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La Realidad Virtual como apoyo en psicoterapias para niños con autismo y/o ansiedad social: una revisión sistemática

Virtual Reality as a support in psychotherapies for children with autism and/or social anxiety: a systematic review

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RESUMEN

Propósito

El crecimiento de las aplicaciones de Realidad Virtual (RV) para terapias ha aumentado y se ha diversificado con el tiempo. A través de la RV, se anima a los pacientes a sumergirse en entornos virtuales para interactuar y socializar. En este artículo analizamos las terapias que aplican la RV, como estrategia que atiende necesidades de salud, para mejorar la calidad de vida del paciente en trastornos mentales como la ansiedad y el espectro autista. Además, comparamos las similitudes y diferencias de las terapias, evaluando la eficacia de la RV. Finalmente, presentamos una revisión de la RV desde un punto de vista tecnológico.

Metodología

La búsqueda bibliográfica se guió por las directrices PRISMA; criterios de elegibilidad de los estudios: año de publicación de 2014 a 2022, artículos completos y de acceso abierto. Artículos para mejorar las habilidades sociales en niños y adolescentes con autismo, así como en el abordaje de la ansiedad social en jóvenes. Criterios de exclusión: revisiones sistemáticas, metaanálisis, comorbilidad, postoperatorios y otros trastornos.

Resultados

Consideramos 14 estudios elegibles, con bajo riesgo de sesgo. El 78% de las terapias de RV se implementaron de forma inmersiva y el 85% de forma interactiva, involucrando la participación activa del usuario en entornos virtuales a través de la voz, la mirada y los movimientos corporales. Las terapias de RV para niños con TEA se centran en el desarrollo de habilidades sociales, con reconocimiento de expresiones faciales, reconocimiento de emociones, desarrollo cognitivo social y comunicación verbal y no verbal. Las terapias de RV para la ansiedad social se tratan de manera efectiva con meditación y relajación muscular progresiva.

Conclusión

La RV puede simplificar la vida de aquellos pacientes que no pueden salir de casa, debido a una enfermedad o discapacidad, permitiéndoles cumplir con las sesiones de terapia.

Palabras clave: Realidad virtual, terapias psicológicas, trastornos de ansiedad social, habilidades sociales, autismo (Trastorno del Espectro Autista (TEA)).

ABSTRACT

Purpose

The growth of Virtual Reality (VR) applications for therapies has increased and diversified over time. Through VR, patients are encouraged to immerse themselves in virtual environments to interact and socialize. In this article we analyze the therapies that apply VR, as a strategy that addresses health needs, to improve the patient's quality of life in mental disorders such as anxiety and autism spectrum. Furthermore, we compare the similarities and differences of the therapies, evaluating the efficacy of VR. Finally, we present a review of VR from a technological point of view.

Methods

The literature search was guided by PRISMA guidelines; study eligibility criteria: year of publication from 2014 to 2022, full-length and open access articles. Articles to improve social skills in children and adolescents with autism,as well as in addressing social anxiety in youth. Exclusion criteria: systematic reviews, meta-analyses, comorbidity, postoperative, and other disorders.

Results

We considered 14 eligible studies, with a low risk of bias. 78% of VR therapies were implemented immersively and 85% interactively, involving active user participation in virtual environments through voice, gaze, and body movements. VR therapies for children with ASD focus on the development of social skills, with facial expression recognition, emotion recognition, social cognitive development, and verbal and non-verbal communication. VR therapies for social anxiety are effectively treated with meditation and progressive muscle relaxation.

Conclusion

VR can simplify the lives of those patients who are unable to leave home, due to illness or disability, allowing them to comply with therapy sessions.

Keywords: Virtual reality, psychological therapies, social anxiety disorders, social skills, autism (Autism Spectrum Disorder (ASD)).

1. Introduction

In recent years, virtual Reality (VR) has grown and applications have been developed in different professional areas such as medicine, education, architecture, video games, sightseeing tours, and e-commerce, among others.

VR applications for therapies have increased and diversified over time. It has been found that physiotherapy supported by virtual reality, immerses the patient in an experience that distracts him/her from the pain and can perform the exercises, incorporating it as an analgesic, helping patients to overcome the barriers they put to perform the exercises (Phelan et al., 2021).

Psychotherapies cope with mental illnesses, by using VR to treat different mental disorders (Rivas et al., 2019). This is how VR effectively treats, evaluates, and diagnoses some mental disorders. Some psychotherapies transport patients to immersive and interactive virtual environments, safe and controlled by the researcher or therapist (Bell et al., 2020). VR under the development of virtual environments promotes positive stimuli, which are combined with psychological therapies, proving to be a valuable tool to improve mental health and public health (Jerdan et al., 2018).

VR simplifies the lives of homebound patients by delivering therapies in a self-guided manner, without a therapist, using avatars to instruct the patient. The therapies incorporate applied computational sciences such as dynamic video technology, machine learning optimization algorithms, biometrics, and programming (Zainal et al., 2021). The objectives of this research are: Compare virtual therapies by category and review intervention methods (traditional therapy vs virtual therapy). To analyze the effectiveness of therapies for anxiety, and autism disorders. Also, present a review of VR from a technological perspective, showing a comparative table of both software and hardware implemented to support each of the disorders studied.

Method

In the systematic review by PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (citation), the searches were in PubMed, Web of Science, Springer Link, and Science of direct. The terms searched:

a. (social skills) AND (virtual reality in children with autism)
b. (((recognition of emotions) AND (facial expressions)) AND (virtual reality)) AND (children with autism)
c. ((virtual reality) AND (psychological therapies)) AND (patients with anxiety)
d. (Virtual reality) AND (therapies for patients with social Anxiety disorders)

For the development of this article, bibliographic searches of articles published from 2014 to September 2022 were performed.

Eligibility criteria

The selection process of publications was based on studies dedicated to psychotherapies with virtual reality in patients with mental disorders of autism and anxiety. Primarily articles to improve social skills, and emotional recognition in children and adolescents with autism. As well as articles to treat, social anxiety. We considered the summary of articles corresponding to the topics addressed in this review, especially open access articles that show the method, design, implementation, and results.

Exclusion criteria

Studies outside the 8-year range, systematic reviews, meta-analyses, studies with augmented reality and mixed reality were excluded. Also, those that included comorbidity, postoperative, addictions, psychosis, and therapies for adults with autism. Some subtypes of mental disorders such as fear of flying, stress, and obsessive-compulsive disorder.

