, beta, gamma) are more related to emotion than waves with low frequency (Delta, theta).

Comparison of results: Fig. 2 shows the results of the fear of heights ratio before and after 20 experimenters. It can be seen from the figure that among the 20 experimenters, two of them did not change much before and after training, and the other 18 changed significantly before and after training. Therefore, in general, we believe that virtual reality has a certain effect on the treatment of fear of heights [2].

2.4 Effectiveness Analysis

2.4.1 Advantages of VRET

VRET has a strong sense of experience, has a certain degree of hypnosis, and can combine multiple perception channels. After adding some unstable factors, it can quickly and effectively elicit the fear response of patients, so as to facilitate exposure desensitization treatment. The treatment process of VRET can be controlled at any time. HMD

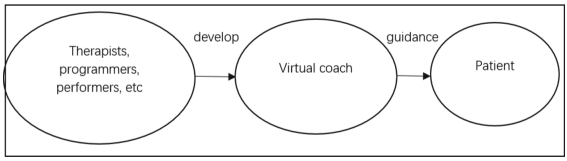

Fig. 3. Training process (Oxford VR)

is connected with the computer operated by the therapist [4]. The therapist can use the user interface to see the actual situation of the patient, delimit the rating according to the performance, and also see the position of the patient in the virtual world; If necessary, the therapist can also control the patient's position in the virtual environment. Through the real-time measurement of relevant physiological indicators, the therapist can adjust the virtual reality scene at any time [3]. If the patient's physiological indicators do not reflect the fear state, the therapist can appropriately raise the environmental level. In case of extreme physiological indexes and unstable behavior during treatment, the therapist should reduce the level or even suspend the treatment in time.

2.4.2 Reasons for Insufficient Application of VRET

In recent years, the application of VR technology in the treatment of acrophobia in China is still less, and it is in the initial stage. Find out the reasons, such as the limitation of development technology and the difficulty of virtual scene development; In addition, different personalities and attitudes of individuals are easy to have an effect on the treatment effect. Everyone's acceptance is different. Whether the clinical effect has curative effect remains to be discussed [7].

2.5 Prospect of VR in the Treatment of Acrophobia

2.5.1 Interdisciplinary Research in Computer and Psychology

VR technology is the crystallization of the rapid development of computer software and hardware technology, sensing technology, robotics, artificial intelligence, behavioral psychology and other scientific fields. "Reality" is any environment or thing that may or may not exist in reality. "Generated" means "virtual computer". With the development of this technology, users can experience the immersive feeling in the virtual world created by computer. In a recent study, Oxford virtual reality(Oxford VR) company invented an app to treat acrophobia [1]. This study does not need a therapist, but guides the patient's behavior through a simulated coach to achieve the actual intervention effect. The training process is shown in Fig. 3. This can reduce the patient's resistance and facilitate the entry into the treatment state. Patients can customize the treatment through communication with virtual coaches, so that patients are more willing to enter the height that puzzles them. It leads patients to carry out a series of graded exercises in the virtual height to promote cognitive change, that is, to develop safe memory to offset fear Association [15]. The results of randomized grouping experiment show that the fear of heights of those who use virtual coach is significantly lower than those who do not receive treatment.

