



An Experiential Study of an Immersive Virtual Reality Mental Relaxation Game

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Abstract: By using a questionnaire, this paper does an experiential study on an immersive virtual reality mental relaxation game. The selected game which designed and developed by the author is called *Journey of Relaxation*. Then this paper does an evaluation of the experience of the game using the Game Experience Questionnaire; Next this paper does a study of the game's presence using the Presence Questionnaire. Next this paper does a study of the relaxation effects of the game using the State-Trait Anxiety Questionnaire. The results show a significant decrease in anxiety state after the experience, the relaxation effect is remarkable. There is a high correlation between the effects of mental relaxation and immersive virtual reality environments, relaxation is better in immersive than non-immersive environments. The more immersive the environment, the higher the sense of presence, the lower the level of anxiety state, and the more relaxed the player feels.

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Keywords: immersive virtual reality; experimental study

1. Experience evaluation of immersive virtual reality psychological relaxation games

1.1 Experimental content

Usability is an important indicator of interactive products, which is the degree to which users think the product is effective, easy to learn, efficient, easy to remember, less mistakes and satisfactory, and is the core of product competitiveness. Through usability testing, we can find out the problems existing in the product before launching the official product, analyze the reasons behind it, change the places that do not meet and affect the use of users, re-test the iterated product, and release the product after achieving the expected effect, which can save the cost of the enterprise, expand the product revenue, and enhance the economic interests.

However, the game experience is different from traditional user experience testing methods. Traditional user experience metrics such as time to completion of tasks, success rate of completion of tasks, etc., do not apply to games. Traditional human-computer interaction applications are based on increasing productivity, and thus creating as few dilemmas as possible for the user, deliberately designing puzzles and dilemmas in the game to challenge the player. Traditional human-computer interaction applications should try to maintain the consistency of the experience, while games should provide different and rich experiences as much as possible. Based on preference, gender, age, experience, and so on, different people have different feelings about games. Based on this consideration, this study adopts the

subjective questionnaire method to evaluate the experience of the virtual reality game "Relaxation Journey" designed by the author. Specifically, the Game Experience Questionnaire (GEQ) designed by I Jsselsteijn et al from Eindhoven University of Technology in the Netherlands, which is derived from their results in the Game Experience Lab of the university, is taken. The questionnaire has been translated into many languages and successfully used in several research projects around the world [1].

The questionnaire consists of seven components, Competence, Sensory and imaginative immersion, Flow, Tension/Annoyance, Challenge (Challenge) Negative affect (negative) and Positive effect (positive) a total of 33 items. Using a five-level Richter scale, subjects were given scores from 0 to 4 to indicate degree of agreement: 0 being not at all, 1 somewhat, 2 medium/moderate, 3 fairly, and 4 very. Since the purpose of this game is to obtain psychological relaxation, users can choose levels according to their wishes, and the story of the game is not designed. "I am interested in the story of the game" in project 3 is not in line with this design, and Project 3 is deleted. Since the game has no time limit and players are not required to complete a certain goal within the time, item 33 is deleted, so the remaining 31 items are selected as the final questionnaire. Among them, items 2,9,14,16,20 belong to competency; 11,17,18,26,29 are perceptual and imaginative immersion; Items 4,12,24,27,30 are flow; Items 21,23,28 are stress/worry; Items 10,22,25,31 are challenges; Items 6,7,8,15 are

negative emotions; Items 1,3,5,13,19 are positive emotions. In order to obtain reliable data, the 31 items representing the seven components were arranged in order so that the subjects were not affected by the classification, as detailed in Appendix 1.

1.1.1 Experimental purpose

The game experience questionnaire was used to conduct measurement and experience analysis for this design, and the experience effect of the designed virtual reality psychological relaxation game "Relaxation Journey" was measured in seven dimensions of competence, perceptual and imaginary immersion, flow, tension/annoyance, challenge, negative emotion and positive emotion. Analyze and learn from the results to improve the game experience.

