ISSN: 2472-3703 DOI: 10.6911/WSRJ.201910_5(10).0006

Experimental Study on the Role of VR in Relieving the Emotions Problems of Adults

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Abstract

Emotions exert a profound impact on people's learning, work and life. A relaxed, joyful mood is of help to people's work and study performance. The features of VR such as immersion, interaction and imagination enable users to experience the virtual environment in an immersive way and help users in psychological adjustment. In this study, 40 adults were selected as subjects, divided into the experiment group (20 people) who received VR films and the control group (20 people) who received light music. Based on the James-Lange two-dimensional emotion model, EEG technology and the Self-Assessment Manikin (SAM) were adopted to identify the serenity-excitement dimensions of emotions in order to compare and analyze the differences between the roles of music and VR films on human emotions. The results showed that the experiment group was significantly more relaxed than the control group, indicating that VR technology can be used as an optional method for the staff to adjust and relax emotions.

Keywords

VR; James-Lange two-dimensional emotion model; emotion regulation; EEG.

1. INTRODUCTION

With the robust social and economic development nowadays, people are living a frenetic life. The growing demands for life have piled on the pressure for modern people, exacerbating people's emotional problems. Emotions exert a profound impact on people's learning, work and life. A relaxed, joyful mood is of help to people's work and study performance[1]. In daily life, people often listen to music, view pictures, and refresh videos to alleviate the pressures of life and work, in order to relieve stress and relax emotions. For the working people, listening to music has become the main choice for them to relax.

In recent years, VR – the technology that can provide realistic virtual environment through multiple perceptions such as sight, hearing and touch – is increasingly applied to people's lives. The features of virtual reality such as immersion, interaction and imagination enable users to experience the virtual environment in an immersive way and help users in psychological adjustment[2]. At present, many studies have applied VR technology to rehabilitation therapy[3] [4], psychological counseling[5] [6], etc., but few studies focus on the effect of VR on the emotional regulation of ordinary working people.

The application of EEG technology to emotion recognition is a kind of emotion recognition method based on the central nervous system. It identifies emotions by analyzing the differences of signals sent by the brain under different emotional states. Compared to other physiological signals, brain signals can more easily reflect the emotional state of the brain, with a high recognition rate. Therefore, it is increasingly applied to emotion recognition research. For example, Sammle et al[7]. analyzed the emotions induced by music as through EEG signals,

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201910_5(10).0006

and found that joyful music created stronger δ wave in the forehead center region. Petrantonakis et al[8]. repeatedly acquired EEG signals in the forehead area of the brain, in an effort to identify emotions through EEG signals. It has identified six emotions such as happiness, surprise, anger, apprehension, disgust, and sadness, and the recognition rate reached 84.72%. Zheng Weilong et al[9]. applied the deep belief network to the sentiment classification based on EEG, with a recognition rate of 87%.

In emotional regulation, for the commonly used sentiment classification models, American psychologist James and Danish physiologist Lange respectively proposed the same emotional psychology theory in 1884 and 1885 respectively, namely emotion is a feeling of physical changes[10]. Based on this cognition, they divided emotions on vector points in dimensional space. The differences of different emotions are measured by the distance between corresponding points in vector space. The similar emotional states are closer in space, and the change of different emotions can be regarded as a gradual transition (see Figure 1).

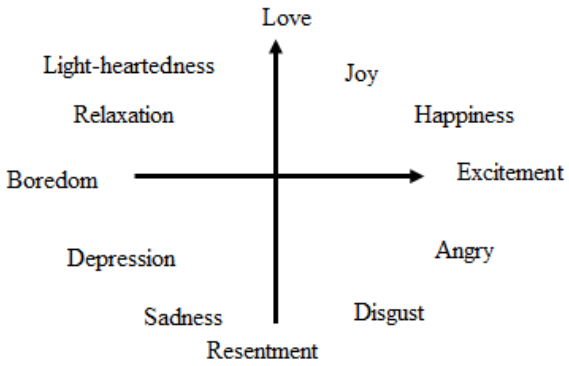

Figure 1. James-Lange two-dimensional emotion model

Therefore, based on James-Lange two-dimensional emotion model, this study adopted EEG technology to identify the serenity-excitement dimensions of emotions in order to compare and analyze the differences between the roles of music and VR films on human emotions, with a view to understanding the effect of VR on the emotional regulation of ordinary working people.

