# Incorporating Virtual Reality into clinical practice to develop social skills for children with autism spectrum disorder

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**KEYWORDS**

Autism Spectrum Disorder, Occupational Therapy, Social skills, Technology, Virtual reality

**ABSTRACT**

**Background:** Individuals with Autism spectrum disorder (ASD) typically encounter challenges in areas such as socio-emotional reciprocity; non-verbal communicative behaviours; and forming, maintaining, and comprehending relationships. Recent research suggests that Virtual Reality (VR) may be more beneficial than conventional occupational therapy for certain purposes. VR provides a controlled artificial environment with auditory and visual inputs, making it a suitable platform for teaching and practicing social skills in children with ASD. **Objectives:** This study aimed to examine the impact of VR-based interventions on fostering social abilities among children diagnosed with ASD as a part of clinical treatment. **Study Design:** Quasi experimental study design was employed. **Methods:** This study used the Indian Scale for the Assessment of Autism (ISAA) for screening. Thirty ASD diagnosed children were split equally between the control and experimental groups. The experimental group received a VR-based intervention for 36 sessions, 35 minutes per session, whereas the control group underwent conventional occupational therapy (OT) such as sensory integration, group therapy, social skills training and play therapy. The Autism Social Skills Profile-2 (ASSP-2) was administered pre- and post-intervention to evaluate socio-emotional reciprocity (SER), social participation avoidance (SPA), and detrimental social behaviour (DSB). **Results:** The results from the Mann Whitney U test revealed that the social skills scores on the ASSP-2 showed significant improvement after VR intervention in experimental group, compared to conventional OT (P=0.037, 95% confidence interval [CI] = -7.347, 0.787). **Conclusion:** The substantial improvement in the experimental cohort suggests that VR-based therapy enhances social skills in children on the autism spectrum, offering significant insights into existing research and advocating for its integration into clinical practice by occupational therapists.

## INTRODUCTION

According to Diagnostic and Statistical Manual of Mental Disorders (DSM-5), autism spectrum disorder (ASD) is a neurodevelopmental disorder featuring impairment in social communication and the manifestation of restricted and repetitive behaviors.[1] Children with ASD often exhibit prominent deficits in social skills, including a lack of reciprocity in social interactions, an atypical approach to social situations, and failure to share interests and emotions. They may also struggle with non- verbal communication, displaying poorly integrated verbal and non-verbal cues, unusual body languages, facial expressions, and eye contact. Additionally, they often struggle to form and maintain relationships, display challenges in adjusting their behavior, engage in imaginative play, and make friends. Moreover, they may be more vulnerable to being bullied by their peers. Therefore, children with ASD can be positively influenced by creating a supportive environment that promotes the development of social skills.[2-3]

This is possible with VR technology, a computer-simulated tool that allows users to experience a three-dimensional artificial sensory environment. VR applications immerse users in a computer-generated environment using interactive devices, such as VR headsets, goggles, and data gloves.[4] The objective of utilizing VR as an intervention tool is to develop a comprehensive, interactive, and immersive artificial environment.[5] A systematic review and meta-analysis conducted in the year 2023 substantiated the efficacy of immersive VR training for children on the autism spectrum, demonstrating a positive trend in cognitive, social and emotional abilities.[6]

Although numerous studies have demonstrated substantial progress with the use of virtual reality for children with ASD, its extensive implementation in the clinical setting has not materialized; therefore, this study aimed to explore the acquisition of social skills in children with ASD through the integration of VR technology in a clinical context. The results of this study may add value and support existing research by providing a more comprehensive understanding of the subject matter and by highlighting areas for further exploration and investigation.

## METHODS

A quasi-experimental research design and convenient sampling technique was adopted. The independent and dependent variables were VR-based intervention and social skills, respectively. Thirty children aged 6-12 years diagnosed with mild to moderate ASD were recruited from Prathikshaa Rehab Centre (Chennai, India). Children with other neurological developmental disorders, severe autism, visual impairments, visual processing disorders, and previous records of epileptic seizures were excluded. This study was conducted according to the guidelines of the declaration of Helsinki and was approved by the institution scientific review board (ISRB) of the saveetha college of occupational therapy (SCOT/ISRB/047/2023). Informed consent was obtained from the caretakers of the children and administrative firm.