1.1.2 Experimental conditions

In order to meet the smooth experience and immersion of virtual reality games, it is necessary to have an independent room without being disturbed, a desktop computer equipped with high-end graphics card and processor, a set of helmet display, Arduino microcontroller connected to the computer through USB, and Arduino fan module and heart rate sensor. Design of the "Relaxing journey" game software, a pair of gamepad, mouse, keyboard, a pair of hi-fi headphones, choose a comfortable computer rotating chair, convenient for users to turn and operate after wearing a helmet.

1.1.3 Experimental subjects

Ten young people aged 20 to 30 were selected as test subjects, all of whom had received or were receiving higher education, had gaming experience, and were interested in virtual reality but had not used virtual reality headsets.

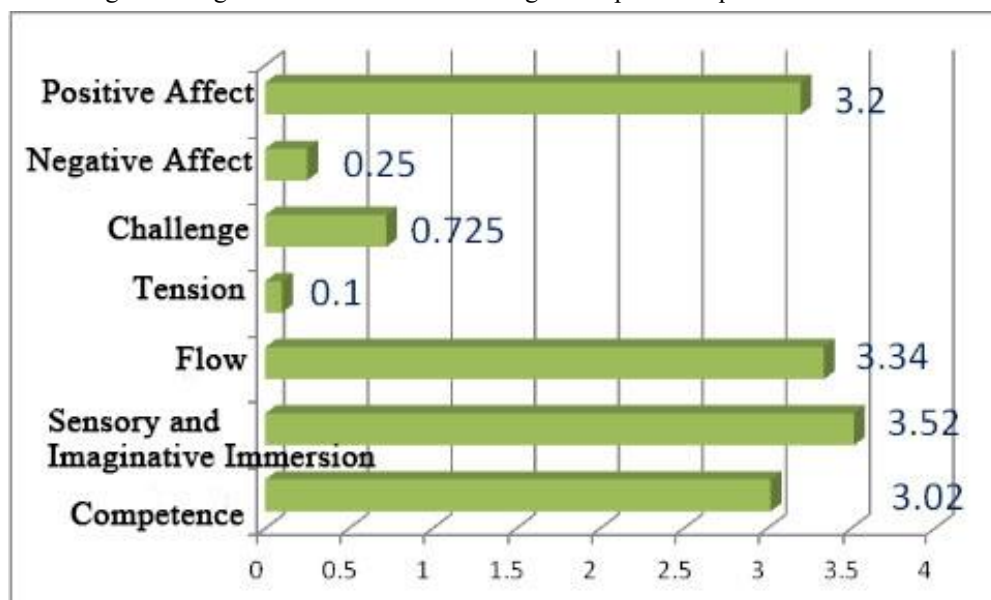
1.1.4 Experimental process

Firstly, the purpose and game content of this experiment are introduced to the test subjects. Firstly, the method of helmet use, the method of heart rate sensor wearing and precautions are explained to the test subjects. The test subjects are informed that they can end the test themselves if they have any discomfort during the experience, and the test subjects are allowed to choose the input mode of gamepad or mouse and keyboard to play the game. Then they put on the device and the heart rate sensor. When the tester is ready, he enters the game session without interfering with his operation. After the game was over, the testers were asked to fill out the game experience questionnaire. Finally, thank the tester for their participation, and ask if the tester has any other questions or comments to end the test.

1.2 Result analysis and discussion

Collect 10 valid questionnaires from all the testers, sum up each data to calculate the average value, as shown in Figure 1, and then calculate the average value again in the seven factors of game experience, as shown in Figure 2:

Fig. 1 Average values of each item in the game experience questionnaire



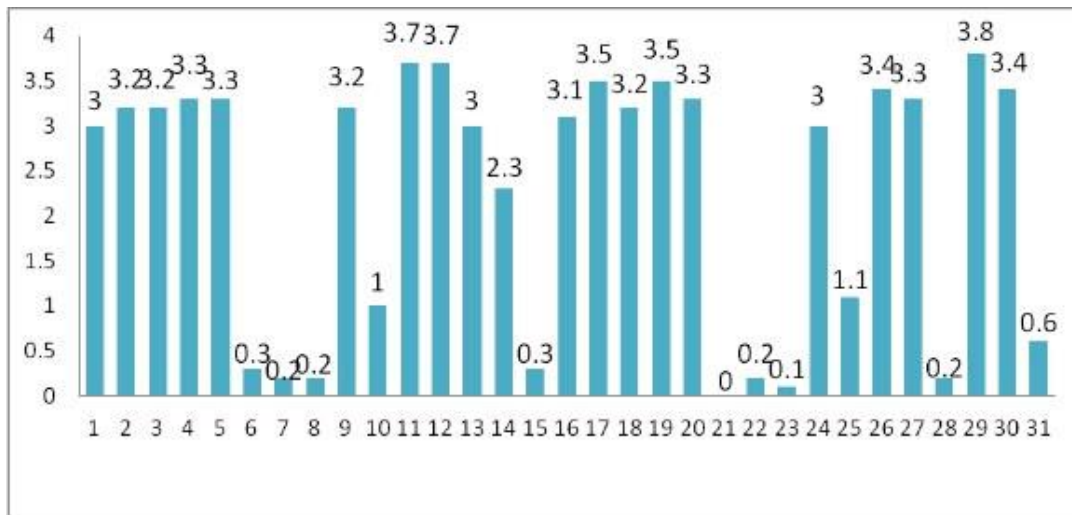


Fig. 2 Aggregate average of the seven dimensions of game experience

The average score was 3.2 for positive emotion, 0.25 for negative emotion, 0.725 for challenge, 0.1 for tension/annoyance, 3.34 for flow, 3.52 for perceptual and imaginative immersion, and 3.02 for competence. As can be seen from the figure, the design achieved high scores in positive emotion, flow, perceptual and imaginative immersion, and competency, and low scores in negative emotion, challenge, and tension/annoyance. The highest is divided into perceptual and imaginative immersion, and the lowest is divided into tension/annoyance, which is in line with expectations. Using the helmet-mounted display, the game achieved high scores in the flow and immersion sections, indicating that the immersion was verified, and many testers found the game aesthetically pleasing and enriched their experience. There is no absolute win or lose in the game, and the design that players can jump between levels at will ensures a high score of competency. The purpose of the game is to relax, so the difficulty design tends to be easy. In the three low scores, the highest challenge component indicates that the game has a certain degree of difficulty, which is because the tester's first contact with virtual reality, both operational and cognitive learning needs a period of time. In short, players feel good in the game, physical and mental pleasure, immersed in it, the body and mind are occupied by the game, think that the difficulty of the game is relatively easy, there is basically no trouble and tension in the game, the game is a little challenging but can be overcome.

Through experience and analysis, virtual reality games are very different from traditional games. First of all, the way of game and interaction are different, because the vision is completely covered, new input methods must be adopted, and in order to pursue

immersion, virtual reality is more appropriate to take the natural human body interaction rather than keyboard input. At this stage, there is no unified input method, there are mouse, keyboard, gamepad, motion control, etc. Each input method will bring different interactive ways and game experience. The second is the difference in game content and how players interact with it. The game content in virtual reality games is more exquisite than that in traditional games, and the details of in-game objects are more abundant to simulate reality. Players observe the objects in the game carefully in the game, while traditional games go straight to the result and ignore the objects in the game scene. In the end, gameplay gives way to immersion. Being immersed in a virtual reality game allows the player to have a presence experience, and staying immersed is the primary goal of a virtual reality game. Players enjoy interacting with elements of the virtual world even without any gameplay, and if the immersion is broken and there is no sense of presence, no matter how good the game is, the player's experience will be diminished.

2. Research on the presence of immersive virtual reality mental relaxation games

2.1 Experimental content

According to the game experience questionnaire, this design has the highest score of immersion component, indicating high immersion. In order to further study the factors affecting the acquisition of the sense of presence when users are immersed in the virtual world, questionnaire survey method is adopted for research.

Presence is a subjective feeling, which is the user's intuitive feeling in the virtual world, so subjective reporting is the most suitable measurement method.