2. RESEARCH METHODS

2.1. Experiment Tools

2.1.1 EEG signal acquisition device

In this study, FOCUSEDU brain wave detection headbands developed by BrainCo were used as an EEG signal acquisition device. Through BrainCo's brainwave detection headbands and software, researchers could track the wearer's attention level, and the device could also collect and record the wearer's brain wave signals such as alpha wave and beta wave in real time. Studies have shown that alpha waves represent a bridge between conscious thinking and sub-consciousness and can be used to characterize the feeling of calmness and deep relaxation[11]. The higher the alpha wave activity, the more relaxed the mood. Therefore, this study mainly used FOCUSEDU to collect the numerical values of alpha waves.

2.1.2 Emotion elicitation device

This study used HTC VIVE Focus head-mounted device. HTC VIVE is one of the best VR products on the market. VIVE Focus head-mounted device provides an immersive experience for the subjects through one head-mounted display and one single-handheld controller. The

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device uses inside-out tracking technology and six degrees of freedom (6DoF) to achieve world-scale positioning. It comes with Ultra HD 3K AMOLED screen.

2.1.3 Emotion elicitation material

Emotion requires certain external stimuli. The subjects can have expected emotional states through stimuli such as image and text, video, sound, and smell. As the experiment time is limited and the long-time use of current VR will cause discomfort such as dizziness, the video or audio duration should be appropriate. The emotion can be maintained at a certain level for a time to obtain sufficient valid data in a limited time. Therefore, the duration of the stimulus material is generally two minutes or so. According to this standard, this study selected 20 segments of VR video or audio that creates an immersive feeling in VR and strikes a chord in the minds of the subjects.

In order to ensure that the emotional changes of the subjects could be accurately measured under the experimental conditions, ten volunteers were selected for preliminary experiment in this study to find the experimental materials that reached the ideal state in a short time. To be specific, the 10 volunteers first evaluated and experienced these VR videos or audio, and their brainwaves during the experience were recorded. At the same time, after watching each video, the volunteers were asked to write the VR emotion evaluation form. According to the results of the document and the brainwave data, the study selected 4 segments of videos and audio with a degree of dominance greater than 3 and the highest average arousal degree and 4 segments of video or audio with the least arousal degree. Eight segments of stimulus materials were obtained.

2.1.4 Self-Assessment Manikin

The Pleasure, Arousal, Dominance (PAD) emotional state model proposed by Mehrabian and Russell [12] is often used to describe and measure emotional state (see Figure 2). It consists of three dimensions: 1) Pleasure-Displeasure: Pleasure, indicating a positive or negative feeling; 2) Arousal-Nonarousal: degree of arousal, indicating the degree of arousal to the outside world; 3) Dominance-Submissiveness: degree of dominance, indicating the impact on the outside world or others. The PAD model builds a three-dimensional emotional space, so that each emotion can have unique coordinates in the emotional space, which can represent dimensional emotions and map the discrete emotion[13]. The PAD model corresponding to the serenity-excitement mood under this study is relaxed (+P-A+D) namely high pleasure, arousal and low dominance, and excited (+P+A+D) namely high pleasure, arousal and dominate[14].

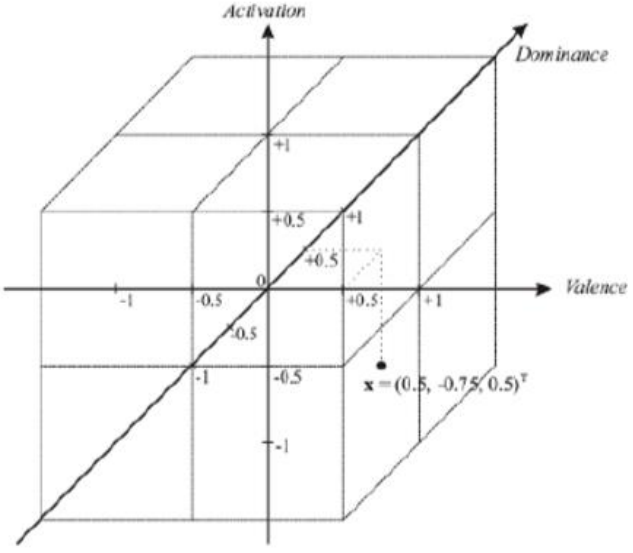

Figure 2. PAD emotion model

ISSN: 2472-3703 DOI: 10.6911/WSRJ.201910_5(10).0006

Self-Assessment Manikin (SAM) is a method for measuring the emotional reaction of the subjects[15]. The subjects select the abstract cartoon character drawings according to the current emotional state to express the degree of pleasure, arousal, and degree of dominance (See Figure 3). As there is no SAM system suited to the VR version, this study transformed the evaluation system into a VR version. Before the subjects begin the experiment and after the subjects receive the stimulus materials, they will be asked "Please select the drawing that best matches the current emotional state from No. 1-9 in each line according to your current emotional state."

