Research on Rehabilitation Training in ADHD based on Virtual Reality Technique

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Abstract: In the rehabilitation of children with attention deficit hyperactivity disorder (ADHD), most people have focused on medication and traditional behavioral interventions, while the application of modern technological has not received sufficient attention. The rise of virtual reality technology has brought unprecedented opportunities for the rehabilitation of children with ADHD and is highly compatible with the rehabilitation needs. Virtual reality technology can be skillfully integrated into various intervention methods such as electroencephalogram biofeedback, gamification therapy and exposure therapy. Through the instant feedback mechanism, it can bring significant improvements in terms of attention improvement, behavior improvemment and social ability enhancement for the rehabilitation training of children with ADHD.

Keywords: Virtual Reality Technology; Attention Deficit Hyperactivity Disorder; Rehabilitation Training

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD), commonly known as hyperactivity disorder, it is an extremely common neurodevelopmental disorder in childhood. Its typical characteristics are manifested as follows: difficulty in concentrating, with a continuous distracted state lasting for more than six months; excessive restlessness, being full of energy all day long and constantly making small movements; and also accompanied by irresistible impulsive behaviors, acting recklessly and without due consideration[1]. These symptoms bring many obstacles to children's growth, seriously interfering with their academic progress and making it difficult for them to improve their academic performance; they also disrupt interpersonal communication, causing frequent conflicts when children get along with their peers; and furthermore, they cast a shadow over the orderly progress of daily life, making it a challenge to keep regular schedules and take care of personal affairs.

Among various neurodevelopmental disorders, the prevalence of ADHD in children is quite prominent[2]. The latest data shows that in the past decade or so, the prevalence of ADHD among preschool children in China is about 6%, which means that there are approximately 20 million children across the country who may be facing the challenges of ADHD.

The causes and pathogenesis of ADHD in children have not yet been fully revealed, which undoubtedly adds many difficulties and challenges to the rehabilitation training work for it. Therefore, exploring and developing effective training tools has become the focus and difficulty of current research. Traditional treatment methods for ADHD, such as medication, behavioral therapy, and family education, have indeed played a certain role in alleviating the symptoms of ADHD in past clinical practices and have become the treatment options relied on by many patient families. However, these traditional methods also have many limitations that cannot be ignored. For example, although medication can control some symptoms in the short term, it is often accompanied by relatively obvious side effects, such as loss of appetite, insomnia, and mood swings, bringing additional troubles to children's physical development and daily life; the efficacy of behavioral therapy largely depends on the professional level of therapists and the degree of children's cooperation, and in actual operation, its efficacy often fluctuates and is difficult to maintain stably in the long term; although family education can create a family environment conducive to children's rehabilitation to a certain extent, parents often lack systematic and professional guidance and have difficulty accurately grasping the ways,

methods, and degrees of education, resulting in uneven effects[3].

Meanwhile, under the sweep of today's digital wave, computer technology has penetrated into every corner of society at an astonishing speed, with its popularity constantly rising and profoundly changing people's ways of life and work. In the crucial field of special children's education and intervention, modern science and technology have shown strong application potential and broad development prospects and have gradually become an important force in promoting the progress of this field.

In recent years, virtual reality technology has emerged suddenly. With its unique advantages of immersion and interactivity, it has set off a wave of innovation and transformation in numerous fields. Especially in the rehabilitation training of children with ADHD, it has not only quickly attracted extensive attention and high expectations from the medical, educational, scientific research and other sectors but also has initially demonstrated many unique advantages that traditional treatment methods do not possess in actual clinical applications and educational practices, bringing new hope and possibilities to children with ADHD and their families. It is expected to reshape the pattern of ADHD rehabilitation treatment and open a new era of more precise, efficient, and personalized rehabilitation.