Most of the existing studies have adopted the method of post-test questionnaire. This study uses the Presence Questionnaire by Bob G. Witmer and Michael J. Singer [2]. Currently, 24 items in the third edition of the questionnaire are classified into seven factors affecting the sense of presence: They are Realism, Possibility to act, Quality of interface, Possibility to examine, and Self-evaluation of performance, Sounds, and Haptic. Among them, the possibility of careful observation refers to the possibility that the user can carefully observe the object in the virtual world, and performance evaluation refers to the user's performance in virtual reality. On the basis of the seven-level semantic difference scale, the questionnaire set up a middle point in the fourth level, where 1 means not at all, 7 means very, and the middle point means medium. Among the 32 items, items 3, 4, 5, 6, 7, 10 and 13 represent the degree of authenticity. Manipulative items 1, 2, 8, 9. Items 14, 17 and 18 represent the quality of equipment. Items 11, 12 and 19 represent possibilities for careful observation. Items 15 and 16 represent performance evaluations. Hearing is 20, 21, 22. Items 23 and 24 represent the sense of touch. Statistical data of 32 items, except items 14, 17, 18 for the reverse order, the remaining items to obtain data between 6 and 7 is identified as a high score, 4 to 6 is medium, 1 to 3 is low.

2.1.1 Experimental purpose

In order to further analyze the players' sense of presence and its composition structure in the virtual reality game designed in this paper, the proportion of each factor affecting the sense of presence and its specific reasons are analyzed.

2.1.2 Experimental conditions

It is the same as the game experience evaluation, so I won't go into details.

2.1.3 Experimental subjects

It is the same as the game experience evaluation, so I won't go into details.

2.1.4 Experimental process

First, briefly introduce the test content, game content and game equipment, then help the tester to wear the corresponding equipment, the tester to experience the game, and fill in the presence questionnaire after the end.

2.2 Result analysis and discussion

The average value of each data in the presence questionnaire was calculated by adding up, and a bar chart was drawn, as shown in Figure 3. Then they were classified into the seven factors affecting the sense of presence, and the average value was calculated again, as shown in Figure 4.

Fig. 3 Average value of each item of presence perception

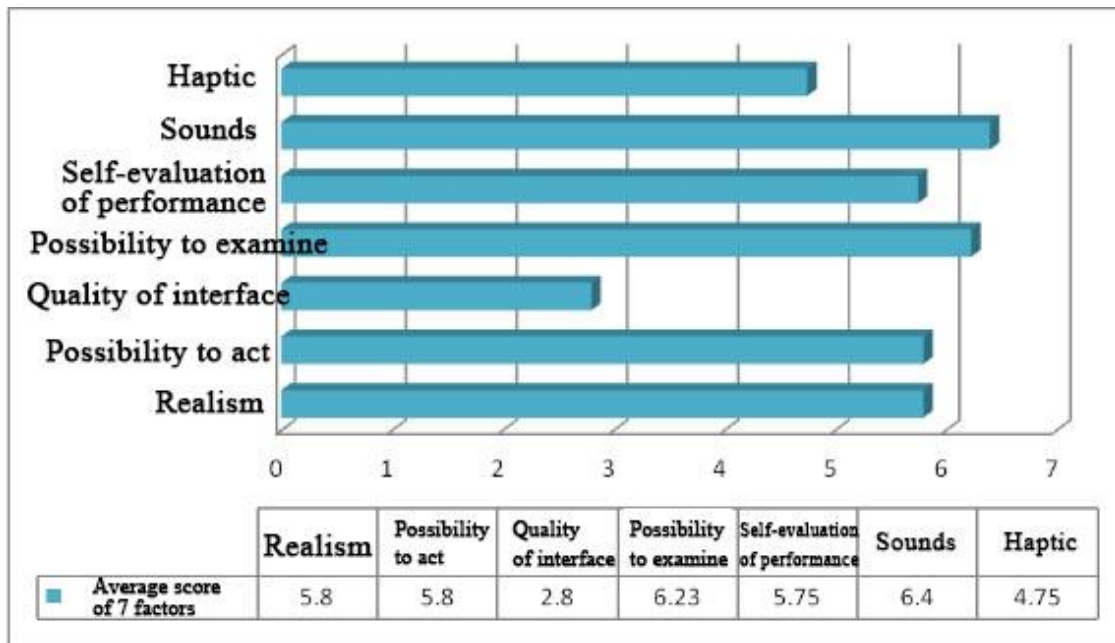
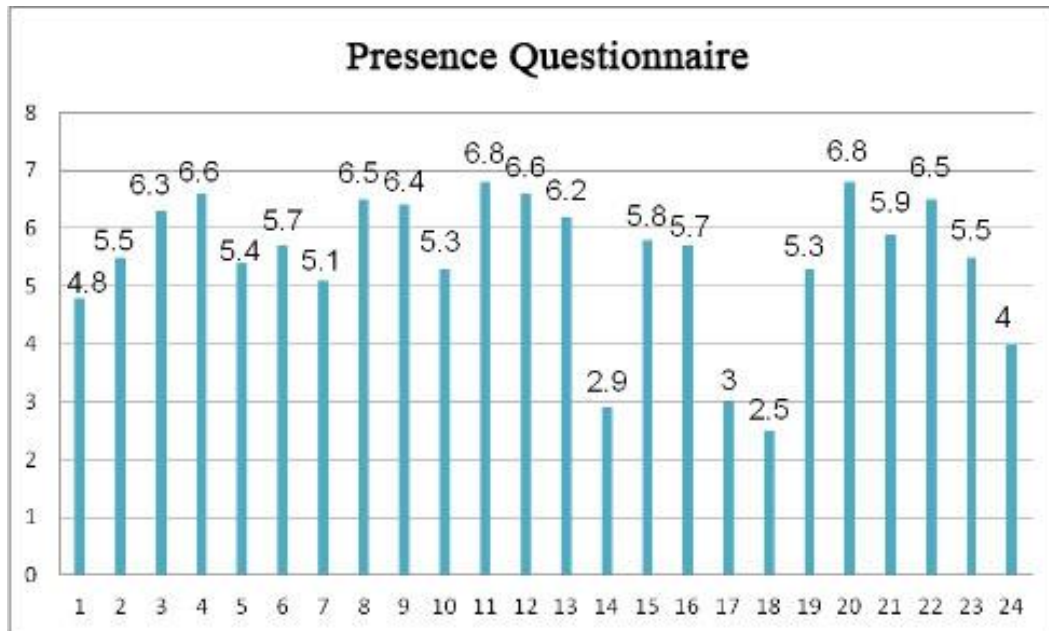


