The Open Journal of Occupational Therapy

Volume 9
Issue 3 *Summer 2021*

Article 15

July 2021

The Potential of Virtual Reality in Social Skills Training for Autism: Bridging the Gap Between Research and Adoption of Virtual Reality in Occupational Therapy Practice

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Recommended Citation

Pandey, V., & Vaughn, L. (2021). The Potential of Virtual Reality in Social Skills Training for Autism: Bridging the Gap Between Research and Adoption of Virtual Reality in Occupational Therapy Practice. *The Open Journal of Occupational Therapy, 9*(3), 1-12. https://doi.org/10.15453/2168-6408.1808

The Potential of Virtual Reality in Social Skills Training for Autism: Bridging the Gap Between Research and Adoption of Virtual Reality in Occupational Therapy Practice

Abstract

Impairments in social functioning greatly hinder children and youth with autism spectrum disorder (ASD) from responding appropriately and adapting to various social situations. As a result, individuals with ASD get fewer opportunities for social inclusion, physical well-being, and forming interpersonal relationships. Virtual reality (VR) has been studied extensively in this area, where a large body of evidence shows that VR is a promising tool for social skills training (SST) in individuals with ASD. With the flexibility and projected effectiveness that VR offers, it can provide more opportunities to learn and practice strategies for recognizing daily challenges that involve forming social relationships and associated reasoning. This paper discusses the gap between the effectiveness of VR-based SST and its adoption in occupational therapy (OT) practice. There is a significant dearth of resources for the development of occupational therapists to effectively administer these interventions. Such resources that summarize empirically supported VR interventions to teach social skills to people with autism would be very valuable in training therapists who wish to employ them. Using theory-driven approaches, this paper intends to empower occupational therapists in becoming efficient and confident in using this technology for addressing social skills deficits in people with ASD.

Keywords

virtual reality, virtual environment, autism, ASD, social skills, occupational therapy, occupational therapist, professional training, experiential learning

Cover Page Footnote

Author Lori Vaughn discloses: I am an Academic Advisor at Boston University working with students to complete their doctoral work. This manuscript is a product of that doctoral work.

Credentials Display

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DOI: 10.15453/2168-6408.1808

The prevalence of autism spectrum disorder (ASD) in children is now 1 in 54 as compared to that reported in 2018 by the Centers for Disease Control and Prevention (CDC; 2020a). Deficits in communication and problems with social interaction are core characteristics of children and adolescents with ASD (CDC, 2020b). Emotional and social adaptation skill deficits greatly hinder children with ASD from adapting to various environments. These difficulties add to their inability to respond appropriately to effectively participate and engage in various social situations. When working with individuals with ASD, occupational therapists address core deficit areas. Using physical and psychosocial theoretic approaches, occupational therapists analyze activities requiring an individual to integrate or use sensory-motor skills, cognition, communication, social skills, and behavior (Cardon, 2016). Young children with ASD may show social skill delays in terms of limited eye contact, social smiling, joint attention, and pointing, whereas older children and adolescents may show difficulties maintaining conversations, taking another's point of view, initiating social interactions, reading nonverbal body cues, and making and keeping friends (Bohlander et al., 2012). Helping individuals with ASD improve their social skills is an important goal because individuals in this population report having fewer friends, less satisfying friendships and relationships, and more feelings of loneliness than their typically developing peers, despite desiring more peer interaction and friendship (Kasari et al., 2011). Occupational therapists use group-based social skills training (SST) programs to promote interaction with other children and provide opportunities to use newly learned skills in a relatively realistic setting (White et al., 2007), peer-mediated interventions, social stories, activity-based interventions, picture exchange communication systems, and parent-mediated interventions in both clinic-based and contextual settings to improve social skills in children and youth with ASD. However, what is meaningful and functional for one individual may or may not be the same for another as every individual has different cognitive abilities, learning styles, and interests. To address deficits in social interaction, traditional SST does not explicitly teach awareness of facial expressions but, rather, focuses on ancillary content, such as hygiene and conversation (Golan & Baron-Cohen, 2006). Taken together, these results show a good consensus that traditional, clinic-based forms of SST do not work well for youth with attention deficits and that alternative approaches or modifications are needed to address social impairment in this population (Mikami et al., 2017). SST curricula are used as an intervention modality that involves direct instruction of social skills delivered in a manualized sequence, which is often provided in clinical or classroom-based group settings (Bottema-Beutel, 2018). The empirical and descriptive studies focused on interventions in SST were shown to lack satisfactory methods and design (Vasquez et al., 2015). Meta-analysis and systematic reviews have concluded that there is a general lack of several critical indicators of effectiveness, including generalizability and maintenance of the skills learned, robust research designs such as randomized control trials, and appropriate outcome measures to identify effectiveness on meaningful outcomes of change in social behavior (Bottema-Beutel, 2018).