The selection is shown in Fig. 1 by mental disorder. The search for autism yielded 2502 articles; after automation and elimination of duplicates, 130 articles remained; applying the screening criteria, 8 were selected (see Fig. 1 (a)). For screening, studies should not be combined with other diseases or other types of mental disorders or medication treatments. These aspects applied to all disorders. For social anxiety disorder, the searches yielded 8465 studies; after automation and removal of duplicates, 121 studies remained. After the screening, 6 studies for social anxiety (see Fig. 1 (b)).

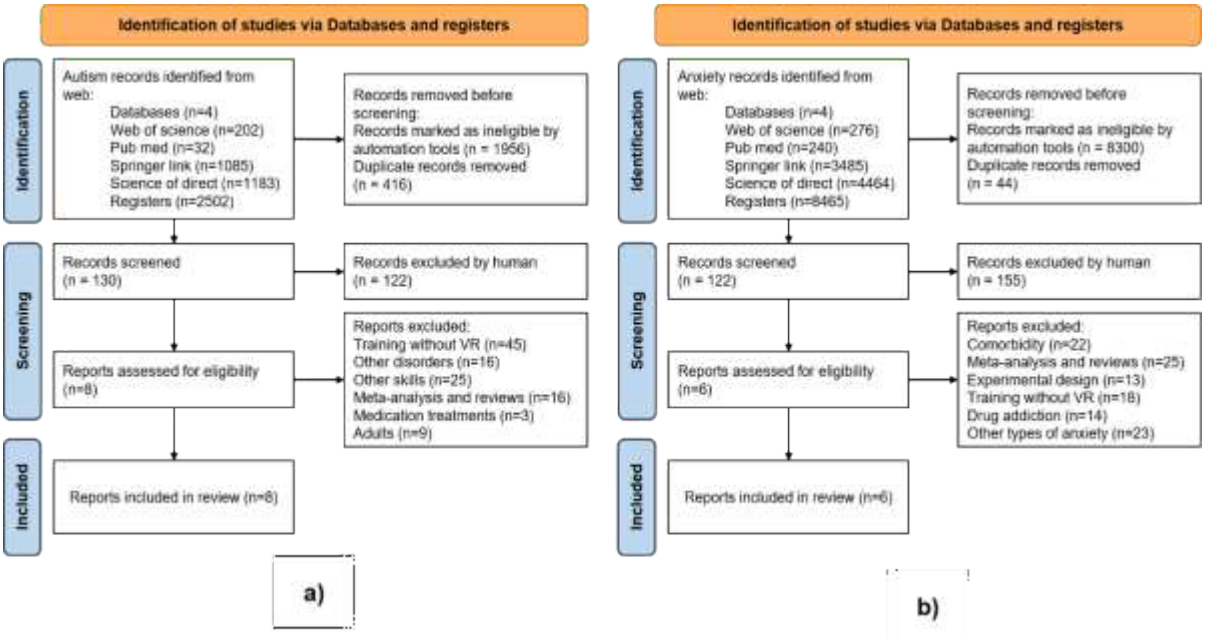

Figure 1. PRISMA Flow Diagram of Study Selection Process, (a) autism, (b) anxiety

Risk of bias and quality Assessment

The Cochrane risk of bias assessment tool was selected to assess the methodological quality of the included studies. The tool was selected according to the methods recommended by the Cochrane Collaboration (Higgins, 2011). The following judgments were used: low risk, high risk, or unclear (either lack of information or uncertainty about the potential for bias). For the assessment of the risk of bias and methodological quality of included studies, the parameters assessed were random sequence generation, allocation concealment, blinding of participants and staff, blinding of outcome assessment, incomplete outcome data, selective reporting, and other biases (see Fig. 2).