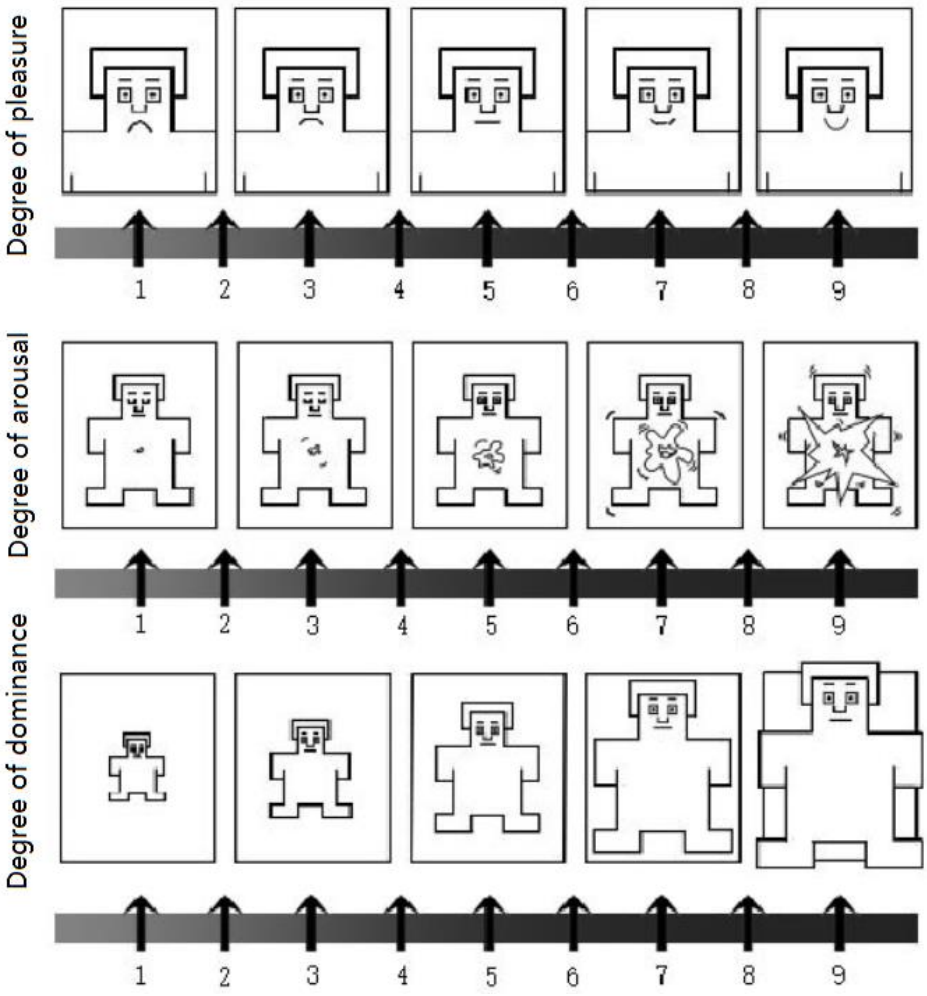

Figure 3. Drawing of SAM

2.2. Selection of Subjects

The volunteers in the experiment were 40 social workers aged 22-26 (20 males and 20 females), with right-handedness, good health, normal hearing, sound sleep, and no brain damage or mental disease history. Participants had the habit of watching movies or listening to music at non-regular intervals. The subjects had experience of VR experience, and were not nervous in the test. The subjects had English competence above Band 4 (CET-4), and could understand the language in video or audio.

2.3. Experimental Process

The experiment mainly includes the following steps (see Figure 4):

Step 1: Inform the subjects of the experiment goals and precautions, explain the steps of the experiment, and inform that the EEG collection equipment is non-invasive and harmless. Enter

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the basic information of the subjects, such as name, gender, age, etc., explain the meaning of SAM form, and guide the subjects to operate the equipment.

Step 2: Before wearing EEG and VR equipment, the subjects fill out the SAM emotion evaluation form according to the current status. The experiment staff put the brainwave detection headbands on the subjects.

Step 3: The subjects had a calm mind, adjusted the appropriate posture, while the baseline brainwave data were collected for 1 min 40s.