Virtual reality technology provides a safe virtual environment for children with ADHD, allowing them to conduct rehabilitation training without risks. The design of virtual tasks is full of fun, which can attract children's attention and improve their participation. In addition, virtual reality technology also has the flexibility of the reinforcement mechanism, which can be personalized adjusted according to the specific situation of each child to ensure the maximization of training effects[4]. The diversity of training indicators makes the rehabilitation training more comprehensive and can improve multiple aspects of children with ADHD. Virtual reality technology also realizes the rationality of resource utilization. By simulating real scenes through the virtual environment, it not only saves costs but also helps to alleviate their symptoms, thereby reducing the negative impact on individuals, families and even society. It can be said that virtual reality technology is bringing unprecedented hope and possibilities to the rehabilitation of children with ADHD from a brand-new perspective.

2. Overview of Virtual Reality Technology

Virtual reality technology, namely VR (Virtual Reality), is a cutting-edge innovative technology that integrates many high-tech fields such as computer technology, simulation, multimedia display, and sensor technology. Its core lies in constructing a highly simulated virtual environment, which is carefully generated by a computer and presented in a three-dimensional form. When users put on a series of specially designed and compatible high-tech devices and step into this carefully created virtual world as if passing through the door of time and space, they will be pleasantly surprised to find that they are already immersed in a sensory experience space that highly matches the real world in many details and has almost no difference, including the subtly simulated olfactory enjoyment, which can stimulate users' sensory nerves from all directions and angles, thus achieving a multi-dimensional, deep, and extremely natural and smooth sensory interaction effect[5], making users feel as if they are on the scene, blurring the boundary between the virtual and the real, and starting an unimaginably wonderful perceptual journey.

VR technology has three significant characteristics:

1. Immersion: Users can be completely immersed in a virtual environment through VR devices and obtain an experience similar to that of the real world.
2. Interactivity: Users can use various sensing devices to establish a direct interactive relationship with the virtual environment. For example, they can use somatosensory devices such as handles and gloves to track their body movements and achieve natural interaction with the virtual environment to control and respond to the virtual world.
3. Imaginativeness: VR technology can not only simulate the real environment but also create environments that do not exist in reality, allowing users to imagine and create.

Since it was proposed in the 1960s, virtual reality technology (VR) has entered a stage of rapid development in the 1990s. Up to now, it has developed relatively maturely and is widely favored by the world. As a cutting-edge

technology, virtual reality is widely used in many fields such as the military, medical care, and education. Especially in the education field, its influence is becoming increasingly significant. In the field of educational rehabilitation, for the educational rehabilitation of children with ADHD, virtual reality technology shows its unique advantages. These children often face the problem of difficulty in concentrating, but the immersive experience of virtual reality can effectively attract their attention[6]. With the help of the interactivity of virtual reality technology, children can use sensing devices such as handles and data gloves to have vivid and interesting interactions with various characters or objects in the virtual world, thus changing from passive audiovisual recipients to active learning participants. In the virtual environment, they can freely express themselves and release their emotions, which is helpful for their psychological rehabilitation.

In addition, virtual reality technology can provide children with ADHD with rich and diverse information, which is not only novel and interesting but also can be continuously updated, thus attracting their attention more effectively. It not only stimulates children's imagination but also promotes the improvement of their imaginative ability. The unique charm of virtual reality technology perfectly matches the needs of children with ADHD, paving a powerful technical assistance path for their rehabilitation process.

3. Application of Virtual Reality Technology in the Rehabilitation Training of Children with ADHD

By applying educational concepts such as constructivist teaching theory or sensory integration theory, virtual reality technology can improve educational efficiency more effectively in the rehabilitation training of children with ADHD. The three-dimensional learning environment constructed by the virtual reality system enables learners to perceive and interact with virtual objects and obtain instant feedback.

