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Application of Virtual Reality Technology in Medical psychology

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Abstract: *Virtual reality (VR) is a computer-generated three-dimensional environment simulation. With VR, people can interact with computers in seemingly realistic ways. In recent years, with the booming development of VR industry, more and more VR technologies have been applied to the practice of Medical psychology. The application of this technology in the practice of Medical psychology can disperse and transfer patients' attention to physical discomfort, alleviate the pain caused by disease and treatment, reduce negative emotions, enhance treatment confidence and compliance, and improve the quality of life. Taking the four main application fields of remote clinical consultation and nursing, psychosomatic disease, cognitive dysfunction intervention and motor function rehabilitation of stroke patients as examples, this paper expounds the status and progress of virtual reality technology in the practice of medical psychology.*
Keywords: *Virtual reality; Medical psychology; Clinical practice*

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I. Introduction

Virtual Reality (VR), also known as spiritual technology, is an important direction of simulation technology. It combines simulation technology, computer graphics, network, artificial intelligence, multimedia, multi-sensor technology and parallel processing technology to create a humanized multi-dimensional information space, simulating the functions of human hearing, vision, touch and other sensory organs, with the help of professional devices such as sensor helmets and data gloves, allow users to enter virtual spaces, perceive and operate objects in the virtual world, and communicate with the system in real time through human natural means such as language and gestures, obtaining a real feeling of immersing, thereby relaxing emotions, acquiring knowledge, deepening understanding, and sprouting creativity [1].

VR has the following four main characteristics: First is multi-channel perception. In addition to the visual perception that ordinary computers have, there are also auditory perception, tactile perception, motion perception, and even sensory characteristics such as taste and smell. The ideal VR should have all the perceptual functions that humans possess. Second is presence, also known as immersive, which refers to the degree to which users feel that they are the protagonist in a simulated environment, to the extent that virtual situations make it difficult for users to distinguish between true and false. Third is interaction, which refers to the degree to which participants can manipulate objects in a virtual environment and the natural degree to which they receive feedback from the environment (including real-time performance). For example, he can use his hands to directly grasp an object in a virtual environment. At that time, he has a feeling of holding something in his hand and can feel the weight of the object, and the object caught in the field of view also immediately moves with the movement of his hand. Final is imaginative, which refers to the degree to which objects in a virtual environment move autonomously according to the requirements of the operator and their respective motion models and rules. For example, when pushed by an external force, an object will move in the direction of the force, flip over, or fall from the desktop to the ground.

The concept of VR was first proposed by VPL Exploration Company and its founder Jaron Lanier in the mid-20th century. Later, NASA's Ames Space Center took the lead in developing low-cost virtual reality systems using popular LCD displays and other devices, promoting the advancement of VR hardware. With the development of computers and human-computer interaction methods, VR is gradually penetrating into various professional fields, such as aerospace, military, communication, medicine, education, art, entertainment, architecture, and commerce. In the past 20 years, more and more researchers have applied VR to medical psychology and achieved good results.

II. Application of VR in Medical Psychology

2.1 Application in Remote Diagnosis and Care

State University of New York [2] has developed an electronic glove, which collects the feeling of medical staff's hands when giving physical examination to patients through the sensors on the fingertips of the glove, and stores it into a computer database; At the same time, remote nursing staff can choose this data, and as long as they wear these gloves, they experience the feeling of personally examining the patient, which can be used for remote nursing and consultation.

2.2 Application in the Treatment of Psychosomatic Diseases

Psychosomatic diseases refer to those somatic organic diseases and somatic functional disorders that psychosocial factors play an important role in the occurrence, development and prognosis of diseases. They are a kind of diseases between somatic diseases and neurosis. There are many kinds of psychosomatic diseases, which can occur in various systems and organs of the human body, especially those dominated by autonomic nerves, such as pain, primary hypertension, diabetes, asthma, ulcer disease, ulcerative colitis, rheumatoid arthritis, hyperthyroidism, and cancer.

VR assisted treatment of psychosomatic diseases mainly utilizes the principle of distraction to shift patients' attention from uncomfortable sensations or the accompanying negative emotions to other stimuli. People can only focus their attention on one thing at a certain moment. If they shift their attention from the discomfort sensations or negative emotions to a task of interest, or a job that can concentrate their attention, they can block the connection between conditional stimuli (such as illness) and reactions (such as pain), reducing their discomfort. This is not to say that patients passively shift their attention from uncomfortable sensations to other things, masking the existing discomfort, but rather an active regulatory process that can truly reduce the response of neurons to harmful stimuli [3].

