

VR Technology Enhances: The Healing Effect of Immersive Natural Scenes

Hanfu He[†], Yu Wang and Wei Cui^{*†}
School of Design and Innovation, Tongji University, China

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Abstract: Background: In the post-epidemic era, people have experienced a long history of separation from normal life and production order. Long-term "isolation" of abnormal home life, leads to great mental pressure. Research has shown that most of the human "healing" state is realized in the natural environment, and immersion in the natural state helps people in physical and mental recovery and improves cognitive function. Due to many objective conditions such as COVID-19, walking into nature becomes very difficult for people to be quarantined at home. Aims: Therefore, with the help of virtual reality technology (VR), it is a very meaningful research direction to help people to get natural "healing" without leaving home. Methods: This paper, through the theoretical combing and generalization and experimental data research, evaluates the design of the natural environment in VR, and innovatively applies the psychological attention recovery theory and related theories to the exploration of VR images. Results: The experiment in the study invited 30 subjects to conduct an immersive experience and evaluation, and the conclusions met the theoretical elaboration. Conclusion: This paper has a very practical significance for the practical application of human-computer interaction in the post-epidemic era.

1 INTRODUCTION

In early 2020, covid-19 broke out and spread around the world, with many negative effects -- economic, scientific, political, and life. The impact persists to the present day. To successfully prevent the spread of the epidemic, several nations and areas have taken preventative measures., including China, have issued travel bans, forcing people to live in isolation or semi-isolation for a long time, and their living space has become relatively closed. Whether working, studying, or living, people emphasize a "Non-contact" way of interaction, which includes "Home office", "Online courses", "Online shopping" and other ways.

Our research aims to help people in a closed state to effectively improve their mental and spiritual health and reduce negative emotions as much as possible. Through research, we found that for people living in a closed environment for a long time, the natural environment has a good spiritual and psychological healing effect. This shows that the natural environment can effectively help restore people's attention and relieve stress.

To achieve this objective, we evaluate an immersive image of a natural setting created using VR (VR) technology. VR is a method of material removal human-computer interaction (HCI) technology in which the user encounters the device virtual scene with real-world sensations. Its fundamental characteristics can be summarized as "3I": Immersion, Interaction, and Imagination. Using VR (VR) technology for an immersive experience of the physical world and psychological healing, which is still an epidemic in long-term home isolation, has a significant practical application.

2 THE THEORETICAL BASIS OF THE HEALING EXPERIENCE

2.1 Theory of Attention Recovery

The "Attention recovery theory" (ART), originally proposed by psychologist Kaplan (Kaplan, S.; Talbot, J.F., 1983), refers to environments that may

[†] Senior journalist of the South China Media Group

partly complement, restore, or renew exhausted or wasted psychological resources; that is, a setting that is restorative despite the constant consumption of both physical and mental resources and talents that are characteristic of urbanized surroundings. This theory from the perspective of cognitive psychology, the direct attention as the medium of environmental cognition, excessive consumption of direct attention will lead to mental fatigue, in the natural environment can effectively repair the cognitive resources(Kaplan S,1992), Harting according to the theory developed subjective recovery evaluation scale, used to measure people's restorative subjective feelings.

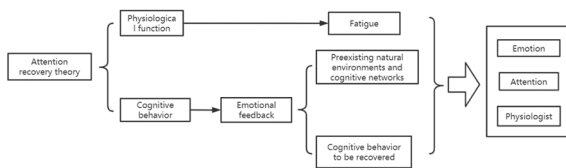


Figure 1: The theoretical framework of ART

Attention recovery theory believes that a restorative environment can restore previously depleted cognitive resources, especially directed attention, to promote health, while a restorative environment experience should include four features: being away, fascination, extent, and compatibility. Away is being psychologically and geographically away from the usual environment that causes mental stress and physical fatigue, reducing the use of directed attention and thus gaining the chance to relax. Attrition means that when the environment is very attractive, it can deliberately cause indirect attention, thus relieving fatigue and releasing stress. Scalability refers to the environment having a certain breadth and coherence, which means that there is enough space and content in the environment for people to explore and discover. Compatibility means that the activities supported by the environment meet the goals and preferences sought by the individual. If the activity provided by the environment cannot fit with the individual's preference and motivation, it is difficult to have a recovery effect(Joye et al.,2018;Kaplan et al.,1989,Stevenson et al.,2018).