The application of virtual reality technology in the rehabilitation training of children with ADHD can be in the following aspects:

3.1 Combination of Virtual Reality and EEG Biofeedback Training

In the field of rehabilitation for children with ADHD, the organic combination of virtual reality and electroencephalogram (EEG) biofeedback training is like a pioneering key, unlocking an unprecedented innovative rehabilitation path[7]. With the help of advanced brain-computer interface (BCI) technology, children can step into a brand-new interactive space. When they are immersed in the carefully constructed virtual environment and carry out rich and colorful interactive activities, they simultaneously receive accurate feedback information based on EEG frequency components. This feedback is not lagging or intermittent but instant, just like sensitive nerve endings, constantly sensing the state of children's electroencephalogram activities and quickly converting them into intuitive and easy-to-understand feedback signals.

This instant feedback mechanism is of great significance for children with ADHD. It can help children control the allocation and focus of their own attention more efficiently. Whenever children try to concentrate on completing tasks in the virtual situation, positive feedback signals will give them clear and positive encouragement, thus gradually strengthening their self-control ability and making them more proficient in controlling their attention.

It is worth mentioning specifically that the BCI system based on the P300 potential stands out in many practices and studies. It successfully connects the scattered attention of children, effectively maintains the stability and durability of their attention, and provides a solid guarantee for children's learning and exploration in the virtual environment. With the continuous improvement of attention, positive changes have also occurred in children's behavior. The disorderly behaviors caused by hyperactivity and impulsiveness in the past have gradually decreased, and instead, more orderly, focused, and rule-compliant behavior patterns have emerged, laying a solid foundation for their return to the normal track of learning and life and injecting a powerful driving force into the rehabilitation cause of children with ADHD.

3.2 Combination of Virtual Reality and Time Management Games

Children with ADHD often encounter difficulties in time perception. The time

management games created by virtual reality technology provide children with a way to rebuild their perception of time.[8]. This gamified training method is not only full of fun but also enables children to gradually master the abilities of time perception and patient waiting while completing tasks through virtual reality technology. Research has confirmed that this intervention training has a significant effect on improving the time perception of children with ADHD.

In the process of growing up, children with ADHD often encounter difficulties in the key dimension of time perception and have difficulty accurately grasping the passage of time and the rhythm. The time management games created by virtual reality technology just illuminate a brand-new path for children to rebuild the time perception system. This unique gamified training paradigm is not the traditional boring preaching but full of novelty and fun, like a magical world full of fantasy, firmly attracting children's attention and curiosity and making them immerse themselves involuntarily. When children fully engage in the task situations created by virtual reality technology, each action and decision are closely related to the progress of time. In the process, they gradually learn how to keenly perceive the flow of time and how to maintain patience and composure while waiting, and are no longer driven by inner restlessness and impulsiveness.

Research has confirmed that this intervention training has a significant effect on improving the time perception of children with ADHD. Their time perception ability has been significantly improved, and they can deal with various time challenges in life and study more calmly, laying a more solid foundation for their future growth and development.

3.3 Combination of Virtual Reality and Exposure Therapy

In the field of psychotherapy, exposure therapy has always been regarded as a highly effective treatment method and has played a key role in helping many patients overcome psychological barriers, showing its unique and irreplaceable value. Now, with the rapid development of science and technology, virtual reality technology has been skillfully integrated into exposure therapy, building a safe and precisely controlled simulation environment for it to ensure that each step can be promoted on a stable and orderly track.

With the help of virtual reality exposure therapy, children with ADHD seem to be placed in situations that are highly similar to real life. Although these situations do not really exist, they vividly reproduce the scenes that may trigger children's fear and anxiety emotions by virtue of the powerful simulation ability of virtual reality technology, allowing them to face their inner troubles up close. Children gradually learn to adapt to those situations that once made them shrink back and gradually overcome the deep-seated fear and anxiety emotions in their hearts.

Compared with traditional exposure therapy, virtual reality exposure therapy has higher acceptability and lower cost, so it has broad application prospects in treating mental health problems such as ADHD.