2.1.1 Application in Pain Treatment

Pain is a complex physiological and psychological response, and its nature, degree, temporal and spatial characteristics, as well as perception of discrimination and response, are all constrained by various psychological and social factors, with an extremely strong subjective color. Pain signals can be regulated by psychological factors at any level and link of transmission. Psychological factors such as attention, suggestion, and emotion can all alter pain responses. Distraction, benign suggestion and joy can reduce pain reaction. Among the many factors that affect pain experience, attention to pain is particularly important. Therefore, distraction has become an effective means of alleviating pain.

Ren Haixia et al. [4] randomly divided 160 children aged 5-8 who needed pulpotomy treatment for deep caries and were accompanied by pediatric dental fear (CDF) (120 of whom were mild CDF and 40 of whom were moderate CDF) into a mild fear VR group (Group 1, 60 cases), a mild fear notification – demonstration – operation (TSD) group (Group 2, 60 cases), a moderate fear VR group (Group 3, 20 cases), and a moderate fear TSD group (Group 4, 20 cases). Group 1 and Group 3 underwent surgery wearing VR glasses (VR group), while Group 2 and Group 4 underwent surgery using TSD behavior guidance (TSD group). The results showed that the heart rate and pain level of the VR groups during treatment were lower than those of the TSD groups, and the treatment compliance and difference in anxiety scores before and after treatment were higher than those of the TSD groups; No children in the VR groups reported eye fatigue, while 95% of the children reported being very comfortable and playing VR games was fun.

VR assisted burn rehabilitation treatment is achieved by shifting the patient's attention from pain and its accompanying negative emotions to relaxed and pleasant stimuli in the virtual world, thereby reducing pain [5] and achieving a reduction in medication dosage, enhancing the efficacy of drugs or other therapies. The treatment is safe and effective, without drug resistance, and without side effects such as constipation, nausea, vomiting, sedation, lethargy and respiratory depression caused by Analgesic.

Some scholars [6] believe that VR can reduce the subjective pain level of burn patients by 35-50%. Carrougher et al. [7] conducted VR adjuvant treatment research on 39 patients with an average age of 35 years and an average burn area of 18% in a double-blind crossover randomized controlled experiment within the subject. All patients first receive routine medication analgesia treatment, followed by two consecutive days of physical therapy, one of which is VR adjuvant therapy and the other is routine physical therapy. The treatment sequence is randomly arranged and patients are required to practice VR under the guidance of experts or therapists. Before and after each treatment, the patient's pain level and joint activity were test. The results showed that compared with conventional physical therapy, VR assisted burn rehabilitation therapy was more interesting, the pain was greatly reduced after treatment (the pain level, the time to pay attention to pain, and the pain level were reduced by 27%, 37%, and 31% respectively), and the joint mobility was improved, but it did not reach clinical or statistical significance; 97% of patients did not experience significant discomfort (such as nausea) after VR training. Faber et al. [8] conducted a comparative study on 36 patients with an average age of

27.7 years and an average burn area of 8.4%. First, routine care (such as changing gauze and cleaning wounds) is administered to the patients once, followed by 1-7 consecutive VR care sessions. The strongest pain level of patients was measured by using a visual analog scale after each nursing session. The results showed that compared to routine care, nursing operations in VR settings can significantly reduce pain. More importantly, VR intervention can effectively reduce extreme pain. A study have shown that compared to patients with mild to moderate pain, VR is more effective for patients who report the pain reaching its highest intensity (severe to extremely severe pain) during debridement [9]. Another study showed that compared to conventional wound debridement, the six patients with the highest pain intensity showed a 41% reduction in pain during VR assisted wound debridement. Teeley et al. [10] conducted a consecutive 3-day experiment on a group of fracture patients, with the first two days of VR assisted hypnosis and the third day as the baseline period (without VR assisted hypnosis). During these three days, the patients took analgesics (opioids) as usual. Test the patients' pain and anxiety levels before and after the first two days of treatment, as well as on the third day. The results showed that after the first two days of hypnosis, the patients' pain was reduced by 70%; on the third day, the patients' pain was reduced by 30%.