The tools used in this study were the Indian Scale for the Assessment of Autism (ISAA) and the Autism Social Skills Profile second edition (ASSP-2). The ISAA is an established standardized objective assessment tool employed to diagnose and measure the degree of ASD. It is a 5-point rating scale consisting of 40 items. Severity was classified according to scores (<70, no autism; 70–106, mild autism; 107–153, moderate autism; and >153, severe autism).

The computed score of Cronbach's alpha coefficient (α=0.93) demonstrated excellent internal consistency and reliability. Additionally, the significant correlation of the items with total scores indicated high validity.[7] Bellini's ASSP-2, which is a 4-point Likert scale containing 49 items was used to assess the social skills of children. The 49 items were grouped into three sub scales including, Socio-emotional Reciprocity (SER-26 items), social participation/avoidance (SPA-14 items), and detrimental social behaviors (DSB-9 items). The preliminary psychometric properties of the ASSP possesses exceptional psychometric properties, such as internal consistency, test-retest reliability, and concurrent validity.[8] Scoring was based on information from parents/ caretakers and direct observation of the children following the guidelines of the scales.

**Intervention Protocol**

After the initial ISAA screening, thirty included children (N=30) were equally divided into experimental group (n=15) and control group (n=15) by simple and feasible randomization method, based on odd and even numbers. Each child was given a sequential identification number. Children with odd numbers were allocated to control group, and those with even numbers were assigned to experimental group. Thereafter, were subjected to pre-test using ASSP-2. The experimental group received various VR social skills lessons, including communicative eye gaze, conversational skills, descriptive language, imitation, understanding and using gestures, emotional regulation, response to auditory information, and social interaction, as shown in **Figure 1**.

| Component | Lesson and task | A glimpse from the lesson |
|---|---|---|
| 1) Communicative eye gaze | Watch it go<br>(The children visually tracks the moving object) |  |
| 2) Imitation | Be a copy hero<br>(The children will imitate an action from an array of six, performed by the avatar) |  |
| 3) Responding to auditory information | Listen and follow the yoga instructions<br>(The children will imitate the yoga poses) |  |

**Figure 1. Examples of VR scenarios**

**Source Floreo | Research-based Virtual Reality Therapy for the Neurodiverse**

A wireless VR headset was used, with focal distance, pupil distance, and headband adjustments tailored to each child. The duration of the VR sessions for each child was approximately 30–35 minutes. A total of 36 sessions were carried out over 3 months. **Table 1**. represents the VR lesson plan. These lessons were meticulously organized to ensure optimal learning outcomes.

| Sessions | Intervention |
|---|---|
| 1,2 | Pretest was assessed |
| 3-5 | Communicative eye gaze lessons were given (Meet the animals, watch it go! Emma is pointing, Look and find 180). |
| 6-8 | Conversational skills lessons were given (Choose your greeting, chit chat with myra, Join the conversation: Park, Join the conversation: Cafeteria). |
| 9-11 | Descriptive Language lessons were given (Spatial concepts: Up and down, Left and right, In and out). |
| 12-14 | Imitation lessons were given. (Be a copy hero, be an echo hero, Show 'em what to do, Start the gestures game) |
| 15-17 | Understanding and using gestures lessons were given (Start the gestures game, who's turn is to push the swing? Move, giraffe! It's time to swing). |
| 18,19 | Emotional Regulation lessons were given (Play the Marimba, Watch the train, Snowfall, Find the fish, Breathing train) |
| 20-22 | Responding to auditory information lessons were given (Listen and find 1 or 2 animals, by name; Listen and find animals by feature) |
| 23-25 | Social Interaction lessons were given (Reunite the animals, Magic mix; Who's next? Painting with friends) |
| 26-28 | Communicative eye gaze lessons were given (Who made that sound? Safari survey, Look and find 360). |
| 29-31 | Imitation lessons were given (Who made that sound? Safari survey, Look and find 360) |
| 32-34 | Understanding and using gestures lessons were given (Emma is pointing, Look and find 360, Look and find 180). |
| 35,36 | Post test was assessed |

**Table 1. Details on the intervention consisting of 36 sessions**

During each session, three to four VR lessons were conducted, with a brief break between sessions to minimize VR-induced visual fatigue. The software utilized in this study was Floreo VR, which is an FDA-approved virtual reality platform specifically designed to train social,

behavioral, and life skills in neurodiverse individuals.[9-10] The use of Floreo VR necessitated a wireless VR headset, an iPhone 7 or higher, iOS 15 or higher, and a Wi-Fi connection. The same materials were used in this study. The execution of the VR application is illustrated in **Figure 2**. Conventional occupational therapy (OT) interventions included Sensory Integration (SI), Group therapy, social skills training and play therapy. Eventually, the post-test was conducted.