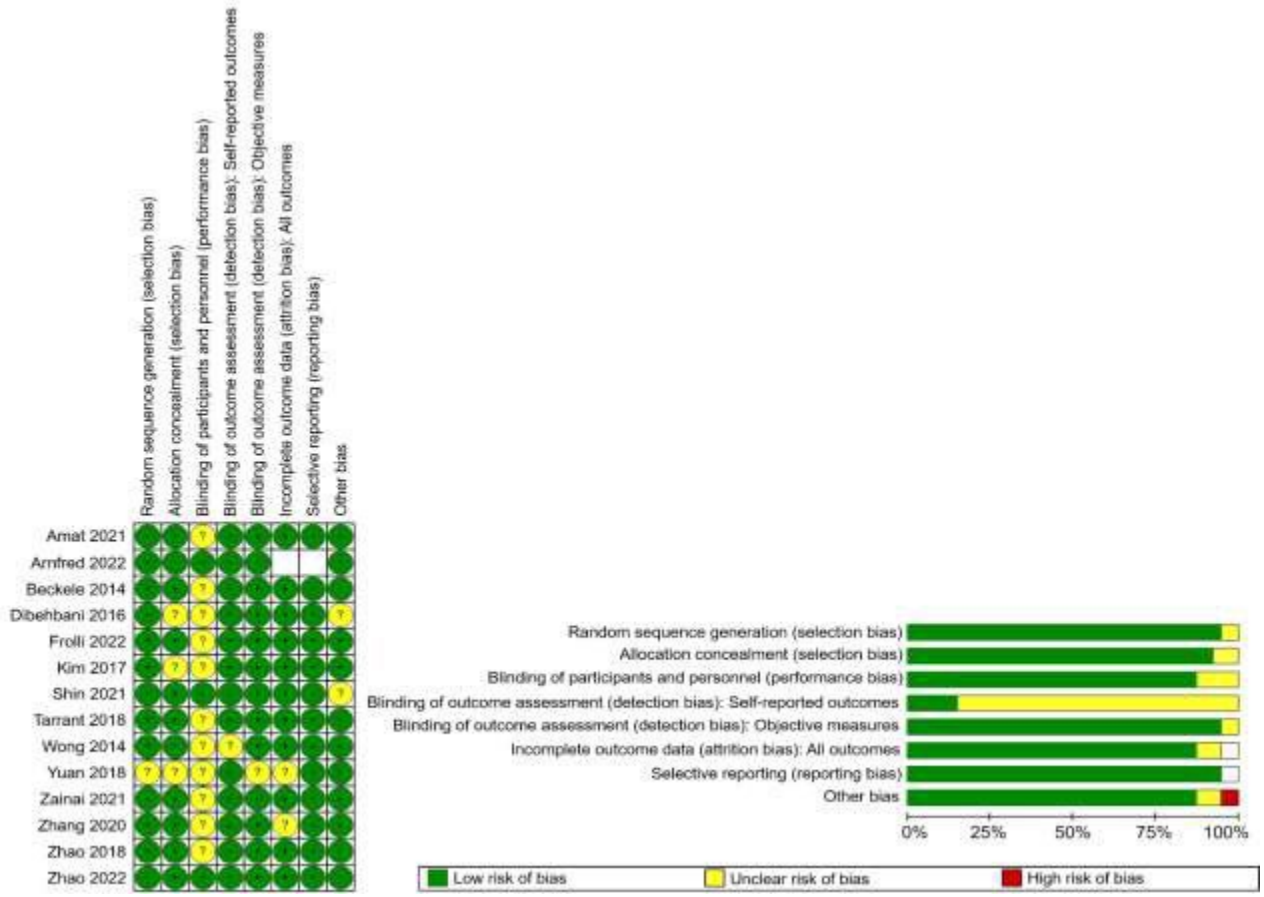

Figure 2. Risk of bias in individual studies

2. Background on autism and anxiety

Within the background: autism has grown over the years, in 2000 one for every 150 children was detected, and in 2018 one for every 44 children. It is four times more frequent in boys than in girls (CDC, 2023). Autism is a neurodevelopmental disorder that globally affects the individual's higher brain functions, such as intelligence, language ability, and social interaction (Mulas et al., 2010).

In recent years, anxiety and depression have become prevalent worldwide. According to figures from the World Health Organization (WHO), it increased by 25% due to the Covid-19 pandemic. At the same time, in 2019, the number of patients suffering from anxiety was approximately 301 million people. This disease is characterized by excessive fear and worry (WHO, 2022).

2.1. Traditional therapies for the management of autism and anxiety

For the management of these disorders, traditional therapies are diverse and help to improve the patient's conditions. The following are the most commonly used:

a) Therapies for children with autism (Autism Spectrum Disorder ASD), behavior management therapy, consists of reinforcing desired behaviors and reducing undesired behaviors; Cognitive behavioral therapy, focused on the link between thoughts, feelings, and behaviors; Early intervention, is performed between two and four years; Educational therapies, develop communication in classes; Therapies to improve joint attention, develop attention such as following a person's gaze or looking at something; Social skills development training, improve interaction with others; Speech and language therapy, improve communication skills and interaction with others; Social cognition training, help in understanding the emotions and intentions of others and act accordingly (NICHD, 2021); Social stories, is a technique of teaching social behavior, how a person should act at a certain time (Gray, 1993).

b) Therapies for anxiety management: Cognitive Behavioral Therapy (CBT) is an effective psychological treatment for anxiety disorders, depression, and severe mental illness. CBT treatment involves changing thinking patterns such as: improving understanding of behavior, using problem-solving skills, learning to develop confidence, and learning to recognize distortions in thinking. CBT strategies include coping with fears, role-playing, learning to calm the mind and relax the body. CBT includes exposure therapy, which consists of exposing the patient to objects or situations they fear, gradually, to confront patients with situations that help them to control fear, negative feelings, and thoughts (Beck, 2011).

2.2. Software, hardware for virtual reality, and other technologies

Psychological therapies appreciate virtual reality as a support tool. VR is defined as a computer-generated virtual environment where the user experiences and interacts in places that mimic the real world. In the virtual environment, sensory stimuli are experienced with scenarios, sounds, images, and 360-degree videos. Complementing the above, 360-degree videos immerse the viewer in complete scenes, to explore and view the video from different angles. Like 360-degree images, they contain the entire scene, unlike a photograph, which must be taken several times.

Continuing with psychological therapies with VR, virtual environments such as a room, supermarket, elevator, farm, or objects are recreated. For this, video game engines are required, such as 3ds Max, Unreal, Stride, Godot, and Unity 3D, the latter being the most widely used. Psychological therapies with VR can also include immersion, an example being 360-degree videos. The immersion consists of involving users in a new experience, immersing the viewer in an almost real world, it is the illusion of being present in a virtual environment; hardware devices are required for an immersive experience, oculus go, oculus rift, oculus quest, HTC Vive, HTC Vive Pro, that include manual controls, except VR glasses for Smartphone, it is only a viewer that requires a mobile phone.

In contrast, a non-immersive experience is viewed on the computer screen without head-mounted glasses. Some VR psychotherapies require devices that record movements and use Tobi-eye for eye tracking and leap motion for hand movement detection. In addition, VR therapies can be complemented by other technologies, in particular artificial intelligence (AI), the ability of machines, or systems, to learn from data through algorithms and apply what they learn. Applications of AI include computer vision for object detection and video and image analysis. The OpenCV library contains hundreds of useful algorithms for facial expression recognition, object tracking, and so on.

Another application of AI is natural language processing (NLP) so that the system understands text and speech as humans do. VR therapies require the system to interpret, recognize, and analyze text and voice. For example, Google's Speech-to-Text tool converts speech into text.

The avatars guide the development of the therapy and are programmed with finite-state machines, which detect events that are converted into actions performed by the avatar. They can also include intelligent agents modeled with AI algorithms to respond to the needs of the application and can process and interpret information from the environment. A further tool for VR therapies is EyeMMV (Eye Movements Metrics & Visualizations), which is used for eye movement observation, visualization techniques, supports eye tracking metrics and is very useful in therapies for children with autism.

Given this preamble, the formal structure of this paper is described below: Section two describes VR psychotherapies for ASD. Section three presents VR psychotherapies for anxiety disorders. At the end of this section we describe the characteristics of the therapies addressed in summary form within a set of tables. Likewise, we presented the similarities and differences of VR psychotherapies from a technological perspective are discussed, as well as the form of implementation (immersive or non-immersive). Within these tables, it is verified whether they integrate traditional psychotherapies into the therapeutic plan or not and whether they work with the support of therapists. The results of each study are compared to verify the effectiveness of the therapies and finally, the inclusion of other applied computer sciences in support of these therapies is reviewed. Section four presents the discussion and section five describes the conclusions.

3. Virtual therapies in patients with Autism Spectrum Disorder (ASD)

Following is a description of selected works that employ psychotherapies with Virtual Reality applications in support of patients with Autism Spectrum Disorder.

Bekele et al., (2014) focus their study on adolescents with ASD, mentioning that one of the deficiencies of this disease is recognizing non-verbal communication and recognizing facial expressions. In their study, they teach adolescents to recognize facial expressions, supported by avatars in simulated situations in virtual environments. The project contains seven avatars: four males and three females with the physical characteristics of teenagers. The facial expressions used are joy, surprise, contempt, sadness, fear, disgust, and anger. Each expression has four levels of emotional intensity (low, medium, high, and extreme). They examined glances between facial and non-facial regions using an eye tracker and also analyzed the time spent on emotion displays in the forehead, eyes, and mouth. Heat maps of facial expressions were used to assess differences between groups of adolescents with and without ASD. This study can help not only in recognizing facial emotions but also in the way children with ASD recognize emotions.