In conclusion, the application of virtual reality technology in the rehabilitation training of children with ADHD has significant advantages and great potential. By integrating multiple methods such as EEG biofeedback, time management games, and exposure therapy, virtual reality technology provides more interesting and effective rehabilitation means for children with ADHD, helping to improve their quality of life and social skills[9]. With the continuous progress of technology and the in-depth application, we believe that virtual reality technology will play a more important role in the rehabilitation field of children with ADHD.

4. Effects of Virtual Reality Technology in the Rehabilitation Training of Children with ADHD

The application of virtual reality technology in the rehabilitation training of children with ADHD has achieved remarkable results, which are specifically manifested in the following aspects:

4.1 Improvement in Attention

After the introduction of virtual reality technology and the implementation of precise and targeted training, the attention development of children with ADHD has achieved a remarkable improvement. According to relevant research data, when children participate in the virtual reality training programs carefully designed and

planned by professional teams, their scores in the rigorous scientific attention assessment system have achieved a leapfrog increase, with an average improvement rate of more than 20%. This data has brought new hope and confidence to many families and professionals. For children who have been troubled by ADHD for a long time, such progress is like a ray of light illuminating the way forward. In their learning process, they can absorb knowledge and understand classroom content more efficiently, keep up with the teaching rhythm, and gradually narrow the gap with their peers in academics; in daily life, they can also better complete basic tasks such as tidying up personal items and following family rules, reducing the chaos and conflicts caused by inattention, thereby significantly improving their quality of life and social experience, laying a solid foundation for their integration into the normal track of learning and life, and having an immeasurably far-reaching positive impact on their future development. It seems to open a door of hope for their normal growth and development.

4.2 Improvement in Behavior

The unique training mode constructed by virtual reality technology has played an efficient and positive intervention and correction role. After a period of systematic training, the scores of these children in the professional behavior assessment system show a significant downward trend. This distinct data change deeply reflects that they have already made gratifying and significant progress in their self-behavior control ability. The previous hyperactive manifestations that were difficult to suppress and the impulsive behaviors that burst out instantly have been greatly reduced. They have begun to be able to control their bodies and behaviors more steadily and firmly, showing stronger awareness of rules and the ability to follow instructions when facing various situations, as if building a solid and reliable "normative framework" for their behaviors, thus greatly optimizing their behavioral performance in daily life and making them gradually move closer to normalization and orderliness. This positive change from the inside out has strongly promoted the communication and interaction between them and their families, teachers, and peers to move in a more harmonious and harmonious direction.

4.3 Improvement in Social Skills

Virtual reality technology has brought new hope and possibilities for children with ADHD in improving their social skills. With its powerful technical advantages, it carefully creates a rich variety of social scenes, covering all aspects of social interaction from daily communication and interaction to communication and cooperation in specific situations. Through highly realistic situation simulation, children feel as if they are in real social situations. The impact of such remarkable progress is far-reaching and extensive. It not only helps children integrate into social environments such as schools, families, and communities more smoothly and naturally at present, reducing the sense of loneliness and marginalization caused by social difficulties, but more importantly, it carefully builds a broader and more solid interpersonal network for their future. This will become an important support for them to obtain support, share happiness, and grow together on the road of life in the future, laying an extremely solid foundation for their long-term development in aspects such as academic development, career pursuit, and personal life, helping them shine their own unique brilliance on the broad stage of life and move forward steadily towards a future full of hope and beauty[10].

5. Summary and Prospect

Virtual reality technology has shown remarkable results in the rehabilitation training of children with ADHD. By simulating the real environment and providing multi-sensory stimulation, this technology has effectively attracted the attention of children with ADHD and promoted the improvement of their emotion management, social interaction, and daily life skills. Looking forward to the future, with the continuous progress of technology and the deepening of research, the application prospects of virtual reality technology in the rehabilitation training of children with ADHD will be even broader. We expect that this innovative therapy will bring positive changes and well-being to more children with ADHD.

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