VR can also be applied to chronic pain management. A study [11] compared 14 randomized controlled trial, and found that compared with simple conventional care or other forms of treatment, virtual reality therapy has a significant alleviating effect on pain caused by chronic muscle or bone diseases. Compared with conventional analgesia, patients who use virtual reality assisted analgesia have significantly alleviated pain, reduced other symptoms, and improved joint mobility and motor function.

2.1.2 Application in Cancer Treatment

Cancer and its treatment are both strong stress for patients' physiology and psychology. Physically, it can cause pain, fatigue, nausea, vomiting, hair loss, sexual dysfunction and other discomfort, and emotionally, it can cause anger, depression, anxiety, guilt, hostility and other adverse reactions.

Many physical symptoms (such as vomiting, fatigue, and pain) of advanced cancer are unpredictable, long-lasting, and difficult to alleviate. This not only leads to "anticipatory anxiety" about the occurrence of symptoms, but also brings inconvenience to the implementation of traditional psychotherapy with clear time limits. VR effectively transfers patients' negative attention from the disease and is more suitable for cancer patients due to its flexibility in operating time.

The application of VR in cancer treatment mainly includes the following eight aspects: First, expanding nursing evaluation methods. VR application in cognitive appraisal and rehabilitation is designed based on environmental theory. It is close to the daily life of patients, can reflect their real cognitive level, and help them master multiple skills. The VR based cognitive appraisal and rehabilitation system for cancer patients designed by Zeng YC et al. [12] includes three modules: assessment, intervention and evaluation. The patient wears a helmet mounted display and evaluates visual and auditory memory, executive function, and speech fluency based on the prompts of VR evaluation system. Combining computer deep learning technology, the system predicts the risk of cognitive function for subjects, and then conducts cognitive rehabilitation training for them with different characteristics of cognitive impairment based on the evaluation results. This system achieves cognitive rehabilitation by providing visual, auditory, and virtual social stimuli to patients, while adjusting the difficulty and progress of training individually based on the patients' performance. The results of 21 patients show that VR cognitive appraisal and rehabilitation system are effective and popular with patients. Second, expanding health education methods. Jimenez et al [13] constructed a virtual environment radiotherapy training course, and studied the degree of mastering radiotherapy knowledge and its psychological impact through a quasi-experiment conducted on 37 patients with breast cancer. In addition to conventional health education, 19 patients in the experimental group also received a 1h of virtual environment radiotherapy training course to present radiotherapy process, thoracic anatomy, radiotherapy dose and other relevant information through the virtual environment; The control group of 18 patients only received routine health education; The results showed that the experimental group had a better mastery of radiation therapy knowledge than the control group. The VR course has rich visual content and diverse forms, visually presenting the radiotherapy process, helping patients understand the principles and advantages of radiotherapy, enhancing their treatment confidence, and expanding the form of health education. Third, reducing the fatigue. VR based exercise can effectively alleviate fatigue caused by cancer and its treatment [14]. Hoffman et al. [15] conducted 10 weeks of VR walking exercise with home as the main venue on 7 non-small cell lung cancer patients who underwent thoracotomy. The patients could increase their walking time once a week as needed, and after the walking exercise, they underwent VR balance exercise. The results showed that the average score of fatigue decreased from 4.8 to 1.32 points. Schneider et al. [16] conducted a cross design experiment on 20 patients with breast cancer who received intravenous chemotherapy. During chemotherapy, patients wore a headset and selected favorite scenes from deep-sea diving, visiting art museums or solving puzzles. The results showed a decrease in fatigue scores among patients who used VR during chemotherapy. A meta-analysis by Zeng et al. [17] showed that VR based interventions can significantly improve cancer-related fatigue symptoms, improve quality of life, and increase survival opportunities by reducing treatment-related pain. When patients wear VR devices, they can find the joy brought by the virtual world and enjoy a more comfortable experience mentally, thereby reducing fatigue. Fourth, relieving negative emotions. VR creates an immersive feeling for patients, immersing them in the virtual world, breaking away from real pain, and effectively alleviating negative emotions. Chirico et al. [18] conducted research on patients with breast cancer, and found that VR can alleviate anxiety and improve depressive mood more than music therapy and conventional nursing. House et al [19] used the VR rehabilitation training system to conduct cognitive and limb rehabilitation training for 6 patients with breast cancer in the community by means of color matching or card matching in the game library. The results showed that the average score of depression was 8.3 points lower than that before the intervention, and the fear of movement of the affected limb was significantly reduced. Baños et al. [20] engaged 19 cancer metastasis patients (aged 29 to 85 years, with an average of 60.9±14.54 years, including 10 males) in a VR navigation game for a total of 4 times (30 minutes per session) over a week to stimulate their pleasure and relaxation emotions. Before and at the end of each game, patients' emotional states were tested using a visual simulation scale, and relevant qualitative data was collected using an open-ended questionnaire. The results showed that the patient believed that games were not very difficult, and even if occasional difficulties could be solved through practice. They feel that games are very enjoyable and practical, which can divert attention from their physical condition, relax body, and alleviate negative emotions. When 11 cancer patients (7-15 years old) received chemotherapy, Schneider et al.