Children with ASD struggle with social skills, so Didehbani et al., (2016) safely address this issue, with virtual reality social cognition training (VR-SCT). The scenarios are adjusted to different complexities, depending on the age of the participant. Patients have personalized avatar that closely resembles them and their doctors. Doctors take on various roles within virtual environments, including a voice modifier, with which they change their voice to a child, woman, or man. The lifelike virtual scenarios are used to train social cognition, ranging from a school classroom, school canteen, playground, campground, racetrack, fast food restaurant, technology shop, and one department. Patients in the sessions deal with different scenarios in which they confront conflicts, deal with a bully, bond with friends, meet new people, and handle social dilemmas. To learn in different contexts and to train social skills such as initiating a conversation, knowing their emotions, collaborating with others, making decisions, developing social relationships, and self-affirmation.

A further study is presented by Yuan and Ip (2018), they focus on practicing the skills repeatedly, the virtual environment is a four-sided cave, which allows interaction with objects and avatars. The psychotherapy comprises six scenarios: one relaxation, four training, and one consolidation scenario. These scenarios are controllable, and safe, in a typical Hong Kong primary school environment. During the session, patients are guided and supported by a trainer, and at the end of the training, the children improved their emotional expression and regulation, as well as social interaction. This type of VR-based intervention is a valuable complement to traditional therapies for children with ASD, resulting in improvements in emotional understanding, social communication and adaptive behaviors.

Promoting real-time interaction and verbal communication between players through gameplay was the objective of the study presented by Zhao et al., (2018). Its design is engaging, easy to learn, and interactive and each game has a time limit. VR therapy forced both players to communicate and work collaboratively, to virtually move the same object, they must control the direction of the movements, without the help of a player, the piece can neither be chosen nor moved. The authors implement the client-server architecture, to play in real time on different computers. It requires a tracker that detects eye movements (Tobii eyeX), and a controller to detect players' hand movements and gestures in front of the screen (Leap motion). At the end of the study the children with ASD improved their social, communication and joint attention skills. This therapy provided a safe and comfortable environment for children with ASD.

Another way to speak about communication and social collaboration challenges in children with ASD is Creta, an intelligent agent that interacts in a collaborative virtual environment (CVE). In this project, communication and collaboration skills are monitored and indexed. Creta has two modes of human-human interaction (HHI) and human-intelligent agent interaction (HAI). Creta in HHI mode monitors the interaction of two patients, evaluates communication and collaboration. Creta in HAI mode, the patient plays with the intelligent agent and evaluates the performance of the patient's collaboration and communication skills. The project uses a finite state machine for the intelligent agent's cues, in addition, two machine learning models were built, the first one measured communication skills and the second one measured collaboration skills (Zhang et al., 2020).

On the other hand, to improve basic attention skills as following and sharing glances in children with ASD, InViRS was created, containing an algorithm that detects eye contact in real-time, an algorithm for adjusting the difficulty of the task, and an avatar controller that coordinates in real-time. All this is for joint and individualized closed-loop attention. VR psychotherapy manages the difficulty based on gaze data, game states, and avatar states. In addition, it contains two games, in the first game the player has to pop bubbles by looking at them, and in the second game the player has to put together a puzzle, the child looks at the piece, and it is highlighted with a color and moves the object with the mouse. If the participant does not look at the piece, the avatar is activated with

assistance events, so that the child focuses and completes the task. InViRS significantly improved the time to complete the game and response time in children with ASD (Amat et al., 2021).

Another more recent study was conducted in Rome, which was used for emotional literacy in children with ASD, using two different methods: the first with traditional therapy by a therapist and the second with VR support. There were two groups: the first used emotional literacy with VR (VRI) and the second used individual intervention with a therapist (IIT individual intervention with a therapist). The first group used 3D projections, worked with scenes for the recognition of primary emotions (PE) and secondary emotions (SE). Then they worked on situations with both primary emotions (ESPE) and secondary emotions (ESSE). The second group, working with 76 photographs using traditional therapy, aimed at emotional literacy. Like the first group, they first worked with primary and secondary emotions. Then they worked with primary and secondary situations and emotions by randomly presenting the photographs. Both groups did the same time for emotion recognition, but the VR group was faster in using primary and secondary emotions (Frolli et al., 2022).

Finally, Zhao et al., (2022) developed a study comprising two groups: a VR intervention group and a control group. In the control group, they conducted the following three conventional training sessions with a duration of 40-45 minutes each: the first training is about a group class, where the therapist gives oral instructions to the children and offered reinforcement if the child did not respond. The second training is about sensory integration, where the children develop gross motor skills. And the third training is to develop fine motor skills. The VR intervention group, besides including conventional training, contains six scenes developed with virtual environments: looking for things, a garden, forest animals, crossing the river, identifying vegetables, and selling vegetables. This experiment aims to focus on cognitive understanding, social imitation, gross motor skills, emotional expression, and language of children with ASD in an immersive, fun way, proving to be better than the control group only in the area of cognition and social interaction.

4. Virtual therapies for patients with Anxiety disorders

Anxiety disorder is characterized by excessive fear and worry. The types of anxiety are panic disorder, phobias, social anxiety, agoraphobia, and separation anxiety (WHO, 2022). Next, is a description of selected works that employ psychotherapies with Virtual Reality applications in support of patients with Anxiety disorders.

Wong et al., (2014) developed a study to treat social anxiety in preadolescent children. It is an interactive, but non-immersive school-based environment where children interact with virtual avatars (teachers, principal, and peers), the virtual settings are classroom, hallways, and gymnasium. The program contains four social skills, initiating conversation, maintaining conversation, giving and receiving compliments. Each skill has 3 levels of difficulty. The therapist has the power to control the direction, pace, and level of difficulty. This software is used at home with brief, repeated interactions, three times per week. In addition to the weekly clinic session.

Kim et al., (2017) developed a VR application, which uses mobile devices for the treatment of social anxiety. The therapy is performed by the patient, from the comfort of their home with the help of avatars that inform and introduce the patient during the training sessions. The heart rate is taken during the VR training, they analyze the percentage change in the listening and speaking phase. The psychotherapy addresses social situations with virtual environments simulating school, business, and everyday life, with levels of difficulty increasing as they progress. Results showed that it is beneficial in reducing anxiety and improving social interaction skills in patients with social anxiety.

