

Virtual Reality and ADHD: a review of literature

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Abstract

This article critically examines the potential benefits of utilizing Virtual Reality (VR) in the rehabilitation of children diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). ADHD, prevalent among children aged 3 to 5, presents significant challenges in education, social interactions, and interpersonal relationships. Several studies indicate that VR technology serves as a valuable tool in addressing these challenges by offering adaptable solutions tailored to each child's unique needs, establishing a secure and focused environment. VR actively engages children, providing effective tools for behavioral assessments, facilitating comprehension and amelioration of cognitive deficits. It aids therapists in precise diagnosis and assessment while improving working memory, executive functions, and attention. The application of VR in the rehabilitation of children with ADHD, grounded in behavioral and physical models, is especially advantageous as it replicates virtual environments for diagnostic purposes, training sessions, ongoing monitoring, and therapeutic interventions.

Keywords

ADHD, virtual reality, children, rehabilitation, review.

1. Attention Deficit Hyperactivity Disorder (ADHD)

Attention Deficit Hyperactivity Disorder (ADHD), also known as hyperactivity, is a neurodevelopmental disorder primarily characterized by the presence of symptoms related to inattention, impulsivity, and hyperactivity [1,2,8,9]. Issues associated with ADHD, such as low self-esteem and relational difficulties, can impact daily life, social behaviors, interpersonal relationships, and education [1,5,6]. ADHD is considered by the Diagnostic and Statistical Manual of Mental Disorders as one of the most common psychiatric conditions [2,10]. In fact, it is recognized that approximately 5% of children aged 3 to 5 are affected by ADHD, with their behavioral competencies in various aspects being lower than their neurotypical peers [11]. Rehabilitation for this condition focuses on medical therapies, psychological counseling, and behavioral therapies [12,13,14]. Behavioral therapies include school adjustments, social skills training, and cognitive rehabilitation. Alternative methods, such as speech therapy and family counseling, also demonstrate effectiveness in the rehabilitation of children with ADHD [1,3,4]. The utilization of virtual reality technologies emerges as an innovative therapeutic strategy for ADHD rehabilitation, providing simulations of real-life situations in a safer and more effective manner compared to traditional therapies [1,4,5,6,7].

2. The Impact of Virtual Reality in ADHD Patient Rehabilitation

Virtual Reality (VR) is a technology that emulates imaginary or real environments [15,16]. Allowing users to interact in three-dimensional settings, VR finds applications in education, entertainment, medical, surgical, etc. [15,17,18]. This is because this technology has the capability to easily create

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environments similar to real life [5,19,20]. Among various types, immersive VR, desktop VR, projective VR, and CAVE (C-Automatic Virtual Environment) are among the most common [4]. Some key advantages offered by VR include high motivation in patients, environment customization according to needs, stability between users and stimuli, complete recording of patients' behaviors and functionalities, facilitating rapid feedback, and ensuring time and cost savings [5,19]. In terms of rehabilitation, VR enables individuals with disabilities caused by brain damage to confront experiences that are difficult or impossible to experience in the real context [21,22]. However, a significant obstacle arising from the use of rehabilitation technologies in virtual environments is a psychophysiological issue [25,26]. Indeed, during a virtual reality session, users may experience discomfort such as headaches, seizures, nausea, etc. [23,24].

Virtual reality (VR) proves to be an effective tool in the rehabilitation of patients with ADHD, allowing a more reliable assessment of cognitive processes through neuropsychological tests such as the Continuous Performance Test (CPT) [27,28]. Some studies indicate that the CPT integrated into VR (VRC-CPT) provides greater ecological validity and is preferred by children with ADHD compared to the traditional CPT [29]. The combination of virtual reality and interactive tests, with specific stimuli, proves useful in removing distractions and maintaining the attention and concentration of patients, contributing to the rehabilitation of children with ADHD [5,19,30,31,32,33]. Virtual reality environments enable the detection of cognitive deficits [29]. The utilization of virtual reality (VR) technologies, like computer-generated graphics emulating the actual world, diminishes disruptions in the daily routines of individuals, facilitating the transfer of skills acquired within the VR environment to real-world situations [34,35,36].