2.2 The Theory of Stress Reduction

The theory of stress reduction (SRT) was originally proposed by the psychologist Roger Ulrich based on the perspective of psychological evolution. This theory believes that people in daily life by a variety of social and environmental factors, can produce different degrees of the psychological and

physiological stress response, long time stimulation makes people produce pressure, anxiety, tension, and other negative emotions induce mental fatigue, natural environment can promote physiological recovery and psychological relaxation, and most of the urban environment will hinder people from pressure(Ulrich,R.S,etal,1991).

Theoretical investigation reveals that people's attention is drawn away from negative thoughts and toward more positive ones when they are in environments of moderate complexity under pressure, with visual attention, insight, mystery, no potential threats, the ground appearance being uniform, a deflection field of vision including plant and water. When the mind and body are brought back into harmony after experiencing a disruption, health is restored. There are distinct philosophical and mechanical foci in each theory.

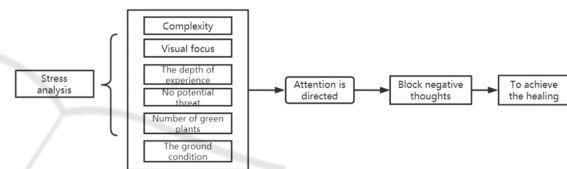


Figure 2: The theoretical framework of SRT

Comparing the attention recovery theory with the stress reduction theory, it can be found that the attention recovery theory explains how one's limited attentional resources might be restored by considering the effects of weariness in natural experience and the change of cognitive ability. Stress reduction theory, on the other hand, focuses on how one's feelings for nature affect one's life. Positive mood shifts and a dampening of autonomic arousal are two telltale signs of recovery(Staats,H.etal,2003), increased efficiency in finishing tasks requiring focused attention, and many other aspects(Stevenson,etal.,2018). Healing emotions result from interactions with natural settings(AnnAtchley,etal,2012,). A healing atmosphere enhances cognitive performance(White, M.P,etal,2013), enhance mental condition and decreasing stress(Bielinis, E.etal,2019).

3 THEORIES AND STANDARDS

The two important core theories of restoration environment described above explain the mechanism on the recuperative influence of nature and define the evaluation criteria of the healing effect of the natural

environment on humans basically in two aspects: subjective restorative evaluation and cognitive ability, which shows the feasibility of realizing healing through the integration of natural environment with VR technology.

3.1 Definition of Relevant Standards

3.1.1 Subjective Recovery Evaluation

The theory of retaliatory environment itself developed into the: Perceived Restorative Scale (PRS), a major approach to the subjective perception of restoration, focuses on Being Away, Fascination, Extent/Coherence, and Compatibility of four restorative environmental characteristics for the subjective evaluation of the environment

3.1.2 Cognitive Ability

Cognitive ability is mainly investigated by classical cognitive experiments of cognitive psychology, including Digital Span Forward/ Backward (DSF/DSB), Digital Span Forward/ Backward, Sustained Attention to Response Task(SART), Necker Cube Pattern Control Task (NCPCT), SDMT, Symbol Digit Modalities Test, etal.; Cognitive neuroscience measurements such as EEG and MRI can also be used.

3.1.3 The Emotional Influence of the Real or Virtual Natural Environment

There is much evidence to suggest that persons who socialize in natural surroundings suffer less adverse effects on their levels of attention and cognition as well as their stress levels. Natural immersion through VR technology can also effectively alleviate negative emotions, and studies have found that before and after virtual natural immersion, participants' self-reported anxiety levels(Herman L M,etal,2019) and stress levels decreased significantly (Valtchanov D, etal,2010); Compared with the virtual urban environment, the virtual natural environment can significantly alleviate negative emotions such as confusion, fatigue, anger, hostility, nervousness and depression(Split-Pin and Hsiao-Yun L,2018); Virtual nature is not inferior to the performance of negative emotions compared to the real natural environment(Mimnaugh KJ,etal,2020).