Tarrant et al., (2018) presented a system using VR therapy for anxiety management. They analyzed Alpha and Beta brain waves, which were recorded with an encephalographic study (EEG). The results obtained from the EEG were analyzed with sloreta (low-resolution electromagnetic tomography), in the regions of interest (ROI) which were: the posterior cingulate cortex (PCC) and anterior cingulate cortex (ACC) associated with cognitive and emotional processing. The patterns associated with anxiety and stress are Beta waves (increase) and Alpha waves (decrease). Therefore, a decrease in Beta frequency and an increase in Alpha waves are consistent with reduced anxiety and stress. During the study, they performed three measurements, in both groups (control and intervention VR). For the meditation in the VR group, they used 360-degree videos with a duration of 5 minutes, accompanied by piano and violin music. The viewer was voice-guided to mindfulness meditation. After the meditation, the Alpha and Beta waves changed validating the decrease in anxiety.

On the other hand, virtual reality exposure (VRE) therapies for social anxiety have been effective, and regulated by therapists, but this therapy works in a self-guided manner without a therapist. For the VRE training, two scenes, a formal job interview, and an informal dinner, were created with dynamic video technology, driven by machine learning optimization algorithms, biometrics, and programming. The videos could be operated with a tablet enabled to detect head movements and voice. The virtual therapist guides the patient through the scene, repeating instructions if the patient does not respond within 5 seconds. The virtual dinner environment covered the four domains of social fear: fear of assertiveness, fear of intimacy, observation anxiety, and performance anxiety. By performing this self-directed VRE treatment patients did not feel policed, which helps to build confidence, to tolerate, and consequently decrease their symptoms. The audio instructions allowed patients to perform the exercises without difficulty (Zainal et al., 2021).

To treat panic disorder, self-guided virtual therapy is supported by cognitive behavioral therapy. VR treatment exposed patients to feared situations gradually. In this context, Shin et al., (2021), carried out a study that contains an avatar as a virtual therapist that teaches patients progressive muscle relaxation and breathing. The patients were exposed to various situations in virtual environments guided by the avatar such as driving a car, taking an elevator, getting on a plane. Each virtual environment has different exposure levels and different virtual-guided and unguided modalities. The VR intervention was effective in treating panic symptoms and restoring the autonomic nervous system.

Another study for patients with social anxiety and agoraphobia was presented by Arnfred et al., (2022). They compared live cognitive behavioral group therapy (CBT-in vivo) vs. cognitive behavioral group therapy with virtual reality exposure (CBT-in virtuo) for mixed anxiety, showing very good results among the participants. They developed 13 virtual scenarios: supermarket queue, crowded shopping mall, attending a party, formal meeting and making a presentation, job interview, small talk, debating in a canteen, entering an auditorium, leaving your department, waiting and taking the bus, crossing a bridge, taking the lift, taking a commercial airliner, each having four to six levels of difficulty.

In summary, Table 1 presents the characteristics of the VR treatment plan of the articles reviewed for autism spectrum disorders.

Authors	Metrics, variables, scales, and tests used	Sample size	Duration of study	Traditional therapy	Therapy applied with VR	Study results	Limitations of the study
Bekele et al., (2014)	ADOS SB WISC WASI	20 participants 10 with ASD and 10 without ASD Aged 13-17 years old	One hour session	Social skills development training	Developing non-verbal communication with VR	SA system is capable of making changes, in emotion recognition and in the way emotions are recognized Children with ASD were slower in their responses than children without ASD	Small sample size Refine the stimuli and further develop the VR-programmed
Didehbani et al., (2016)	WASI NEPSY-II AR Ekman60 Triangles	30 children Aged 13-16 years old	5 weeks with 10 one-hour sessions	Social Cognition Training	VR Social Cognition Training (VR-SCT)	Improved social cognitive skills, as well as emotion recognition, social attribution and logical reasoning	Small sample size No VR vs. non-VR comparison group No real-time display of avatar emotions
Yuan & Ip., (2018)	PEP-3 (using 10 subtests, 6 measure developmental skills, and 4 measure maladaptive behaviors)	94 children	Unknown	Social stories	Social Stories in CAVE (cave Assisted Virtual Environment)	Determined the competencies of each child and improved the expression and regulation of emotions, as well as social interaction in	CAVE is expensive to develop and maintain, requires a large space, is fixed, and cannot be moved to other institutions

						children with autism	
Zhao et al., (2018) SRC	SRC Complete pieces (/minute) Cooperative Efficiency (%) Total play time (S) Back-and-fort Sentences (/per minute) Words count of one player (/minute)	12 groups: one child with ASD and one child without ASD	Unknown	Social skills development training	Interactive and collaborative games that detect eye, hand, and gesture movements	Improved game cooperation and communication by sharing information and discussing game strategies	Small sample size No haptic interface
Zhang et al., (2020)	SRS-2 ADOS IQ SCQ Success Frequency Failure frequency Dragging time Collaboration time	40 participants: 20 with ASD and 20 without ASD	40 minutes sessions with a 10 minutes break between each game	Behavioral therapy	Collaborative virtual environments with distributed systems for two players interacting with each other remotely	Moderate to high improvement in communication and collaboration skills	Limited to certain interactions and relatively small in size
Amat et al., (2021)	ADOS SCQ SRS-2 Score Time to complete(seconds) Responsive time (seconds) Fixation point Ratio of gaze Fixation on the eye to gaze Fixation on other facial features	18 children 9 children with ASD and 9 children without ASD Aged 7-13 years old	three sessions, with 5 to 10 days between visits	Therapy to improve joint attention	VR therapies focused on building joint attention skills	Improved performance with higher scores and shorter response time. Improved gaze communication	Relatively small sample size
Frolli et al., (2022)	VCI PRI WMI PSI	60 people were randomly divided into	Three times a week, for 3 months	Emotional Literacy Psychotherapy	Emotional Literacy Psychotherapy with Virtual	Helps to recognize emotions from facial expressions and basic and	Not tested with different levels of autism

	QIT ADOS-2	two groups			Reality (VRI)	complex social skills. Emotion and situation recognition for primary and secondary emotions	Does not assess the maintenance of acquired skills in the medium and long term
Zhao et al., (2022)	PEP-3 Cognitive Language comprehension Gross motor Mimicry Social Interaction Emotional expression	47 children were divided into groups: VR intervention and control. Aged 3-5 years old	Three times a week for 12 weeks	Cognitive behavioral therapy and social skills training	VR therapies for training: cognitive, emotional, gross motor, imitation, language understanding	Effectively promotes cognitive and social communication skills	No training guide to guide and support children in the virtual environment

Table 1. VR therapies for autism spectrum disorder

Note. ADOS = Autism diagnostic observation Schedule, *ADOS-2* = Autism Diagnostic Observation Schedule, *Ekman60* = Facial Expressions of Emotion Stimuli and Test, *IQ* = Intelligence Quotient, *NEPSY-II AR* = Second edition-facial affect recognition, *PEP-3* = Psychoeducational Profile, *PRI* = Visual perceptual reasoning index, *PSI* = processing speed index, *QIT* = intelligence quotient total, *SB* = Stanford Bitnet, *SCQ* = Social Communication Questionnaire Lifetime, *SRC* = Social Responsiveness Scale, *SRS-2* = Social Responsiveness Scale, Second Edition, *Triangles* = Social Attribution Task, *VCI* = verbal conversion index, *WASI* = Wechsler Abbreviated Scale of Intelligence, *WISC* = Wechsler Intelligence Scale for Children, *WMI* = working memory index.