A meta-analysis conducted by Bashiri et al. (2017) revealed that many professionals, including doctors and therapists, are adopting VR systems for clinical rehabilitation. Rehabilitation therapies based on virtual reality employ strategies that take into account interaction, system usability, and user perceptions. They offer specific stimuli that can be utilized to eliminate distractions and create safe environments that capture the subjects' attention, thereby enhancing their concentration abilities [32,33]. Regarding challenges in cognitive performance, such as working memory, executive function, and attention in children with ADHD, literature highlights that VR technologies are extremely useful for assessing, providing instruction, and improving these conditions. They offer a stable virtual environment that allows patients to adapt their lifestyle through cognitive training [15,28,37,38,39]. Often, children with ADHD experience difficulties in problem-solving, behavior management, and cognitive adaptability [19]. Behavioral models play a crucial role in the rehabilitation process for individuals with ADHD, demonstrating significant importance in virtual reality-involved therapies. VR technologies facilitate action-based responses in these children, helping to reduce behavioral symptoms and problems [34,40]. Other studies have indicated VR's ability to enhance memory functionality, sensory processing, and the five levels of attention, including focused, sustained, selective, alternating, and divided attention in individuals with ADHD [1,15]. Some research, concerning the ecological relevance of neuropsychological tests, suggests that integrating these tests into virtual reality contexts increases both ecological validity and the ability to transfer skills and knowledge acquired from the virtual environment to the real world [5,19,29,30,32,33]. A key point underscoring the importance of virtual reality technologies is that using medication within virtual contexts proves more effective than in non-virtual environments, contributing to reducing omission errors and reaction times during the assessment of children with ADHD [41]. Based on these results, it appears that VR games express a wide range of human emotions and are particularly effective in rehabilitating children with ADHD [45]. Furthermore, the use of a virtual classroom in VR, simulating the school environment, and the inclusion of neuropsychological tests, such as the CPT, exhibit higher ecological validity in this context [19,30,31,42]. Despite the various opportunities offered by VR technologies, potential side effects pose a challenge that can threaten the health and safety of children with ADHD. However, this issue is partially manageable through the customization of VR according to user needs, proper calibration, and the use of suitable user interfaces and head-mounted displays [23,25,43,44].

3. Conclusion

In conclusion, ADHD presents challenges that significantly impact the daily lives and development of affected individuals. Traditional rehabilitation approaches involve medical therapies, psychological counseling, and behavioral interventions, but emerging technologies, particularly VR, offer innovative strategies for ADHD rehabilitation [45]. VR, with its diverse applications, provides a unique platform for creating immersive environments that cater to individual needs, enhancing motivation, and offering a more reliable assessment of cognitive processes. The integration of neuropsychological tests into VR environments, such as the Virtual Reality Continuous Performance Test (VRC-CPT), not only proves more engaging for children with ADHD but also demonstrates greater ecological validity compared to traditional methods. The interactive nature of VR environments facilitates focused attention and concentration, contributing to the reduction of behavioral symptoms and the improvement of cognitive functions. Despite the evident benefits, challenges such as psychophysiological issues and potential side effects need careful consideration. Nonetheless, advancements in customization, calibration, and suitable interfaces offer promising avenues to manage these concerns [47]. The potential of VR technologies to bridge the gap between virtual and real-world scenarios, coupled with their ability to enhance memory functionality and attention levels, underscores their significance in the rehabilitation of children with ADHD. As professionals increasingly adopt VR systems for clinical rehabilitation, it is crucial to navigate the balance between therapeutic efficacy and ensuring the health and safety of individuals with ADHD in virtual environments.

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