Step 4: The experiment staff randomly divided the subjects into the experiment group or the control group. If it is an experiment group, the subjects wore VR device, the EEG test VR program was launched, and the emotion elicitation VR material was randomly selected for broadcasting. If it is the control group, the light music was played for duration of 5 minutes.

Step 5: After completing the experience of the stimulus material, the subjects filled out the SAM emotion evaluation form once again.

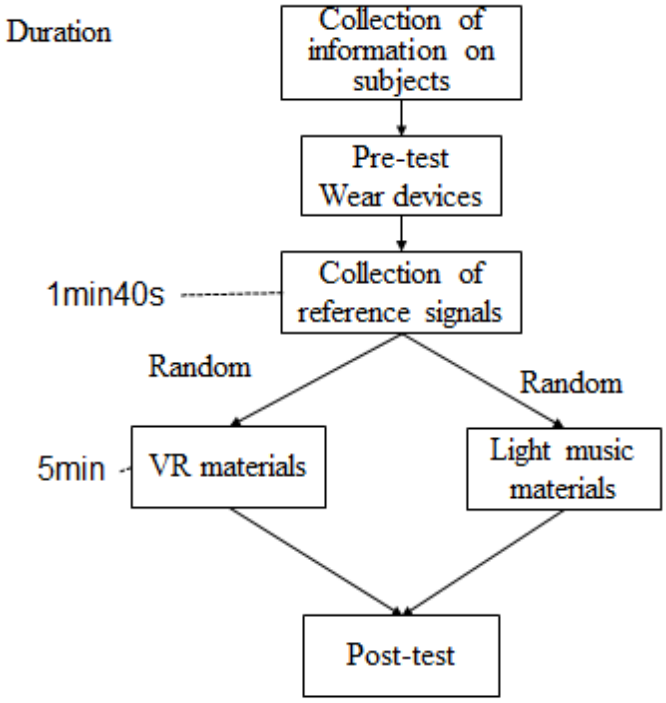

Figure 4. Flow chart of experiment

3. RESEARCH RESULTS

3.1. Analysis of Emotional Differences from Different Stimulus Materials Based on Emotional Reporting

It can be seen from paired-sample t-test (see Table 1) that the VR group had significantly higher post-test results than pre-test results in terms of pleasure, $t=-2.85$, $p<0.01$, $d=0.70$; in terms of degree of arousal, post-test results were significantly lower than the pre-test results, $t=2.97$, $p<0.01$, $d=0.96$; in terms of degree of dominance, the post-test results were significantly lower than the pre-test results, $t=4.25$, $p<0.001$, $d=0.96$. The above results showed that according to the three-dimensional theoretical model of emotion proposed by Mehrabian and Russell, the subjects had a more stable and relaxed state through the emotion regulation realized by VR stimulation, and it had a larger effect.

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Table 1. Test of difference in pre-test and post-test means of the VR group in emotion experience

	Time	N	M	SD	t	p
Pleasure degree	Pre-test	20	5.85	1.18	-2.85	.010**
	Post-test	20	6.75	1.37		
Arousal degree	Pre-test	20	6.90	0.97	2.97	.008**
	Post-test	20	5.95	1.00		
Dominance degree	Pre-test	20	6.90	1.02	4.25	.000***
	Post-test	20	5.95	0.95		

Note: **p<.01, ***p<.001

It can be seen from paired-sample t-test (see Table 2) that the control group had significantly higher post-test results than pre-test results in terms of pleasure, t=-2.46, p<0.05, d=0.59; there was no significant difference between the post-test results and the pre-test results in terms of arousal, t=1.30, p>0.05. In terms of degree of dominance, there was no significant difference between the post-test results and the pre-test results, t=1.61, p>0.05. The above results showed that the emotion regulation realized by the control group only effectively improves the pleasure dimension of the subjects, but did not have a significant impact on the emotion adjustment in other dimensions.