**Figure 2. A child with ASD responding to a non-verbal gesture made by an avatar in the VR scenario**

**Data Analysis**

The researchers employed IBM SPSS version 23.0 to perform the statistical analyses. Owing to the small sample size (30), a non-parametric method was used. The Wilcoxon signed-rank test was applied to analyse the statistical difference between pre- and post-test within the same group, whereas the Mann Whitney U test was utilised to measure differences between the groups. $P<0.01$ and 5% alpha level was measured to be statistically significant.

**RESULTS**

The demographic profiles of the children with ASD, including their allocation to the experimental and control groups, are presented in **Table 2**. The age of the included children ranged from 6 to 12 years, of which the average age was Mean ± SD: 8.8 ± 1.86 for the experimental group and Mean ± SD: 9.2 ± 1.74 for the control group. Both groups included 12 males (80%) and 3 females (20%). According to ISSA severity level, 7 (46.66%) children were classified under mild autism and 8 (53.33%) under moderate autism in control group, whereas the experimental group comprised 6 (40%) children with mild autism and 9 (60%) with moderate autism.

| Characteristics | Control group, n (%) | Experimental group, n (%) |
|---|---|---|
| Number of children | 15 (50) | 15 (50) |
| Age (Mean ± SD) | 8.8±1.86 | 9.2±1.74 |
| Gender (male/female) | 12 (80) /3 (20) | 12 (80) /3 (20) |
| ISAA severity level<br>Mild | 7 (46.66) | 6 (40) |
| Moderate | 8 (53.33) | 9 (60) |

SD: Standard Deviation, ISAA: Indian Scale for Assessment of Autism.

**Table 2. Demographics of the children with ASD**

As shown in **Table 3**, the average post-test mean score (82.1333±5.05494) was higher than that of the pre-test (80.7333±5.24359), and the P = 0.00 (95% confidence interval [CI] = -5.086 to 2.286) is less than 0.05. The pre- and post-test scores of ASSP-2 in the control group showed a statistically significant difference, suggesting that the intervention received by this group resulted in substantial improvement.

| Control group | N | Mean | SD | Z | P | 95% CI |
|---|---|---|---|---|---|---|
| Pre-test | 15 | 80.7333 | 5.24359 | -3.520 | 0.00* | -5.086 to 2.286 |
| Post-test | 15 | 82.1333 | 5.05494 | | | |

*Significant at 0.05 alpha level. SD: Standard Deviation, CI: Confidence Interval

**Table 3. Statistical analysis of Autism Social Skills Profile-2 scales between pre- and post-test of control group.**

As shown in **Table 4**, the average post-test mean score (86.2±4.05674) was higher than that of the pre-test (81.2667±5.03511), and the P = 0.001 (95% CI = -8.206 to -1.661) is less than 0.05. The pre- and post-test scores of ASSP-2 in the experimental group showed a statistically significant difference, suggesting that the intervention received by this group resulted in substantial improvement.

| Experimental group | N | Mean | SD | Z | P | 95% CI |
|---|---|---|---|---|---|---|
| Pre-test | 15 | 81.2667 | 5.03511 | -3.440 | 0.001* | -8.206 to -1.661 |
| Post-test | 15 | 86.2 | 4.05674 | | | |

*Significant at 0.05 alpha level. SD: Standard Deviation, CI: Confidence Interval

**Table 4. Statistical analysis of Autism Social Skills Profile-2 scale between pre- and post-test of Experimental group.**

In **Table 5**, the P = 0.037 (95% CI = -7.347 to 0.787) is less than 0.05. The post-test ASSP-2 scores in both groups showed a statistically significant difference, suggesting that the intervention received by experimental group had greater improvement compared to the control group.