In virtual reality, we combine the natural and urban environments for observation. The study found that compared with the virtual urban environment, virtual nature can effectively enhance positive emotions such as vitality; Virtual nature is beneficial

for both healthy individuals and certain demographics like the elderly.

3.2 The "Presence" of Positive Emotions in the VR Natural Environment

Rehabilitation studies for anxiety and depression are very common in VR(Chirico, A,etal,2019). Exposure treatment that uses virtual fear cues to alleviate anxiety(Riva,G,etal,2021),The most common applications of VR in the field of psychology involve either distracting patients in order to alleviate their suffering via the use of immersive games or providing a natural setting in which they may relax(Lindner, P,etal,2019). Multiple anxiolytic, analgesic, and stress-relieving effects can be produced by being in restorative surroundings(Yu, C,etal,2018). The majority of healing VR based experiences take place in natural settings, which may include scenes from nature(Chung, K.,etal,2018) as well as virtual sceneries(Mattila, O,etal,2020).

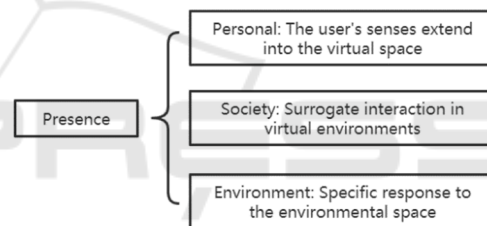


Figure 3: The analysis of "Presence"

It has been shown that exposure to VR can provide a larger degree of improvement in one's pleasant mood. This effect appears to be mediated by a better sensation of embodiment and natural interactions(Yeo,N.,etal,2020). Existence, sometimes known as presence, is a mental state characterized by a sensation of existing in an intermediate situation(Ijsselsteijn, W.,etal,2000). Furthermore, it refers to a certain mental operation(Triberti, S.,etal,2016).That is to say, people are able to have their own unique mental experience while existing in a digital world generated by a monitor screen. There are essentially three groups into which it may be sorted: social, personal, and environmental. The expansion of the perceptual feelings of the encounter into the virtual world, which results in an immersive environment and a sensation of mental engagement, is what is meant by the term "personal existence." The term "environmental presence" relates to the degree to which an experienced reacts to their surroundings, whereas the term "social presence" describes the

degree to which an experienced coexists and interactions with other creatures in a virtual world(Heater, C.,etal,1992). The relationship between social presence and cognition existence is mediated by one's sense of self-efficacy(Lin, C.J.,etal,2015). The researchers advise that it is vital to investigate further the influence of VR technological disparities in diverse situations on individual self-efficacy(Shu, Y.,etal,2019).

Time(Yildirim, I.G.,2016), content(Slater, M.and Udoh, M.,1993), features of users(Huang, M.P.and Alessi, N.E.,1999), attention resources and engagement(Draper,J.V.,etal,1998),Immersion and engagement are factors that affect presence(Barfield, W.and Weghorst, S.,1993). It's common practice to employ a mix of objective and subjective metrics. Feeling present may be gauged by monitoring physiological responses such as heart rate and skin electricity as well as behavioral indicators including facial expressions, body language, eye gaze, and tone of voice.

According to study, sentiments in a virtual world are associated with the perception of one's own presence(Riva, G.,etal,2004), which also describes the relationship between perception of being and emotion(Palanca, A.,etal,2019).

Explore the disparities in healing and experience created by diverse situations and the impacts of restorative settings on emotional responses in VR scenarios by doing research on the linkages between environment, conduct, and regulation of emotions. As a valuable addition to the research of individual cognitive recovery, EEG feedback may be utilized to illustrate the influence of a VR rehabilitation environment on cognitive recovery.

3.3 Performance of VR Technology in the Healing Process

The use of VR technology in the healing process can not only significantly improve treatment conditions and ensure patient safety, but also serve to secure patients' privacy, therefore enhancing patient participation. Compared with traditional psychological intervention methods, VR technology has significant advantages(Kazdin AE and Kendall PC.,1998):

(1) Self-help VR therapy developed for certain mild psychological disorders is anonymous, allowing patients to complete treatment tasks independently in a private space, less limited by time and space. In addition, in the VR environment, patients do not need to face real people, things, and

situations, thus reducing the patient's possible anxiety and fear;

(2) Although the development cost of VR technology scenarios is relatively high, once the development of high-quality VR scene content for specific psychological disorders is completed, It may be readily promoted and applied. At the same time, this will facilitate the establishment of a standardized psychotherapy system that, in the long run, has significant social and economic benefits.