Table 2. Test of difference in pre-test and post-test means of the control group in emotion experience

	Time	N	M	SD	t	p
Pleasure degree	Pre-test	20	6.40	1.00	-2.46	.024*
	Post-test	20	7.05	1.19		
Arousal degree	Pre-test	20	6.25	1.12	1.30	.209
	Post-test	20	5.95	0.83		
Dominance degree	Pre-test	20	6.25	1.62	1.61	.124
	Post-test	20	5.65	1.27		

Note: *p<.05

3.2. Analysis of Emotional Differences in Different Stimulus Materials Based on Brainwave Measurements

As can be seen from Figure 5, the first 20 time points are baseline values, and the last 100 time points are experimental values. The alpha wave effect size of both groups increased somewhat, indicating that under the two experimental conditions, the individual alpha wave became obvious with the presentation of stimulus. As the presentation time of stimulus material extended, the individual mood gradually calmed down, but the extent of stability was somewhat different. The amplitude of the alpha wave of the subjects in the VR group was higher than that in the control group, indicating that the amplitude of stability in the VR group was significantly better than that of the control group. The effect of alpha wave in the VR group was 30.17% higher than that of the control group, and the effect size was 0.97, which was a strong effect.

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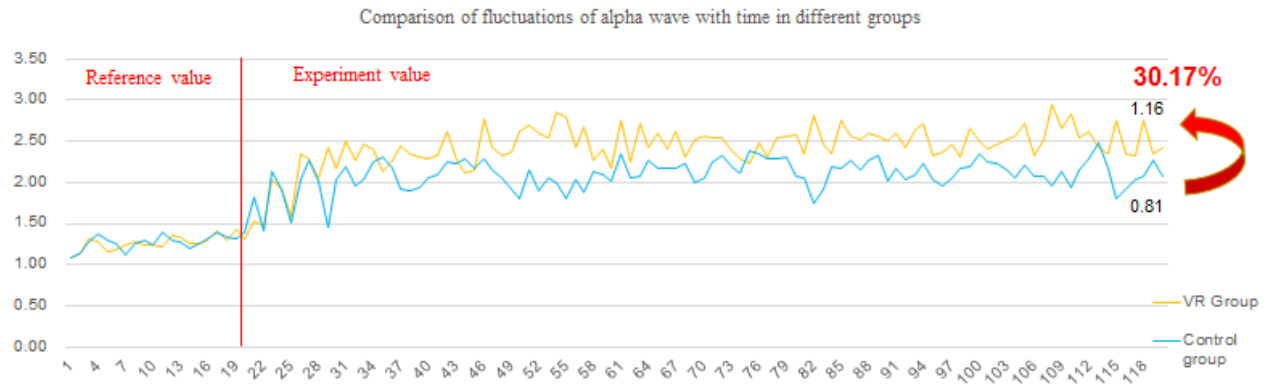

Figure 5. Comparison of fluctuations of alpha wave with time in different groups

Note: The effect size d value measures the degree of impact of different experimental conditions on mood relaxation. A value of greater than 0.8 is a strong effect; a value of 0.3-0.7 is a moderate effect; a value of less than 0.3 is small effect.

The paired sample t-test was adopted to analyze the test results of alpha wave. The results showed that the alpha wave value of the test was significantly higher than that before the test in both the VR group and the control group. To be specific, in the VR group, t=-14.35, p<0.001, d=4.20, which was a strong effect; in the control group, t=-12.40, p<0.001, d=3.68, which was a strong effect, but the effect of the VR group was stronger than that of the control group (see Table 3).

Table 3. Test of differences in pre-test and post-test mean of alpha wave in different groups

		N	M	SD	M middle – M before	t	p
VR group	Before test	20	1.27	0.02	1.16	-14.35	.000***
	During test	20	2.43	0.39			
Control group	Before test	20	1.28	0.03	0.81	-12.40	.000***
	During test	20	2.09	0.31			

Note: ***p<.001

The independent sample t-test was adopted to analyze the test results of alpha waves of different groups. The results showed that the post-test alpha wave in the VR group was significantly higher than that of the control group, t=3.09, p<0.001, d=0.97, which was a strong effect (see Table 4).

Table 4. Test of differences in post-test mean of alpha wave in different groups

	N	M	SD	t	p
VR group	20	2.43	0.39	3.09	.000***
Control group	20	2.09	0.31		

Note: ***p<.001

4. DISCUSSION

The VR scenario provides the viewers with a simulated reality scenario that allows viewers to have a real feeling[16]. The SAM data on two groups of subjects with VR relaxation and

