

# The use of Virtual Reality in Clinical Practice for Autism Spectrum Disorder: A Comprehensive Mini-Review

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## ABSTRACT

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that affects communication, social interaction, and behaviour of individuals. ASD is typically diagnosed in early childhood, and symptoms persist throughout the individual's life. While there is no cure for ASD, various therapies and interventions have been developed to help individuals with ASD manage their symptoms and improve their quality of life. Virtual Reality (VR) is a relatively new technology that has shown promise in the treatment of ASD. Several studies have been conducted to investigate the use of VR as a therapeutic tool for individuals with ASD. In this comprehensive review we have discussed the application of VR technology in ASD and a brief discussion on the various clinical studies that have been conducted using VR technology for ASD focusing on social, emotional, communication and vocational skill training for children within the age group of 7-18 years and also the efficiency of the clinical trials conducted.

**Keywords:** Behaviour therapy; Virtual reality; Autism spectrum disorder; Virtual environment; Technology

## INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder, characterized by limitations in social interaction, language, competence, and communication as well as the persistence of repetitive and constrained behaviours, interests, and activities [1]. Therapy for ASD may take many different forms, including speech therapy, occupational therapy, and behaviour therapy. Virtual reality technology, however, has been used to create creative interventions as a result of current technological advancements.

A perceptually surrounding virtual world might be referred to as immersive. An individual who views themselves as being engulfed by, involved in, and participating with an environment that offers a constant stream of stimuli is said to be immersed in such an environment [2]. Significant increase in the number publications and studies for use of Virtual Reality (VR) for ASD and related neurodevelopmental disorders have significantly increased.

A computer-based technology known as virtual reality provides a secure environment and realistic, three-dimensional stimuli that are comparable to those found in the real world and everyday

situations. The opportunity to learn and rehearse responding to various stimuli in a variety of settings is provided by these stimuli. The versatility to use varied settings and environment makes it a useful tool to help them adapt to these settings and acquire the necessary skills to interact with the settings [3,4]. VR has emerged as an effective treatment for rehabilitation for the neurodegenerative disorders early diagnosis of diseases and to improve the mental and emotional well-being of patients [5-10]. More than just proving to be helpful with the treatment, the VR environment is also used to train medical professionals [11,12].

Researchers have used VR technologies for physical and psychological educational intervention and rehabilitation with success, such as the experiment conducted for daily living, cognitive, and social skills of people with intellectual disabilities [13]. This is due to the assumed veridical nature of the relationship between real and virtual behaviour and experiences as well as the strong stimulus control within Virtual environments. Under the VR therapy sessions, the modules that stimulate various experiences are observed to monitor the response of the diagnosed child and their progression in relation to treatment.

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## Autism spectrum disorder

According to the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders 5<sup>th</sup> Edition (DSM-5) and the World Health Organization's (WHO) International Classification of Diseases 10<sup>th</sup> Edition (ICD-10) definitions, autism falls under the umbrella of autism spectrum disorder which comprise of complex neurodevelopment disorders [14,15]. People who are diagnosed with autism fall into different region of the autism spectrum, which makes them very different from one another. ASD is characterized by deficits in social interaction, communication, and repetitive or restrictive behaviours. While the exact causes of ASD are still unknown, studies suggest that it may be due to a combination of genetic and environmental factors [16]. Because the disorder's symptoms are evident as early as 12 months of age or earlier, early diagnosis is crucial. It is thought to affect 1 percent of people in

the United Kingdom and 1.5 percent in the United States [17].

Over 2 million people in India may be affected by ASD, according to estimates. Asia has a prevalence of ASD of 0.36 percent overall. In Asia, the prevalence of ASD is rising. ASD is more common in East Asia (0.51%), West Asia (0.35%), and South Asia (0.31%), respectively. There are 851,000 autistic children in India, followed by 422,000 in China, 207,000 in Nigeria, 172,000 in Pakistan, and 159,000 in Indonesia. One in 68 children now has autism spectrum disorder. Each person with ASD faces their own challenges and has their own strengths and weaknesses. As a result, it is necessary for each person to have their own individualized treatment plan, which may include one or more of the therapy methods. Up to this point, a variety of conventional therapy approaches mentioned in Table 1 have resulted in significant improvements for children with ASD.

**Table 1:** Effective conventional forms of therapy employed currently.

S.No	Therapy method	Description	References
1	Applied behavior analysis	The "A-B-Cs"- antecedent (what immediately precedes the target behavior), behaviour (the patient's response-or lack thereof) to the antecedent, and consequence (the behaviour's resulting action) are utilized in this therapy approach. The consequences typically involve a strategy known as "positive reinforcement," where the patient is rewarded for exhibiting a desired behaviour and encouraging them to repeat it.	[18]
2	Early start Denver model	This model is based on ABA techniques and is designed for autistic children between the ages of 12 and 48 months. The therapist and parents are heavily involved. A positive bond is formed between the child and the therapist or mentor when leisure and playful activities are used to stimulate social and cognitive skills.	[19]
3	Pivotal response treatment	It is more of an all-around treatment that focuses on core or "pivotal" developmental areas rather than a single behaviour. As a result, it shows improvements in communication, behaviour, and learning development. This uses the behaviour-reward system as well, but the reward is usually more or less related to the behavioural stimulus than it is completely unrelated	[20,21]
4	Occupational therapy	Occupational therapy for the treatment of ASD focuses on developing and improving the child's ability to engage in daily activities and function independently. This may include activities such as self-care, play, and socialization. Occupational therapists use a range of techniques and strategies, such as sensory integration therapy, social skills training, and cognitive-behavioural therapy, to support children with ASD	[22]

## VR for autism

In the past few decades there has been a significant increase in health based applications that has helped to provide support to the population. VR can be used to create 3D simulations of surgical procedures, allowing for pre-operative planning and minimizing the risk of surgical errors [23]. In addition, VR simulations have been used to address various types of provider stress, including procedural stress, burnout, and emotional distress [24]. Apart from this VR training involves using a VR system to simulate real-life environments and provide dynamic and challenging tasks to help patients improve their gait and balance. Studies show that virtual reality rehabilitation training has been linked to significant improvements in Parkinson's disease patients' gait and balance in several studies [25-29].