Below, the characteristics of the VR therapeutic plan of the reviewed articles for anxiety disorders are presented (see Table 2).

Authors	**Metrics, variables, scales, and tests used**	**Sample size**	**Duration of study**	**Traditional therapy**	**Therapy applied with VR**	**Study results**	**Limitations of the study**
Wong et al., (2014)	ADIS-C/P DSM-IV Charleston Outpatient	11 child aged 8-12 years	Unknown	Social Effectiveness Therapy for Children, peer sessions	Provided children with intensive, customizable and flexible social skills practice therapy	Difficulties in video camera monitoring	Unknown
Kim et al., (2017)	MINI HADS LSAS	52 participants	four weeks,12 sessions in total, duration	Cognitive behavioral therapy	Application of VR for exposure therapy	VR application was beneficial in reducing anxiety and improving social	Unknown

			15-30 minutes per module	Exposure therapy		interaction skills.	
Tarrant et al., (2018)	GAD-7 sLoreta	26 participants in two groups: VR and control	One session	Meditation therapy	Mindfulness-in-nature VR intervention	Virtual therapy helped to reduce anxiety and hyperexcitability Both groups increased alpha power	Small sample and only one session
Zainal et al., (2021)	MINI SPDQ SIAS MASI PHQ-9 PSWQ IPQ SUDS	44 participants Aged 19-69 years old	8 sessions	Group Exposure Therapy (EGT)	Self-directed Virtual Reality Exposure Therapy (VRE)	VRE was clinically effective in reducing fears of public speaking	Unknown
Shin et al., (2021) PDSS	PDSS, HRSD, BSQ, APPQ, ASI, STAI, HADS, k-SADS	54 patients in two groups: VR and traditional therapy Aged 19-60 years	Duration 4 weeks, 3 times per week, 12 sessions in total	Cognitive Behavioral Therapy (CBT) (including education about dysfunctional thoughts, cognitive restructuring, breathing re-education, and applied relaxation)	Self-directed VR CBT	The VR group showed significant improvements in psychological distress, concerning panic, anxiety, and depression Decreased heart rate and a balanced autonomic nervous system	High dropout rate Heart rate was not measured in low anxiety states
Arnfred et al., (2022)	LSAS, MIA, POMP, MINI, DSM-5, HAM-6, FNES, WSAS, CSQ, WHO-5, PSP, TLFB, WAI, SSQ	302 participants were divided into two groups: CBT-in vivo and CBT-in virtual Aged 18-75 years	14 two-hour sessions of group therapy, with 8 sessions of in-virtual exposure	Cognitive Behavioral Therapy with exposure therapy, using CBT-in vivo	Cognitive Behavioral Therapy with exposure therapy with virtual reality CBT in virtual	The study is still in progress	No interaction in the virtual environment, immersive 360-degree videos Therapy has not been investigated

							with two different disorders in the same group (agoraphobia and social anxiety)

Table 2. VR therapies for anxiety disorders

Note. ADIS-C/P = anxiety disorders interview schedule for DSM-IV, *APPQ* = Albany Panic and Phobia Questionnaire, *ASI* = Anxiety Sensitivity Index, *BSQ* = Body Sensations Questionnaire, *CSQ* = Client Satisfaction Questionnaire, *DSM-IV* = Diagnostic and Statistical Manual of Mental Disorders, *DSM-5* = Diagnostic and Statistical Manual of Mental Disorders, *FNES* = Fear of Negative Evaluation Scale, *GAD-7* = Generalized Anxiety Disorder 7-item scale, *HADS* = Hospital Anxiety and Depression Scale, *HAM-6* = Hamilton Depression Rating Scale, 6, *HRSD* = Hamilton Rating Scale for Depression, *IPQ* = I group presence questionnaire, *k-SADS* = Korean Inventory of Social Avoidance and Distress Scale, *LSAS* = Liebowitz Social Anxiety Scale, *MASI* = Measure of Anxiety in Selection Interviews, *MIA* = Mobility Inventory for Agoraphobia, *MINI* = Mini International Neuropsychiatric, *PDSS* = *Panic Disorder Severity* Scale, *PHQ-9* = *Patient Health Questionnaire*, *POMP* = Percentage maximum possible, *PSP* = Personal and Social Performance Scale, *PSWQ* = Penn State Worry Questionnaire, *SIAS* = Social Interaction Anxiety Scale, *sLoreta* = low-resolution electromagnetic, *SPDQ* = Social Phobia Diagnostic Questionnaire, *SSQ* = Simulator Sickness Questionnaire, *STAI* = State-Trait Anxiety Inventory, *SUDS* = Subjective Units of Distress Scale, *TLFB* = timeline, follow back, *WAI* = Working Alliance Inventory, *WHO-5* = WHO Well-Being Index, five items, *WSAS* = Work and Social Adjustment Scale.

A comparative summary is shown in Table 3 of the technologies used in each of the psychotherapies reviewed. Among the data presented are the author and year of publication, application of Virtual Reality, other technologies implemented, software and hardware used during VR therapy (see Table 3).

Autism spectrum disorders				
Author and year	**Application of Virtual Reality**	**Other technologies implemented**	***Software***	***Hardware***
Bekele et al., (2014)	Interactive	Head maps and masked scene maps Avatars	Unity 3d Maya	Tobi-eye x120 eye tracker Desktop computer
Didehbani et al., (2016)	Interactive	Morph Vox (voice transformer) Avatars	Second life with 3d designs	Computer, keyboard, mouse
Yuan and Ip. (2018)	Immersive and interactive	Interactive cave with virtual reality	Unknown	Head-mounted goggles
Zhao et al., (2018)	Interactive	Distributed systems Skype Intelligent agent	Unity 3d	Tobii-eye x, Camera, headsets, Leap Motion