Fig. 4 Total average score of the seven factors affecting the sense of presence



According to the principle that score 6,7 is high score, 4 to 6 is medium score, and 1 to 3 is low score (the factor of equipment quality is in the opposite order), we can see from Figure 4-4 that among the seven factors of the design's sense of presence, the possibility of careful observation, the score of equipment quality and auditory factor is high, and the score of reality, controllability, performance evaluation and tactile factor is medium. Among the factors that affect the sense of presence in this design, the proportion of hearing, equipment quality and the possibility of careful observation is relatively large, indicating that the use of sound in the game, the equipment in the game and the possibility of carefully observing objects in the game are the main reasons for players to acquire the sense of presence. The sound of the game is used well, the game uses 3D sound, so that the sound produces a sense of space, so that the player can locate the sound in the game. The quality of the game equipment is high, and the virtual reality helmet equipment used has a resolution of 1920*1080 and a desktop computer with high graphics card computing power to basically meet the game performance requirements. The high score for the possibility of careful observation is attributed to the use of head position tracking devices, which allow players to lean down close and view every detail of the virtual world from different angles, which is especially important for gaining a sense of presence. The realistic factors, manipulative factors, performance evaluation factors and tactile factors that affect the sense of presence in this design account for a moderate proportion, indicating that the virtual world in the game

is relatively real, and the control needs to be improved. The game performance of the players is at a moderate level, and the use of tactile factors is acceptable. The score of reality factor is at a medium level, indicating that the virtual world designed in this design looks more natural and the game world performs well. However, because walking in the virtual world is by keyboard or controller, the difference between it and natural walking is large, which violates the authenticity to some extent, leading to low score. The reason why the manipulative factors and performance evaluation factors are not high may be because virtual reality games are completely new experiences. The reason why the tactile factors affect the player's sense of presence is not high is that only a few places in this design can use the sense of touch, the equipment is relatively simple, the technical content needs to be improved, and the tactile feedback is not real and detailed enough. However, some testers still say that the use of the sense of touch in this design is highly integrated with vision, hearing and environment, which improves the sense of presence to a certain extent.