(3) The therapist can perform scene control, tailor the protocol to the subject's treatment needs, including effectively arranging and combining the number, stimulation, and speed of treatment factors according to the treatment needs, and providing a series of virtual treatment environments without leaving the treatment room.(Bottle C.,2017) In addition, patients avoid direct contact with real stimuli, thus maintaining the safety of treatment. VR therapy alone also minimizes adverse effects and dependence on drug therapy.(Freeman D, Reeve S, Robinson A, et al.,2017)

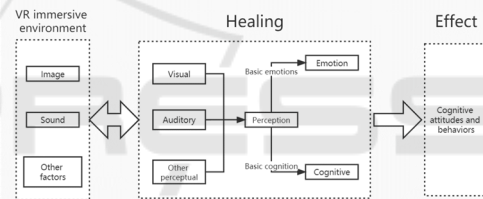


Figure 4: The logic diagram of healing through VR technology

3.3.2 Embodied Cognition in Virtual Nature

According to the embodied cognitive paradigm, cognition is bodily cognition, involving the brain, which is the consequence of the interactions between the body and the external environment during the perception and action processes, and that the anatomy of the body, the way of activity, and the sensory and motor experience determine how the individual directly experiences and shapes the world (Ye Haosheng,2017). Different ways of being and moving may lead to different knowledge and understanding of the world, and the resulting behaviors may also be different. Cognitive dysfunction is not just a higher-level process that occurs inside the brain, it is closely related to an individual's body structure, experiences, physical interactions, and interconnections with the surroundings.



Figure 5: Immersive images were taken using panoramic technology

In general, when a participant is provided with a virtual body different from the ontology in a virtual environment and the action simulation is performed synchronously, and then some value-related attitude evaluation task is completed on the virtual body, the subject's attitude will change with the somatosensory perception of the virtual body (N Yee and Bailenson J- N.,2007).

The study found that when people are in an unnatural environment for a long time, feel lonely, and lack social support (Ward Thompson C, Aspinall P, Roe J, et al.,2016), significant elements impacting social interaction include the quality and quantity of urban green area and sources of water space. Social loneliness causes psychological and physical health problems (Pantell M., et al.,2013). The fusion of virtual nature and social networks will help to combat social loneliness and repair social isolation and inequality due to urban isolation.

4 EXPERIMENT AND ANALYSIS

According to the content already mentioned above, in this part, we take the same natural environment as the research object and use the floor plan and the panoramic virtual immersion as experimental materials respectively. 30 university students with a 1:1 ratio of males and females were invited to participate in the test. After a series of stress tests on logic questions, watch the floor plan and wear VR glasses to watch panoramic immersive images to relieve stress. Experimental evaluation data were conducted on the Perceptual Recovery Scale (PRS).

Currently, the PRS scale is frequently utilized in the evaluation of the restoration of diverse ecosystems, including buildings, urban settings, interior biodiversity, and natural environments. In this experiment, the test scale was used to test the healing effect of experiencing the natural

environment through VR technology, The final results were utilized as an assessment index.

4.1 Test Objects

The experiment selected 30 undergraduate and master's students as the test group, aged 18 to 24 years old, with a male-female ratio of 1:1. The difficulty of stress testing is the same for all test participants.

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4.2 Experimental Methods

The study selects the villa landscape in idyllic scenery, which includes man-made buildings, rivers, lawns, woods, sunlight, white clouds, et al., and the VR version of the scene also includes the perspective of the forest from the villa.

The experiment is separated into two sections and is carried out inside: stress generation and stress relief. In "Stress Guidance", we prepared two sets of logical thinking inference questions, each containing three different sets of questions. The work must be completed by the student within the allotted time.