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music relaxation showed that the VR group reached the standard of emotional relaxation status in Russell's emotional three-dimensional model in terms of pleasure, arousal and dominance. The paired sample's t-test effect d value was 0.70, 0.96, and 0.96, respectively, which were strong effect, indicating that the VR material had a significant effect on emotion relaxation. In the control group that receives light music, except that the post-test effect was higher than the pre-test result in terms of pleasure (d value was 0.59), there was no significant difference with pre-test results in terms of arousal degree and dominance degree. It did not reach the criteria for emotional relaxation in Russell's emotional three-dimensional model. The results illustrated the conclusion that VR materials had a significant impact on emotion relaxation. At the same time, after 5 minutes of relaxation experience by the subjects, the EEG signal data showed that the subjects experiencing the VR scenarios had significantly higher intensity of alpha wave signal than the control group, and the effect of the alpha wave in the VR group was higher than that of the control group by 30.17%, which was a strong effect (d value was 0.97). It indicated that VR relaxation material has more impact on physiological indicators within the same time under the common relaxation stimulus, and VR relaxation materials are more effective at promoting user's emotional relaxation. This is consistent with previous findings by Chiesa et al. [17] and Crescentin et al. [18].

VR technology can relax moods in that its biggest advantage allows users to enter a computer-generated virtual environment similar to the real environment with multiple perceptions through multiple devices. In such an environment, the users participate in the events of the virtual world according to their own feelings, comprehensively perceiving the environment and its content to have an immersive mental state [19]. The individual's perceptual activities such as sight, hearing and touch, as well as emotional reactions such as joy, nervousness and apprehension, will be fully expressed [20]. This sense of immersion and presence is different from what we say involvement, existence, and participation. It is the feeling level of fidelity and the subjective psychological feeling [21]. Through such advantages as realistic feeling level and highly recognized subjective feeling, the users are gradually integrated into and internalize the virtual characters, thus striking a chord in the user's emotions. In the study of the self-efficacy impact brought about by the user's gaming experience under VR technology, Peng W described the role identification and emotional identification of users formed by these influences, as well as the resulting changes in user's mood [15]. Imagine that when the user listens to, touches, and watches the "role" in the comfortable, pleasant environment created by the quiet VR materials, the emotional and spiritual relaxation brought by this experience is unmatched by the single sense. Therefore, VR technology can be used as an optional method for staff to adjust and relax emotions.

In today's rapidly-growing society, the use of VR in people's daily life can effectively help mood relaxation, lessen people's survival pressure, and improve physical and mental well-being. The repetitive and secure environment nature of VR technology not only provides users with multiple effective secure and relaxing experiences, but also enables individuals to gain a greater immersive feeling through interaction in VR scenarios. As the sense of immersion increases, the individual's emotional elicitation and physiological changes will also increase, and the final user experience will see better results. Therefore, VR resources can boost the immersion of VR, enhance the user experience, relieve the users of emotional pressures, and adjust psychological problems.

5. RESEARCH CONCLUSION AND LIMITATIONS

This study focused on exploring the extent to which VR technology influences emotion regulation. As the subjects in the study, 40 adults were randomly divided into two groups: the experiment group and the control group. The former received the stimulus of VR resources and

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then light music stimulus. At the same time, based on the James-Lange two-dimensional emotional model, EEG technology was used to identify emotions in the emotion serenity-excitement dimensions and to compare and analyze the differences between the impact of music and VR resources on human emotions. The study results showed that the experiment group receiving VR technology had a significant improvement in pleasure in emotional self-test, and a significant decrease in the degree of arousal and dominance. Although the control group receiving music stimulus had a significant improvement in pleasure in emotional self-test, the degree of improvement was lower than that of the experiment group, and there was no significant difference in the degree of arousal and dominance. This also showed that judging from the emotional self-test, the experiment group receiving VR resources saws a significant relaxation in emotions. In addition, the difference in the alpha wave of the brainwave confirmed this view. As the experiment progressed, the experiment group tended to have a stable and relaxed emotion.Due to limitations in the experimental conditions, however, this study did not control the impact brought about by other senses, such as music material and VR material. The study failed to effectively control the effect of visual senses while ensuring the same audio. In terms of physiological indicators, this study mainly used alpha wave as the principal indicator, which was subject to certain limitations. In the future, other indicators such as respiratory rate and skin conductance need to be added. Moreover, in the comparative analysis of the brainwave measurement before and after the experiment, a fixed time point should be used. For example, the first 20 time points were used as the pre-experiment state, and the last 20 points were selected as the post-experiment state, and the test of differences before and after the experiment was performed. At the same time, VR technology has advantages in visual and auditory immersion, as well as in other dimensions such as touch and smell that stimulate the emotion of the subjects. This study only used the stimulus material of the VR scenarios. Therefore, the experimental design shall be further improved by adding the multi-dimensional sensory stimulation of VR resources and fully bringing into play the advantages of VR resources. At the same time, it will be refined in the experimental data analysis to further explore the degree of impact of new technologies on emotions.

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