[21] asked them to experience one of the three stories of "The Magic Carpet Story of One Thousand and One Nights", "The Legend of Sherlock Holmes" and "The Seventh Guest" through the VR system. The Symptom Pain Scale and State Anxiety Scale were used to assess the degree of symptom pain of the children. The results of one-way repeated measurement analysis of variance showed that VR can alleviate the pain of the children receiving chemotherapy, but the effect is not long-lasting; the patient's state anxiety level was high during the first chemotherapy, but decreased during subsequent chemotherapy sessions. Schneider et al. [22] conducted a meta-analysis of three studies, and 137 cancer patients (breast cancer, lung cancer or colorectal cancer) were included in the analysis. These studies adopted a double-blind crossover experimental model, and patients all needed two matching intravenous chemotherapy. In one of the chemotherapy sessions, patients were randomly assigned to a group that only received routine chemotherapy or also received VR intervention. Multivariate regression analysis was used to explore the influencing factors of time perception of chemotherapy. The possible influencing factors included treatment methods, demography variables, disease types, fatigue scale scores and state anxiety scale scores. The results have proved that VR can change the time perception of chemotherapy, making patients feel that the time of chemotherapy is significantly shortened. Regression analysis showed that the three variables of disease type, gender and anxiety explained most of the variation of time perception change of chemotherapy ($F=5.06$, $P=0.0008$). Among them, disease type is the most important predictor of time perception change. Patients with breast cancer and colorectal cancer will feel that time passes faster, while patients with lung cancer are not easy to have this feeling. Li et al. [23] used a pre-post-test unequal group control experiment to divide 122 hospitalized cancer children in an oncology department into a control group (70 people) and an experimental group (52 people). The control group received routine care, while the experimental group received 7-day VR game assisted care. The experimental group had significantly fewer depressive symptoms on the 7th day than the control group, but there was no significant difference in anxiety symptoms between the two groups. That is to say, the efficacy of VR is related to the nature of the primary disease and target symptoms. Fifth, relieving pain. At present, there are significant limitations in the treatment of cancer pain, and although there are various treatment measures, they still cannot fully alleviate the pain. Some studies have found that VR is a safe and effective auxiliary treatment for cancer pain [24]. As an auxiliary measure, VR is more effective than the simple use of morphine or other analgesics, and can reduce the adverse effects of drugs. Bani et al. [25] conducted a randomized control experiment on 80 patients with breast cancer. Fourty patients in the experimental group received VR intervention when the morphine dose reached the peak, and the display showed that they were diving in the deep sea or sitting on the beach for 15 minutes, while 40 patients in the control group received only morphine treatment. The results showed that the pain score of the experimental group was lower than that of the control group after intervention. Birnie et al. [26] conducted VR intervention on 17 pediatric and adolescent cancer patients before or during treatment with implantable intravenous infusion devices. The intervention included auditory and visual stimuli, consisting of simulated diver diving and interactive games. The patients expressed deep attraction to VR and reduced pain. Sixth, reducing chemotherapy related discomfort. Cancer patients often experience discomfort such as nausea and vomiting during chemotherapy. In order to help cancer patients relax and assist in treatment, the Psycho - oncological VR Therapy (POVRT) developed by the National Cancer Research Center Hospital in Japan [27] uses virtual environments to reduce discomfort symptoms and alleviate anxiety. The principle is to use special audiovisual devices such as realistic stereoscopic movies to make bedridden patients feel as if they are walking in the forest or listening to the sound of waves by the sea, thereby achieving the effect of relaxing mood and alleviating pain. The use of POVRT can also alleviate the expected vomiting caused by the suggestion of discomfort during the first chemotherapy in some patients. Seventh, improving cognitive impairment. Cancer related cognitive impairment refers to cognitive impairments caused by chemotherapy, including functional degradation in memory, attention, executive function, and processing speed [28]. Up to 75% of cancer patients report some form of cancer related cognitive impairment during treatment, and 35% of patients still do not recover years after discontinuing treatment [29-30]. Chen XM et al. [31] used an immersive and visual VR environment to carry out cognitive training intervention on 80 patients with cognitive impairment related to breast cancer chemotherapy. With the help of virtual scenes and virtual objects, the cognitive function of patients was improved through various game tasks. The results showed that the scores of patients' Montreal Cognitive Assessment Scale were significantly improved. Final, improving daily life skills. Pain, reduced joint range of motion, and decreased muscle strength occur early after surgery, resulting in limited daily activities for patients. Jin AX et al. [32] used a randomized controlled experiment to train 76 patients with breast cancer for 3 months assisted by VR rehabilitation training system. The patients watched the movement demonstration of rehabilitation exercises through the helmet display device, and selected the training difficulty according to the postoperative time and physical condition. The results showed that the degree of edema of affected limbs in the experimental group was lower than that in the control group, and the range of motion of affected shoulder joint was also better than that of the control group.