In the pre-experiment, students responded to three sets of logical thinking inference questions: from easy to difficult. They have the opinion that it is really challenging to finish all three sets of inquiries within the allotted amount of time. During the question, students' emotional states include stress, exhaustion, stress, and curiosity about whether other students can complete tasks as required. The participants' overall levels of stress increased as a direct result of the questions.

After completing the stress test, students are asked to view a one-minute picture of the natural landscape and a VR immersive image. Following the completion of the quiz and the healing process, the students will be asked to complete the PRS scale. This comes from the scale design proposed by scientists such as Hartig in 1997, and we reallocated it according to the four dimensions of attention recovery theory.

Table 1: A scale used for experimental evaluation

Questions		Questions	
Being away	1 I'm just getting out here	12 The environment here is very charming	
	2 This is where I get some breaks	13 Nothing to see here	
	3 Here let me escape the stress for a while	14 There are so many things out here	Extent
	4 It makes me relax here	15 It has confused me here	
	5 This allows me to reduce my unnecessary attention consumption	16 It has confused me here	
Fascination	6 I feel that the scene is appealing	17 It's a mess here	
	7 Numerous fascinating things catch my notice.	18 It's perfect for me	Compatibility
	8 I wish to know more about it here	19 Here, I can do what I want do.	
	9 There is a wealth of history and interesting new attractions in the neighborhood.	20 I simply feel like I belong here.	
	10 I hope to spend more time admiring around	21 I can enjoy the joy in it here	
	11 It's boring	22 I can enjoy the joy in it here	

4.3 Statistical Methods

The intraclass correlation coefficient (ICC) is used to evaluate the dependability of inter-assessor consistency, while Cronbach's alpha is used to estimate the dependability of internal consistency. The Pearson Correlation measures the connection between two variables. Coefficient computes the correlation between each entry's scores and the total score, using exploratory factor analysis to find structural validity and univariate ANOVA to analyze the Perceptual Resilience Scale assessment values and Tukey's test of statistical significance compares outcomes in a variety of situations. For descriptive statistics, the SPSS application is often used.

4.4 Analysis of Results

4.4.1 Reliability Analysis

Each scenario and dimension of the perceptual resilience scale has strong reliability, and Cronbach's α value is between 0.60 and 0.82. The α value of the relevant dimensionality content is around 0.72.

At the same time, a consistent analysis of the scale data submitted by 30 students showed that the overall correlation was $p < 0.001$, and the four dimensions (distance, attractiveness, extent, and compatibility) $p < 0.001$

Table 2: The average score and reliability interval of the test values of the subjects

Being away		Fantastic		Extent		Compatibility	
Natural Images	VR	Natural Images	VR	Natural Images	VR	Natural Images	VR
1.8	3	2.5	2.625	4.25	3.5	2.2	3
1	3	2.625	3.625	3.5	3.25	3.4	2.4
2.4	3.4	2	2.875	3.75	3	2.6	3
2	2.8	2.75	3.25	3.75	2.75	2.2	3
2.6	3.2	2.25	2.375	1.75	1.5	1.4	1.8
2	4.4	3.125	4.375	2.75	4.75	2	4
2.6	3.6	2.625	3.5	3.75	2.5	2.4	2.8
2.4	3.4	2.75	3	2.75	2.75	2.6	3.6
3.4	3.6	3	2.625	2.75	2.75	2.8	3.2
3.8	4.2	3.25	3.5	4.5	2.25	2.8	2.4
3.4	4	3	3.125	3	2.25	2.8	3.6
3.2	3.6	3.25	3	3.75	2	3.2	4
3.2	3.8	3.5	3.375	3.25	2.25	2.6	2.8
3	4	3.125	3.125	2.75	2.25	3.6	3.6
3.8	2.6	2.625	3.375	2	1.75	3	4.6
3.4	4.6	3.25	2.75	2.25	1.75	3.4	3.4
3.4	3.6	2.875	3.25	2	2	3	4
3.4	4	2.75	3.5	2.5	2	3	4.4
3.4	4	3.75	2.625	3	1	3.8	3.8
3.4	4.4	3.375	3	2.25	1.25	3.6	3.2
4.4	4.2	3	3.375	1.75	2	3.4	4.2
4.4	4.2	3.125	3.375	2	2.25	4.2	4.4
4.2	4.2	3.5	3.375	1.25	1.5	3.6	4.4
4	4.8	3.375	3.875	0.25	1.75	4.4	4.4
5	5	3.875	3.25	1.5	1	3.6	5
4.6	5	3.5	3.875	1	1.75	5	4.2
4.8	4.8	4.125	3.5	1.75	1	5	4.8
4.4	4.2	3.375	3	2.25	1.75	3.8	3.8
3.8	4.2	3.125	3.375	1.75	2	3	4.6
1.8	3	2.625	3.375	2.75	2.25	2.6	2.8
3.296296296	$\alpha=0.68$	3.069444444	$\alpha=0.65$	2.583333333	$\alpha=0.71$	3.17030303	$\alpha=0.74$