Zhang et al., (2020)	Interactive	Intelligent agent Natural language processing Machine learning Finite state machine	Natural language processing and machine learning technologies Speech recognition software (Google Cloud Speech API)	Microphone, headset, cameras
Amat et al., (2021)	Interactive	Finite State Machine (FMS) Matlab with the EyeMMV toolbox Avatars	Unity Autodesk Maya	Tobii eyeX and Hearing aids
Frolli et al., (2022)	Immersive	3d photographsStatistical software spss 26	3D videos	3D VR viewer
Zhao et al., (2022)	Immersive and interactive	Statistical software spss 25	Unity 3d	VR Glasses
Anxiety disorders				
Author and year	**Application of Virtual Reality**	**Other technologies implemented**	***Software***	***Hardware***
Wong et al., 2014	Interactive immersive	Avatars	Virtual Reality Video Games by Virtually Better, Inc.	Computer, camera, usb
Kim et al., (2017)	Immersive and interactive	Avatars	Unity 3D 3d s Max 2014	Galaxy s6 phone Samsung Gear S2 Insta360 pro
Tarrant et al., (2018)	Immersive	Algorithm sLoreta (low-resolution tomography analysis) Electroencephalogram (EEG) BrainAvatar software Qeeg.pro (website for the service: reports)	360-degree photography and video by storyUP VR	Samsung Gear VR Smartphone Samsung Android s7 BrainMaster Discovery
Zainal et al., (2021)	Immersive interactive	Machine learning optimization algorithms, biometrics, and programming	360-degree videos Worked with companies: Beha VR and Limbix	pico goblin VR headset
Shin et al., (2021)	Immersive interactive	Arterial SA-3000P	3ds max 2014 Unity 3D	Camera insta360 Samsung phone Samsung Gear VR
Arnfred et al., (2022)	Immersive and interactive	Not mentioned	360-degree videos	Oculus go Headset

Table 3 Technologies Applied in VR Psychotherapies

5. Discussion

Among the findings found in this review, it is worth highlighting that of all the studies reviewed, 78% of VR therapies were implemented immersive, and 85% were implemented interactively, involving active user participation in virtual environments using voice, gaze, and body movements.

The challenges faced by children with ASD can be effectively addressed by VR therapies, which focus on building social skills, facial expression recognition, emotion recognition, social cognitive development, and verbal and non-verbal communication. 87% of VR therapies for autism were interactive, and developed through fun, enjoyable, and safe play. 38% of these therapies were implemented in an immersive way, while the remaining 62% were not, using desktop computers, devices that detect the movement of the hands in front of the screen (leap motion), and eye-tracking devices (Tobii-eye). In this way, they avoid the problems caused by immersion, such as dizziness, imbalance, and nausea. They also prevent the adjustment of controls in the hands of young children.

Technologies that helped to complement the intervention plan for children with ASD were: speech recognition with natural language processing, speech transformer, client-server architecture, and distributed systems to work collaboratively on different computers. They also used Skype and Zoom to maintain real-time communication. In addition, they used Machine Learning intelligent agents or avatars to guide the children in their therapy. Unlike therapies for children with ADS, the VR therapies for treating anxiety were 100% immersive and focused on young people and adults. 83% were interactive, with patients facing feared situations and interacting safely in virtual environments.

Anxiety is treated in different ways because there are different types, for example, Kim et al., (2017) treated social anxiety patients with virtual scenarios to face different situations from home. Tarrant et al., (2018) used meditation through 360-degree videos to reduce anxiety levels, monitored with brainwave recording. While Zainal et al., (2021) was without therapist supervision (self-guided), this helped to build patient confidence and reduce anxiety symptoms. Arnfred et al., (2022) used VR group therapies with 360-degree videos to treat anxiety. Shin et al., (2021) treated panic disorder, with progressive muscle relaxation, breathing to lessen and control symptoms, with the guidance of avatars.

The technologies implemented in the anxiety therapies were diverse, ranging from virtual environments with Avatars, 360-degree photography and video, tomography reading and analysis for regions of interest, web page for sloreta reports (Qeeg.pro), machine learning optimization algorithms, biometrics and programming.

The similarity between the studies includes teams of medical specialists, therapists, VR app developers, and incorporates traditional therapies applied for decades in the treatment of psychological disorders. The requirements considered in the design of the VR applications were: the patient's condition, safety, situation tolerance, usability, duration and level of difficulty, and above all co-morbidity. Those involved in the study contributed ideas, performed tests and adjustments together with the medical team, to ensure usability and patient safety. Some studies conducted comparative studies, dividing participants into groups of traditional vs. VR psychotherapies.

VR was complemented by Artificial Intelligence and its branches, Machine Learning with speech recognition algorithms for training intelligent agents, computer vision that implements algorithms for object detection, gaze, and facial feature classification, as well as intelligent agents and avatars. The VR psychotherapies that have been most enriched by these technologies are those of ASD.

VR psychotherapies should be implemented as a support tool that innovates in the way therapies are taken, without replacing the drugs that the patient is taking, as well as the face-to-face monitoring and follow-up visits with the therapist. The ideal is to include intelligent agents to guide and instruct the patient during VR therapy from home, without the supervision of the therapist.

6. Conclusions

VR in the field of psychology is positioning itself as a support tool in remote psychotherapy, where the patient feels comfortable and is motivated by avatars or intelligent agents to advance in their treatment. This is especially valuable for those who have difficulty accessing traditional therapy due to distances or physical limitations.

With VR it is possible to provide a controlled and safe environment for patients to confront and work through their problems. This has been useful for the disorders analyzed in this study such as anxiety, and autism. Disorders that in the real world can trigger situations that are difficult to expose and treat.

It is important to mention that early detection of ASD is crucial to improve its development; there are several subtypes of autism so each child requires different treatments. Virtual reality therapies focus on improving social, communicative, and cognitive skills, which improve the quality of life of the child and his family. These VR therapies show relevant support at this stage, predominantly interactive activities in creative, eye-catching, safely designed virtual environments, which lead children in a fun way to improve their development. Most of these therapies incorporate games, facilitating and motivating their implementation. However, immersive studies in children with ASD are few due to concerns such as motion sickness and lack of adaptation of the equipment to the anatomy of young children.

It is worth mentioning that, although these issues were addressed separately, there is a 40% probability that patients with autism develop social anxiety due to a deficit in social skills. In this context, cognitive behavioral therapies (CBT) have proven to be effective. In addition, virtual reality (VR) therapies, when applied in the treatment of social anxiety in conjunction with CBT, are effective in exposing patients to situations that they must face to overcome their condition (Kerns & Kendall (2012).

The implementation of this technology is attractive as there are different brands of head-mounted glasses that contain or install the VR application to implement therapies in an immersive way. Another option is to use devices with sensors that detect hand movements, gestures, and gazes to implement non-immersive therapies. The least expensive option is with VR goggles and a mobile phone, where the application is installed and used immersive.