2.2 Application in Clinical Practice of Cognitive Impairment

2.2.1 Application of Cognitive Impairment Assessment

Cognitive function refers to the brain's ability to perform advanced activities, including sensory, perception, attention, memory, language, thinking, consciousness, and even emotions. Cognitive impairment refers to one or more impairments of the above functions. The physiological basis of cognition is the normal function of the cerebral cortex. Any factor that causes structural and functional abnormalities of the cerebral cortex can lead to cognitive impairment, mainly due to delayed development and learning, brain trauma or brain diseases (such as stroke, brain trauma, Parkinson's disease, Alzheimer's disease, multiple sclerosis, severe mental illness), Chronic systemic diseases (such as hypertension, diabetes, chronic obstructive pulmonary disease), or social and cultural conditions (such as malnutrition or environmental deprivation). Due to the complex functions of the brain, a function often involves multiple brain regions (such as the frontal, parietal, temporal, and occipital lobes involved in language comprehension), and different types of cognitive disorders are interrelated, that is, cognitive problems in one aspect can cause cognitive abnormalities in another or multiple aspects. For example, if a patient has deficits in attention and memory, there may be obstacles to problem-solving. Therefore, cognitive impairment is one of the most difficult problems in the diagnosis and treatment of brain diseases. The traditional assessment of cognitive impairment usually uses the Neuro Psychological testing scale, which is divided into comprehensive and single assessment. Its advantage is that the content is relatively comprehensive, with limitations such as consuming a long time, boring process, insufficient objectivity, disconnected content from daily life, difficult to reflect the patient's daily functions, and issues with practice effects and the balance between experimental control and ecological validity. The test results are easily influenced by the examiner factors (facial expressions, intonation changes, and speech action hints, etc.), the examinee factors (such as cooperation, understanding of testing requirements, physical and mental functional status), environmental factors (noise, temperature, bystanders, etc.), and socio-cultural factors (examinee's social status, education level, etc.). VR has brought a hope for the improvement of the above issues [33]. The VR interface is friendly, easy to operate, and easy to understand, with low requirements for the patient's physical and mental state; The task has strong interest and patients are willing to cooperate; It can be achieved through human-machine interaction, reducing the impact on the experimenter and the environment; It can not only simulate the real environment and support direct interaction between participants, but also reproduce and expand traditional testing; The VR evaluation system can flexibly control the content and appearance of stimuli, the complexity of tasks, and the responsiveness of subjects, resulting in richer and more accurate information obtained; A testing environment based on interest motivation can be provided in a way that is closer to real life, and specific functional environments can be created to explore more specific cognitive types. Satisfactory results have been achieved in the initial evaluation of attention processes (attention, unilateral spatial neglect), memory (prospective memory, situational memory, spatial memory, terrain orientation), and executive function. However, the application of VR evaluation of cognitive function still has limitations in terms of technology and equipment, as well as different operational requirements for evaluators and participants [34-35].