*The four dimensions (distance, attractiveness, extent, and compatibility) $p < 0.001$.

4.4.2 Validity Analysis

Content validity, sometimes referred to as surface accuracy or rational validity, relates to the representativeness and adequacy of the questionnaire scale's content. A correlation coefficient links the overall score of the problem to the score of each question. The scale may be predicted with greater accuracy the stronger the association. The more reliable the material, the better. According to SPSS data analysis, the correlation coefficients with each measure were between 0.5 and 0.8.

The experiment analyzes the dimensions of the scale, and the first dimension has a large load of 1 to 5 items, mainly from whether the environment can divert direct attention and relax the spirit to reflect the restorative characteristics of the environment, which is consistent with the "far away" in theory. The second dimension has a large load in 18 to 22 entries, which reflects whether the environment meets people's wishes and needs, highlighting aspects of setting and social dynamics. The "compatibility" of the idea provides trustworthy evidence.

The third dimension has a larger load in entries 9 to 10 and 13, and the fourth dimension has a larger load in entries 6, 11, and 12. Judging from the text of

the article, the third and fourth dimensions are consistent with the "charisma" in the theory, the difference is that the third dimension emphasizes the environmental exploration that environmental charm may trigger, while the fourth dimension is stronger than the attractive qualities of the environment can be seen as the two aspects of "charisma".

In general, the results of the evaluation of two different representations of natural scenes using this scale are basically in line according to the framework of attention recovery theory, and there is a strong correlation between the entries.

5 CONCLUSIONS

In the assessment of the resiliency of nature and its ecosystems, the participant is usually stressed by short-term pressure guidance (Hartig T., et al., 2003), the amount of hydraulic pressure is then determined by how much contact there is with nature. Usually, the short-term pressure guidance method is selected, on the one hand, for the consideration of experimental design, so that the subjects can accept the same degree of pressure within a certain period. Effectively controlling heterogeneity between participants and homogenizing samples; Otherwise, if one were to subscribe to the theory of psychological growth, humans can experience stress in a matter of minutes and respond to their natural environment. This has been confirmed in a series of experiments, establishing a theoretical and scientific foundation for short-term pressure guiding. However, it should also be noted that the pressure formed by short-term pressure guidance is very different from the pressure accumulated in long-term work and life; The effectiveness of environmental restoration will also be affected by exposure duration and pattern. Future research should focus on and investigate the cumulative impacts of stress as well as the ongoing effects of natural touch.

This paper mostly talks about how the perceptual healing scale can be used to judge the state of the natural surroundings in VR images and examines the reliability and validity of the evaluation of different types of information presentation. The findings indicate that the scale has strong reliability and validity, and that its dimensions are more congruent with the four aspects of attention recovery theory.

Based on the results of various studies, it was found that the static photos of the same research materials and the virtual natural scenes in the VR images could significantly improve the subject's restorative subjective feelings (Valtchanov D, et al,

2010), and so on. The virtual natural environment in which the panorama is immersed as the material for research is significantly better than the flat picture (Browand MHM., et al, 2020).

In the distinction between different two different content presentation methods, the scale has a sensitive degree of differentiation, and the recovery of natural scenes in virtual immersive spaces is significantly better than that of two-dimensional pictures. We hope you find the information in this template useful in the preparation of your submission.

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