## LITERATURE REVIEW

There have been several successful studies on VR-based training among the children with ASD. These studies seek to improve communication skills, vocational skills, emotional and social skills, and physical activity among these children by prompting practicing and performance of the respective activities. Children between the ages of 7 and 18 years make up the study group in the majority of studies. One to five is the observed ratio of girls to boys with ASD. Similar trend for the ratio has been observed in these studies. All studies use a similar process where the problem is first recognized and then the script is implemented using game-like activities catered to a specific circumstance to enhance a particular skill. The verbal and non-verbal signals that the kids use in reaction to the stimuli are recorded during the session for real-time data gathering. The information gathered may be the result of doing as instructed by the trainer or as a result of responding to the stimulus. For both the research and control groups, the sessions were held with the trainer present [30-43].

### Social and emotional skills

The majority of studies that have been conducted have succeeded in improving the social and cognitive skills of the children from the study. These studies gave children cues to interact in a VR social environment, including modeling or instructive cuing, reacting, initiating or asking questions, and inactive proximity presence. The children have significantly improved, according to the results of the social encounters and adaptation tasks. The children's success in particular social skills, such as initiating social contacts, interpersonal negotiation, expressing a positive self-identity, and cognitive flexibility, is noted to have improved. Examining the children's eye gaze shift

and eye contact with or without vocal cues helps to improve their social skills through exercises that centre the group's attention [44]. Before and after the research period, pre and post assessments were performed for the purpose of determining the success rate, and these assessments included quizzes like the SCQ and SSQ questionnaire, the faces test with adaptations, the eyes test, the Psychoeducational Profile Third Edition (PEP-3), the ASSQ, SRS, MASC, BASC and the RME [45].

### Communication

Various studies aim to improve the communication skills among the individuals by stimulating a VR social or group setting. By reacting to the character or instructor, these exercises are meant to better the conversation skills of the study's young participants, who have already shown a substantial increase with respect to communication skills. The research investigates how children interact in the virtual environments they experience when interacting with the virtual characters or other children in a group situation. When a virtual character asks them to concentrate on something, the kids will either gesture at it or follow the character's gaze. A common first-order shift of location and second-order assignment was used to evaluate the child's capacity for understanding other people's perspectives. Based on vocal and non-verbal cues, the children's interaction and dialogue were evaluated.

### Vocational skills

The goal of the vocational abilities is to enhance the child's daily tasks. They assist the children in putting the skills into practice in real-world situations and also teach them crucial safety instructions. The daily responsibilities include tasks on cleaning, shelving, and environmental awareness, loading a truck from the back, money management, and social skills. These studies pre and post-assessments were also focused on actual environments, like retail malls. These vocational skills help increase cognitive skills, management skills and spatial skills among these children. When the test findings were analyzed, the children's performance on these exams had significantly improved.

### Physical activity

One of the areas that have received the least research is the use of VR to promote physical exercise in autism children. Through the thrill of immersion, VR technology can divert users from activities they might otherwise want to avoid, such as exercise or physical rehabilitation, and encourage them to interact with the system. The virtual reality exercise game Astrojumper, which was

created to meet the requirements of kids with autism, has attracted a lot of interest from both autistic kids and adults.

## DISCUSSION

Despite the fact that a significant proportion of the world's population is affected by Autism Spectrum Disorder (ASD), there aren't many research studies with the children in Asia. The diagnostic standards previously covered were mainly created with Western participants. Recent study has shown that social and cultural variables affect diagnostic rates and the societal approval of the devices used to make the diagnoses, even though it is thought to be strongly affected by biological factors and a developmental state [46]. As prompt fading is a crucial technique in teaching new skills to people with developmental disabilities, it should be used in the studies and activities to prevent monotony and raise the challenge level. This technique encourages freedom and the generalization of skills. Prompt fading is significant because it helps people learn to operate independently by teaching them how to perform a task without the need for outside cues [47]. For the improvement of the children, repeated activities of a comparable nature but not exactly the same must be included [48]. As the critical role of visuospatial functioning in ASD becomes increasingly apparent from its potential effects on daily living and adaptive behaviours, more VR treatments in this area are required [49]. For children with autism, complicated visuospatial skills and gross movement skills should be given greater importance [50,51]. Most of the studies done are done with a smaller population hence even though there are improvement shown among the children the data is statistically insignificant as the probability of chances are not completely neglected here increasing the need of larger population study.

## CONCLUSION

VR is significantly a new technology that has shown significant potential with respect to the treatment for ASD. However, more research is needed to address safety concerns and to determine the effectiveness of VR interventions for children with ASD. The clinical studies conducted have shown improvements in the autistic children, but the data is statistically insignificant due to the smaller population size the clinical trials are conducted with. Moreover, the heterogeneity with respect to the culture, spectrum and comorbidity among the ASD population must be taken into consideration during the clinical trials conducted. Understanding this heterogeneity will help us provide more effective and personalised treatment solution, achieving one step closer to personalised modules for the kids with autism. The expansion of the technology also with respect to various factors such as the motor skills, cognitive skills and visuospatial skills with the existing social, emotional, communication and vocational skills, will advance the quest of treatment model in these highly heterogeneous population.

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