Tarnanas [36] used a virtual action plan platform (VAP-M) for visiting museums to conduct a comparative study on spatial orientation, prospective memory and executive function of 25 patients with mild cognitive impairment (MCI) and 25 healthy people. The morphological map of the late component of Evoked potential (ERP) was used as an indicator of cognitive impairment. The results showed that both VAP-M and ERP could distinguish healthy people from MCI, the sensitivity of VAP-M was 98%, and the sensitivity of ERP was 87%.

Plancher [37] designed a VR testing system. The test is divided into two steps (scenarios). The first step is to have the subjects act as virtual truck drivers (engaging in active exploration), and the second step is to have the subjects act as virtual truck passengers (engaging in passive exploration). The subjects were asked to remember all the elements in the environment, as well as the relevant spatial and temporal backgrounds. At the end of each scenario, they were tested for recall, recognition of core information (such as environmental elements) and background information (temporal, self-referential, and omnidirectional spatial information), as well as comprehensive abilities. Three groups of participants, including healthy elderly, elderly with mild cognitive impairment (aMCI), and elderly with mild to moderate dementia (AD), were subjected to cognitive function testing under VR conditions, and the test results were compared with the test results of the participants in real situations. The results showed that the spatial information recall and comprehensive scores of each group were better under active exploration conditions. The scores of elderly dementia patients were worse than those of the aMCI group and far worse than those of the healthy group, which was linearly correlated with the degree of hippocampal atrophy, consistent with the results in the literature. It can be seen that this VR testing system can distinguish between healthy elderly, aMCI, and AD patients. Finally, the correlation between patients' daily memory problems and VR test scores is higher than their correlation with authoritative memory test scores.

2.2.2 Application in Cognitive Function Rehabilitation

Cognitive rehabilitation is an intervention system that primarily improves patients' daily functional abilities by improving their ability to process and interpret information or changing the environment. The Plasticity and Functional Reorganization Theory of the Brain is the most important theoretical basis for the rehabilitation treatment of central nervous system injuries. This theory suggests that the brain can undergo functional reorganization through learning and training. That is to say, through training methods such as map assignments, color block arrangement, item classification, number arrangement, and computer dialogue, patients' cognitive abilities such as memory, attention transfer, comprehension, spatial structure, and directional ability can be significantly improved. Common methods of cognitive function rehabilitation include electrophysiological techniques such as transcranial magnetic stimulation (TMS), sensory stimulation, imagination therapy, music therapy, sports training, biofeedback therapy, right brain training and language training. TMS has a short course of treatment (effective after 2-3 weeks of treatment), but the equipment is expensive and can only be implemented in higher-level hospitals; The other methods generally have a long course of treatment, multiple repeated operations, less obvious effects, and are easy to relapse. However, the good therapeutic potential of VR has been recognized, as it mimics patients' daily problem situations, making it easier for patients to apply learning experiences to their daily lives, while also improving their learning ability and behavioral abilities in the real world; Due to its strong interest, patients are easy to persist in learning. Personal computer based VR may be better than immersive VR because they are cheaper, easier to carry, and patients have less fear. Optale et al. [38] divided 36 patients (averaging 80 years old) with verbal narrative memory impairment into a control group and an experimental group. The experimental group underwent a 6-month VR memory training (including VR auditory stimulation and VR path-finding training) with an initial stage of 3 months (receiving 3 sessions of VR auditory stimulation and 3 sessions of VR path-finding training every two weeks); Next is intensive training (once a week for VR auditory stimulation and once for VR path-finding training). The control group received face-to-face music therapy accordingly. At the same time, both groups participate in social, creative, and auxiliary sports activities. Both groups underwent neuropsychological testing during the baseline period, at the end of the initial phase, and after the end of intensive training. The results showed that the memory test scores of the experimental group, especially long-term memory, were significantly improved, while the memory of the control group showed a gradual decrease.