Without a doubt, the COVID-19 pandemic has triggered an appreciation of physical and mental health, which has led us to look for technology-supported alternatives that allow medical treatment (telemedicine) and Virtual Reality therapies to be carried out from home. Technology allows us to enrich the alternatives that can be implemented to improve the mental health of the patient, every day more progress is being made in this area, we can see that several researchers are working on it, and are interested in supporting and reducing these mental disorders, which impact a large number of people in our society.

References

Amat, A. Z., Zhao, H., Swanson, A., Weitlauf, A. S., Warren, Z., & Sarkar, N. (2021). Design of an interactive virtual reality system, InViRS, for joint attention practice in autistic children. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, *29*, 1866-1876.

Arnfred, B., Bang, P., Hjorthøj, C., Christensen, C. W., Moeller, K. S., Hvenegaard, M., ... & Nordentoft, M. (2022). Group cognitive behavioral therapy with virtual reality exposure versus group cognitive behavioral therapy with in vivo exposure for social anxiety disorder and agoraphobia: a protocol for a randomized clinical trial. BMJ open, 12(2), e051147.

Beck, J. S. (2011). Cognitive-behavioral therapy. Clinical textbook of addictive disorders, 491, 474-501.

Bekele, E., Crittendon, J., Zheng, Z., Swanson, A., Weitlauf, A., Warren, Z., & Sarkar, N. (2014). Assessing the utility of a virtual environment for enhancing facial affect recognition in adolescents with autism. Journal of autism and developmental disorders, 44(7), 1641-1650.

Bell, I. H., Nicholas, J., Alvarez-Jimenez, M., Thompson, A., & Valmaggia, L. (2020). Virtual reality as a clinical tool in mental health research and practice. Dialogues in clinical neuroscience, 22(2), 169–177. https://doi.org/10.31887/DCNS.2020.22.2/lvalmaggia

Didehbani, N., Allen, T., Kandalaft, M., Krawczyk, D., & Chapman, S. (2016). Virtual reality social cognition training for children with high functioning autism. Computers in human behavior, 62, 703-711., https://doi.org/10.1016/j.chb.2016.04.033.

Frolli, A., Savarese, G., Di Carmine, F., Bosco, A., Saviano, E., Rega, A., ... & Ricci, M. C. (2022). Children on the autism spectrum and the use of virtual reality for supporting social skills. Children, 9(2), 181. https://doi.org/10.3390/children9020181

Gray, C. A., & Garand, J. D. (1993). Social stories: Responses of students with autism with accurate social information. Focus on Autistic Behavior, 8(1), 1-10. doi: 10.1177/108835769300800101

Jerdan S, Grindle M, van Woerden H, Kamel Boulos MN (2018). Head-Mounted Virtual Reality and Mental Health: Critical Review of Current Research. JMIR Serious Games, 6(3): e14 URL: https://games.jmir.org/2018/3/e14 DOI: 10.2196/games.9226.

Higgins JPT, Green S (editors). Manual Cochrane para Revisiones Sistemáticas de Intervenciones. Versión 5.1.0 [updated March 2011]. La Colaboración Cochrane, 2011. Disponible en www.cochrane-handbook.org.

Kerns, C. M., & Kendall, P. C. (2012). The presentation and classification of anxiety in autism spectrum disorder. Clinical Psychology: Science and Practice, 19(4), 323.

Kim, H. E., Hong, Y. J., Kim, M. K., Jung, Y. H., Kyeong, S., & Kim, J. J. (2017). Effectiveness of self-training using the mobile-based virtual reality program in patients with social anxiety disorder. Computers in Human Behavior, 73, 614-619.

Mulas, F., Ros-Cervera, G., Millá, MG, Etchepareborda, MC, Abad, L., & Téllez de Meneses, M. (2010). Modelos de intervención en niños con autismo. Revista de neurología, 50 (3), 77-84.

NICHD (2021, 4 marzo). What treatments are there for autism? Eunice Kennedy Shriver National Institute of Child Health and Human Development. Recuperado 14 de marzo de 2023, de https://espanol.nichd.nih.gov/salud/temas/autism/informacion/tratamientos

OMS, Trastornos mentales. (2022, 8 June). Organización mundial de la salud. https://www.who.int/es/news-room/fact-sheets/detail/mental-disorders

Phelan, I., Furness, P.J., Matsangidou, M. et al. (2021). Playing your pain away: designing a virtual reality physical therapy for children with upper limb motor impairment. Virtual Reality. https://doi.org/10.1007/s10055-021-00522-5

Shin, B., Oh, J., Kim, B. H., Kim, H. E., Kim, H., Kim, S., & Kim, J. J. (2021). Effectiveness of self-guided virtual Reality-based cognitive behavioral therapy for panic disorder: a randomized controlled trial. JMIR mental health, 8(11), e30590. https://doi.org/10.2196/30590

Tarrant, J., Viczko, J., & Cope, H. (2018). Virtual reality for anxiety reduction demonstrated by quantitative EEG: a pilot study. Frontiers in Psychology, 9, 1280. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6066724/#B24

Wong S. N., Beidel, D. C., & Spitalnick, J. S. (2014). The feasibility and acceptability of virtual environments in the treatment of childhood social anxiety disorder. Journal of Clinical Child & Adolescent Psychology, 43(1), 63-73.

Yuan, S. N. V., & Ip, H. H. S. (2018). Using virtual reality to train emotional and social skills in children with autism spectrum disorder. London journal of primary care, 10(4), 110-112. https://doi.org/10.1080/17571472.2018.1483000

Zainal, N. H., Chan, W. W., Saxena, A. P., Taylor, C. B., & Newman, M. G. (2021). Pilot randomized trial of self-guided virtual reality exposure therapy for social anxiety disorder. Behavior research and therapy, 147, 103984. https://doi.org/10.1016/j.brat.2021.103984, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8759454/

Zhang, L., Weitlauf, A. S., Amat, A. Z., Swanson, A., Warren, Z. E., & Sarkar, N. (2020). Assessing social communication and collaboration in autism spectrum disorder using intelligent collaborative virtual environments. Journal of Autism and Developmental Disorders, 50(1), 199-211. https://doi.org/10.1007/s10803-019-04246-z

Zhao, H., Swanson, A. R., Weitlauf, A. S., Warren, Z. E., & Sarkar, N. (2018). Hand-in-hand: A communication-enhancement collaborative virtual reality system for promoting social interaction in children with autism spectrum disorders. IEEE Transactions on human-machine Systems, 48(2), 136-148.

Zhao, J., Zhang, X., Lu, Y., Wu, X., Zhou, F., Yang, S., ... & Fei, F. (2022). Virtual reality technology enhances the cognitive and social communication of children with autism spectrum disorder. Frontiers in Public Health, 10. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9582941/

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