According to the analysis of the results, the design should pay attention to the following points in the future improvement: first, give the player a beginning to gradually adapt to the virtual reality process rather than directly into the scene, do a good job of novice guidance, patiently answer the questions of novice players. Second, make the walking and movement of players in the virtual environment more natural. Considering that some players will have virtual motion sickness and dizziness will occur when walking, the design has added the mode of instantaneous transfer to various relaxation places to

replace walking, but the needs of players roaming in the scene should not be ignored, and a more natural walking operation mode should be adopted, such as lowering the head to stop and walking with the head up in the game. Third, increase and improve the haptic output, add more ways to experience haptic output, explore other haptic interaction ways, further enrich the player's experience and enhance the sense of presence. Four, give the player a reason to look around. An interesting phenomenon is that many players who use virtual reality for the first time do not turn their heads to look around them, they are used to the habit of using a flat display, and do not realize that the virtual reality world is a 360-degree immersive space rather than a flat surface, and can take visual and auditory cues to guide the user's attention to look around.

3. Study on the relaxation effect of immersive virtual reality psychological relaxation games

3.1 Experiment Content

The State-Trait Anxiety Inventory (STAI), compiled by Charles Spielberger in 1970 and translated into Chinese in 1989, is used to measure the relaxation effect of users. There are 40 entries in total, divided into two parts: the state version and the trait version of anxiety. The former part represents the severity of the subject's current anxiety symptoms, and the latter part represents the subject's consistent or usual anxiety. A four-level scale is used, with 1 indicating none at all, 2 indicating some, 3 indicating moderate, and 4 indicating very obvious. As the test is the relaxation effect of players experiencing the game, it is a short-term emotional experience. However, the latter represents a relatively long-term anxiety tendency as a personality characteristic, which is not consistent with the situation of this study. Therefore, the first 20 items representing the anxious state are selected, that is, the state anxiety questionnaire measures the degree of relaxation. The higher the total score, the more anxious the user is, the more relaxed the user is. Among them, items 1, 2, 5, 8, 10, 11, 15, 16, 19 and 20 are scored in reverse order. See Appendix 3 for a table.

3.1.1 Experimental purpose

The purpose of this experiment is twofold: first, to test the relaxation effect of the immersive virtual reality game "Relaxation Journey", and then to prove the hypothesis of this study that the relaxation effect of the immersive virtual reality relaxation method is better than that of the non-immersive traditional relaxation method.

3.1.2 Experimental subjects

It is the same as the game experience evaluation, so I won't go into details.

3.1.3 Experimental conditions

It is the same as the game experience evaluation, so I won't go into details.

3.1.4 Experimental process

This experiment is divided into two parts. For the accuracy of the study, only the scene of Spring in the Relaxing Journey of this design is used as the experience object. In the first part, questionnaires are used to test the relaxation effect of this design. The steps are as follows: firstly, the test subjects are asked to fill in the state-trait anxiety questionnaire before playing the game, and then the test subjects experience the game and fill in the state-trait anxiety questionnaire again after playing the game. In the second part, to verify whether the relaxation effect of the immersive virtual reality relaxation method is better than that of the non-immersive traditional relaxation method, a desktop non-immersive computer version of the Spring level in the Relaxation Journey was specially made. 10 testers who had not experienced the immersive version were selected to fill in the state-trait anxiety questionnaire after experiencing the game. The questionnaires were collected and compared with those of the participants who had experienced the immersive version in Part 1.

3.2 Result analysis and discussion

3.2.1 Study on relaxation effect

Twenty valid questionnaires were collected, which were state anxiety questionnaires of 10 subjects before and after the experience. The average score was calculated by adding up the data of each sub-paper. SPSS statistical analysis software was used to analyze the data, and the average score of the state anxiety questionnaire of the subjects was 41.6 before the experience and 28.9 after the experience, indicating that the anxiety state of the users had significantly decreased and the relaxation effect was obvious, as shown in Table 1-1. The standard deviation after experience is greater than before experience, indicating that the distribution of anxiety state after experience is uneven, and there are great differences in the acceptance of virtual reality psychological relaxation games, which may be caused by factors such as virtual reality experience is completely different, players' acceptance is different, and their reactions to motion sickness are different. In order to further test the influence of pre-experience and post-experience on the anxiety level of players, SPSS statistical analysis software was used to conduct correlation analysis on the two groups of data. The data was quantitative and the correlation coefficient was Pearson. The results are shown in Table 1-2, which shows that the correlation coefficient is 0.831, the significance level is 0.003 is less than 0.01, and the null hypothesis is rejected. The two are related. This indicates that the anxiety state before and after

experience is highly correlated, and the anxiety state is relieved and the psychology is relaxed after experiencing the virtual reality relaxation game.