2.3 Application of Rehabilitation in Motor Function of Stroke Patients

Abnormal posture regulation is the main factor leading to difficulty walking in stroke patients [39]. Specific reasons include muscle weakness on the affected side, abnormal muscle tone, abnormal posture control, abnormal cooperative movements, lack of control over the shoulders and pelvis, as well as incorrect movement timing patterns and intra joint coordination. Traditional rehabilitation training (such as motor relearning techniques) emphasizes decomposing movement training, which is significantly different from integrated activities in real life. In addition, the training process is cumbersome and monotonous, which can easily cause pain and boredom for patients, making it difficult for them to persist in training. Although traditional rehabilitation therapy uses methods such as exercise therapy, occupational therapy, functional assessment, and psychotherapy, and pays attention to the importance of psychotherapy during the treatment, due to the limitations of existing rehabilitation equipment, it is still not possible to organically combine functional assessment, exercise therapy, occupational therapy, and psychotherapy, especially the inability to integrate psychotherapy throughout rehabilitation treatment. VR simulation of real scenes enables patients to experience the completion of operations [40]. It can induce patients' posture control reactions, provide meaningful task-based training and precise sensory feedback, and ensure that patients undergo three key exercises, including repeated training, performance feedback, and motor maintenance in a real and safe training environment [41]. More importantly, VR can select corresponding rehabilitation training scenarios and task oriented rehabilitation tasks based on the patient's psychological state and condition needs, and stimulate and maintain the patient's initiative and enthusiasm for repeated training through various forms of feedback. Compared to only receiving balance training, patients who received balance training in a virtual environment showed more significant improvements in walking ability, balance function, and mental health [42].

III. Advantages and limitations of VR

3.1 Advantages

First, VR psychotherapy is similar to traditional psychotherapy in terms of clinical conditions (such as informed consent, confidentiality, professional qualifications of the therapist), treatment environment, patient comfort and risk, and does not have special clinical and ethical limitations [43].

Second, the patients undergo treatment in a safe and convenient artificial environment, which saves time and has high compliance. The treatment plan can be personalized and customized. The same scenario can occur repeatedly, facilitating the consolidation of therapeutic effects. The system can obtain feedback information on treatment through multiple sensing devices and store relevant data. By connecting the system to the internet, standardized remote treatment can be carried out, increasing the scope of benefits and reducing treatment costs.

Third, as the new generation of virtual reality devices is becoming increasingly affordable, more and more clinics and patient families are starting to use them, ushering in a technological revolution in mental health. Patients can receive VR training at any time under more ecological and effective conditions. Compared to previous music therapy and entertainment therapy, life skills training based on VR technology is more flexible and easier for patients to accept [10].

3.2 Limitations

VR can improve the efficiency of psychotherapy, supplement and assist various existing treatment orientations, but it cannot replace existing psychotherapy.

First, the effectiveness of VR technology is limited by both the patients and the therapists. Some personal characteristics of the patients (passive involvement tendency, concentration, and suggestiveness) limit the generation of a sense of presence, and VR can have side effects on some people. The Doctor–patient relationship and the consultant's computer operation ability will also restrict the popularization of VR technology.

Second, the patients' understanding of reality is hindered. VR system emphasizes to isolate the users' senses from the real world and immerse them in an information space completely controlled by the computer, which usually requires the help of special display devices such as immersive Helmet-mounted display, so users cannot touch the external reality environment, which hinders their understanding of the real environment.

Third, the VR technology is not yet mature. ⑴ VR technology provides the possibility to solve the contradiction between experimental control and ecological validity. However, transplanting a real laboratory into a virtual world inevitably loses certain factors or details, leading to a decrease in ecological validity. Therefore, VR cannot completely solve the contradiction between experimental control and ecological validity. The improvement of its ecological validity also depends on the improvement of hardware technology and the careful preparation of software, which is not easy to achieve because it is difficult for us to create different virtual environments based on various types of patients. Even making the system accurately reproduce a simple environment requires a huge cost, and the results may not be ideal under current technological conditions, with its fidelity always not fully matching with human sensory abilities. ⑵ The real-time display of 3D graphics requires a large amount of accurate calculations, which may lead to time delay during actual operation. The existence of time delay will affect the operation, making it difficult for the operator to effectively utilize feedback from previous actions to correct the current action.⑶ There are great difficulties in establishing high-quality virtual laboratories, mainly due to the high technical costs.⑷ The objective measurement of therapeutic effects and other issues also constrain the application of VR in psychotherapy.

In summary, VR has broken through the limitations of traditional psychotherapy techniques, providing a realistic and entertaining on-site experience, a controllable personalized training environment, and strong safety. Its application in psychotherapy is becoming increasingly widespread. From the perspective of the development of VR technology, commercial operation contributes to its popularization, while the development of computer and network technology helps to promote the application of remote VR. The clinical skills of consultants remain the key to the successful application of VR.

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