| Post-Test | N | Mean | SD | Z | P | 95% CI |
|---|---|---|---|---|---|---|
| Control | 15 | 82.1333 | 5.05494 | -2.094 | 0.037* | -7.347 to 0.787 |
| Experimental | 15 | 86.2 | 4.05674 | | | |

*Significant at 0.05 alpha level. SD: Standard Deviation, CI: Confidence Interval

**Table 5. Statistical analysis of Autism Social Skills Profile-2 scale between the post-test scores of both groups.**

**Discussion**

This study aimed to investigate the efficacy of Virtual Reality (VR) technology in fostering social skills in children diagnosed with ASD, by incorporating it into a clinical context. The intervention group received VR lessons tailored to address specific social skill deficits including social reciprocity, participation, questioning, receptivity, and recognition of social cues, whereas the control group received conventional treatment. Statistical analyses were performed, and the results revealed that both interventions yielded positive outcomes, but VR intervention caused significant improvement compared to conventional OT.

The results of the control group's post-test showed remarkable upswing after conventional occupational therapy interventions. This finding aligns with previous studies that substantiate the effectiveness of group therapy, social skills training (SST) and play therapy. A study conducted by Rajeev Ranjan *et al.,* concluded that the children with ASD were able to initiate, sustain and finish tasks along with their peers, resulting in enhanced social interaction.[11] A study conducted by Yizengaw SS, found that SST improved SER and SPA, and decreased the DSB on ASSP scale.[12] A study conducted by Kinkuri Sahib *et al.,* demonstrated that play-mediated therapy ameliorated play, leisure, coping and interpersonal skills under socialization domain in Vineland Adaptive Behavior Scale-2.[13]

After 32 sessions of VR intervention, the ASSP-2 scores for SER, SPA, and DSB revealed a noteworthy increase in the experimental group, as well as compared to the post-test scores of control group. These outcomes are consistent with those of other previous investigations as follows. A study conducted in 2022, examined the effectiveness of VR technology in enhancing the cognitive, social and imitative aspects of children with ASD. The study administered, VR therapy for the experimental group and regular rehabilitation training for the control group for 3 consecutive months. Subsequently, arrived at notable results in VR group after intervention ($P<0.05$). Also, greater efficacy was observed in the areas of cognition, language comprehension, social interaction, emotional expression and mimicry compared to control group. ($P<0.05$).[14]

Another study conducted by Frolli in 2021, which aimed to investigate the use of VR for supporting social skills, employed VR based emotional training for one group and therapist mediated training for the other. The results concluded that both standard and VR interventions showed efficacy in the recognition of primary and secondary emotions ($P=0.25$). However, VR intervention resulted in the recognition of secondary emotions with a shorter acquisition duration ($P<0.05$).[15]

Hence, this study provides promising evidence for integrating VR into clinical setting to develop social skills in children with ASD. Contrary to conventional OT treatments, VR is a three-dimensional technology that simulates real life scenarios, such as engaging in conversation with peers, exhibiting nonverbal gestures, visual tracking and other social situations. This controllable and safe technology also enables children to practice lessons repeatedly.

Authors recommends that, continuous follow-ups can be integrated to determine the long-standing effects. Additionally, in a clinical setting, specific lessons can be customized and planned by therapists according to the needs of each child. Also, future studies may consider examining VR lessons in the mother tongue of the research participants.

**Conclusion**

The global occurrence of autism spectrum disorder is notably on the rise. In addition to conventional therapy, innovative approaches to intervention are being explored to address ASD symptoms and occupational therapists may consider adopting virtual reality as a part of the clinical intervention. By providing repeated exposure to various social scenarios, VR interventions help children with ASD develop and refine their social skills, potentially leading to improved real-world interactions and overall quality of life.

**Conflict of Interest**

The authors declare no conflict of interest.

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**Ethical approval and consent**

This study was conducted according to the guidelines of the declaration of Helsinki and was approved by the Institution Scientific Review Board (ISRB) of the Saveetha College of Occupational Therapy (SCOT/ISRB/047/2023). This study was conducted at the prathikshaa rehab center (Chennai, Tamil Nadu, India) for 3 months. Informed consent was obtained from the caretakes of the children and administrative firm.

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