Tab. 1-1 Mean and standard deviation of anxiety questionnaire scores before and after playing the game

	pre-experience	After the experience
Mean value	41.6	28.9
Standard deviation	1.955	2.025

Tab. 1-2 Correlation between pre - and post-experience anxiety questionnaire scores

	Before and after the experience
Person correlation	0.831
Significance (bilateral)	0.003

3.2.2 Correlation between immersion and psychological relaxation

In order to demonstrate the hypothesis of this study that immersion in a virtual reality environment can achieve better relaxation effects than in a traditional non-immersive environment, the anxiety state questionnaire of 10 subjects after experiencing psychological relaxation in an immersive environment was compared with the anxiety state questionnaire of 10 subjects who played a relaxation game in a non-immersive environment. SPSS statistical analysis software was used to do correlation analysis of data in immersive and non-immersive environments. The data are quantitative data, and the correlation coefficient is Pearson. The results are shown in Table 1-3 and Table 1-4. The mean value is 28.8 in immersive environment and 35.6 in non-immersive environment, and the correlation coefficient is 0.987, and the significance level of 0.000 is less than 0.01. It shows that the relaxation effect in immersive environment is better than that in non-immersive environment, and whether the environment is immersed or not is highly positively correlated with the relaxation effect, indicating that the more immersive the environment, the more the user can obtain presence, the lower the level of anxiety, the more relaxed the player. This paper demonstrates the hypothesis that users can obtain better presence in immersive environment, and better sense of presence is conducive to obtaining better psychological relaxation effect.

Tab. 1-3 Mean and standard deviation of anxiety questionnaire scores in immersive and non-immersive environments

	Immersion environment	Non-immersive environment
Mean value	28.8	35.6
Standard deviation	2.201	1.647

Tab. 1-4 Correlation of anxiety questionnaire scores in immersive and non-immersive environments

	Immersive and non-immersive environments
Pearson correlation	0.987
Significance (bilateral)	0.000

4 Summaries

This paper studies the experience of immersive virtual reality mental relaxation games by using questionnaires. It consists of three parts. First, the game experience questionnaire is used to analyze seven factors that affect the game experience, namely, competence, perceptual and imaginary immersion, flow, tension/annoyance, challenge, negative emotion and positive emotion. The results show that the design has a high level of positive emotion, flow, perceptual and imaginary immersion and competence, and a low level of negative emotion, challenge and tension/annoyance. Analyzing the difference between virtual reality games and traditional games, we find that the two interact differently, the game content and the way players

interact with it are different, and the immersion of virtual reality games is more important than the gameplay. Then, the influence factors of acquiring the sense of presence in the immersive virtual world and the proportion of each factor are studied by using the sense of presence questionnaire. The results of the study showed that the design has a high possibility of careful observation, equipment quality and auditory factors, medium realism, manipulation, performance evaluation and tactile factors. The reasons are analyzed and some suggestions are put forward to guide the virtual reality game for beginners, make the walking and movement of the players in the virtual environment more natural, improve the tactile output and give the players reasons to look around. Finally, state anxiety questionnaire was used to test the

relaxation effect of immersive virtual reality games, and to prove the hypothesis of this study, that is, the relaxation effect of immersive virtual reality relaxation methods is better than that of non-immersive traditional relaxation methods. Studies have shown that the anxiety state after the experience is significantly reduced, and the relaxation effect is significant. The effect of psychological relaxation is highly correlated with the immersive virtual reality environment. The relaxation effect in the immersive environment is better than that in the non-immersive environment. The more immersive the environment, the higher the sense of presence, the lower the level of anxiety state, and the more relaxed the players are, which proves the hypothesis.

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