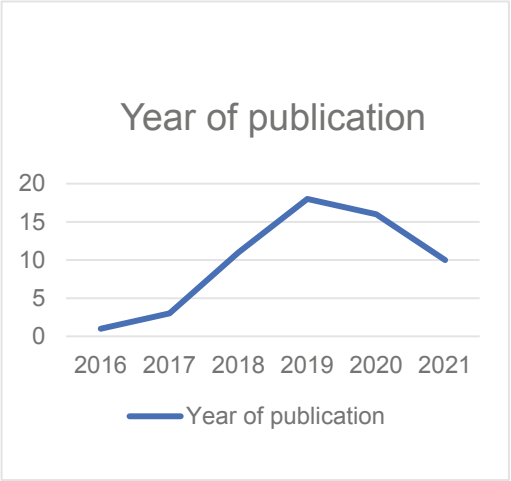

Fig. 4. Relevant literature results

2.5.2 Build a Reasonable and Clear Mechanism and Theory

As shown by the results of literature navigation, research has increased in recent years, as shown in Fig. 4. Scholars at home and abroad have unanimously praised virtual reality technology. Its advantages include interactivity, flexibility, security, time saving, cost saving and repeatability. However, the research on VRET mainly focuses on user feedback and user performance, and rarely explores the psychological mechanism behind it. The research on the mediating variables and regulatory variables of the efficacy of VRET has just begun. Moreover, most researchers' application of virtual reality technology is limited to vision, and other sensory stimuli such as hearing, touch and smell are rarely used. If VRET technology is to be used as an independent psychological intervention means, we need to comprehensively consider the consistency of the two and improve the virtual reality platform. At present, the internal psychological process of using VR technology to treat acrophobia is still a "black box" [14]. Whether there is a linear relationship between its "reality" and anxiety in virtual reality needs to be verified by a large number of experiments.

3 Conclusions

In this paper, the causes of acrophobia and the characteristics of VR technology are described in detail. The research shows that virtual reality exposure therapy (VRET) has strong safety. During the treatment of related patients, patients will not fall accidentally due to a series of symptoms such as visual vertigo, which provides a strong guarantee for the life safety of patients. This paper analyzes the advantages of VR technology in the treatment of acrophobia and the reasons why it has not been widely popularized. Finally, the prospect of the combination of VR development and acrophobia treatment is prospected.

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References

1. Chi Xingbei Research on the US military's response to battlefield phobia under the condition of informatization [J] Theoretical research on military political work, 2007 (02): 85-87
2. Cheng jiangxue Research on the correlation between virtual reality and physiological signal characteristics [D] Tianjin University, 2018
3. Deng Shudan A case study of systematic desensitization therapy on adult animal fear intervention [D] Southwest University, 2020 DOI: https://doi.org/10.27684/d.cnki.gxndx.2020.000251.
4. Kong Jingya Effect of virtual reality exposure therapy on acrophobia and brain mechanism [D] Nanjing Normal University, 2020 DOI: https://doi.org/10.27245/d.cnki.gnjsu.2020.002154.
5. Kahlon Smiti, Lindner Philip, Nordgreen Tine. Virtual reality exposure therapy for adolescents with fear of public speaking: a non-randomized feasibility and pilot study.[J]. Child and adolescent psychiatry and mental health, 2019, 13(1).
6. Liu Jiarong, Hu Qin, Chen Zhihang, Hu Zeming, Deng Yufei, Cai Jiatao, Cai Yong Feasibility study of virtual reality in evaluating acrophobia [J] Technological innovation and application, 2018, (03): 26-28
7. Li Huiyun A case of snake phobia was quickly cured by systematic desensitization, virtual reality exposure and cognitive therapy [J]Campus psychology, 2012, 10 (01): 6-9
8. Tang Qingyang, Liu Qian VR + health: application and Prospect of virtual reality technology in the field of health [J] Educational media research, 2020 (01): 40-42 DOI: https://doi.org/10.19400/j.cnki.cn10-1407/g2.2020.01.009.
9. Wang Baoying, Li boning Design of acrophobia treatment system based on unity3d [J] Information and computer (theoretical Edition), 2018 (12): 101-103
10. Wang YiDe, sign of virtual reality exposure therapy for acrophobia [J] Drama House, 2017 (09): 272-273
11. Wang Xue, Wang Guangxin, Review on the application of virtual reality exposure therapy in psychotherapy [J] Psychological technology and application, 2014 (12): 121418 DOI: https://doi.org/10.16842/j.cnki.issn20955588.2014.12.004.
12. Wang Qiuyu, Wang Chun, Yao Hui, Shi Jiabo, Kong Jingya Application of virtual reality exposure technology in fear and anxiety disorders [J] Journal of clinical psychiatry, 2019, 29 (02): 136-138.
13. Xiao Haichuan, Liao Ying, dear Che Vr virtual reality technology and new progress in the treatment of acrophobia [J] Electronic engineering, (119.02-2019)
14. Yan Jingjiang, Wu Lingdan, sun Hongjin Review of research on the treatment of flight phobia with virtual reality exposure therapy [J] Advances in modern biomedicine, 2007(09):13721374+1382 DOI: https://doi.org/10.13241/j.cnki.pmb.2007.09.063.
15. Zou Xiang, Wang Shuyi, fan Lin, Dou Jiansheng, Wang Yuqi Application of virtual reality exposure therapy in spider phobia: mechanism, effect and prospect [J]Advances in biomedical engineering, 2021, 42 (01): 20-24