Virtual Reality as a Therapeutic Tool

Virtual reality (VR) refers to the interactions between an individual and a computer-generated environment stimulating multiple sensory modalities, including visual, auditory, or haptic experiences (Cornick & Blascovich, 2014). VR is presented to the user as an actual environment in which the individual can interact in a seemingly real or physical way. Users enter it through a portal using high-resolution monitors powered by conventional desktop workstations. The attributes of the environment depend on the technical features of the display hardware, demands of the interface using devices (i.e., mouse, joystick, touch, gesture), as well as the complexity of the virtual display. The use of VR would enable therapists to reach out to a diverse population and address a variety of client factors while continuing to individualize treatment. For this, the teaching process of occupational therapists has to vary and adapt to a diverse population of children with ASD, which requires flexibility. This flexibility could encourage the therapists to modify the traditional approaches to help individuals with ASD. There is an emerging trend of integrating technology into social skills interventions and computer-assisted intervention materials, including video and interactive multimedia, and more recently virtual learning systems, such as VR. Despite this, technology-supported social skill interventions are limited (Ke et al., 2017). Therapeutic applications of VR are based on the theory that the brain can process information more effectively when it is presented through a combination of sight, sound, and touch (Self et al., 2007) where the computer-generated virtual environment (VE) would give a sense of presence to the user. The VR system consists of (a) external tools (visual, auditory, and haptic), which connect the user to the VE; (b) internal tools (trackers, gloves, joysticks and exoskeletons, and mouse), which trace the user's position and motion; (c) a system of graphic image rendering, which creates the VE; and (d) the software and database, which are used to shape models and objects in the virtual world (shapes, textures, and object motion) (Riva, 2006, as cited in Valentina et al., 2013) providing the user with a three-dimensional (3D) sense of presence in a VE. This enables the users to easily change the attributes of, add, or remove objects in ways that might not be possible in a real-world scenario but could be valuable to teach abstract concepts.

While occupational therapists are required to remain up to date with current technology, many practicing clinicians have little experience with VR systems and report a need for training and resources (Glegg et al., 2013). There is a lack of awareness among therapists concerning the intricacies of computers, interfaces, and networks that result from limited exposure in occupational therapy (OT) academic training. There is a plethora of research using VR technology and understanding its elements but a dearth of information to help occupational therapists to use this technology in practice.

VR technology possesses several strengths in terms of potential applications for people with ASD, including malleability, controllability, replicability, modifiable sensory stimulation, and the capacity to implement individualized intervention approaches and reinforcement strategies (Lahiri et al., 2015). The use of technology as a therapeutic tool could allow therapists to tailor the learning process and adjust treatment according to the priorities, individual needs, and progress of the client. Moreover, activities involving technology are often preferred by individuals for leisure, which makes use of VR technology inherently more reinforcing and motivating than strategies that do not use technology.

VR systems employ either head-mounted devices (HMDs) for fully immersive 3D views or conventional desktop systems. In the former, an individual wears the equipment immersing them completely into the VE which blocks out extraneous sights and sounds from the real environment. However, the costs associated with developing HMD systems, as well as the associated side effects, such as cybersickness and the cumbersome nature of using HMDs, have led to a surge of non-HMD systems in the field of rehabilitation, which is the focus of this study. HMDs were reported as being enjoyable, physically and visually comfortable, easy to use, and exciting, and children wanted to use them again with several potential usages for HMDs, including relaxing and feeling calm, exploring somewhere virtually before visiting in the real world, and developing learning opportunities in school for children with autism (Newbutt et al., 2020). While in non-HMD systems, the scenarios are displayed on desktop systems with high-resolution on-screen visuals that do not offer a higher degree of immersion to the user.

https://scholarworks.wmich.edu/ojot/vol9/iss3/15
DOI: 10.15453/2168-6408.1808

The Existing Gap

While there exists considerable literature to direct OT professionals toward adopting VR technology, there is limited adoption of this technology in OT practice. This is the gap between the existing literature and its application by professionals. The use of VR in clinical practice has long been limited by two main factors: the lack of accessibility to systems and resources, and the cost of virtual tools (Lindner et al., 2017; Zanier et al., 2018). There are several factors that contribute to the lack of clinical adoption and acceptance by OT professionals, such as (a) lack of professional training avenues to direct and demonstrate occupational therapists in using this technology appropriately in practice, (b) lack of training and familiarity with the system consoles (Levac & Miller, 2013), and (c) limited availability of instructional manuals for the therapist to modify and individualize treatment activities using existing games and system consoles. Apart from these factors, a perception associated with VR, which is a concern, is that providing a non-social environment on the computer somehow aggravates the social disability of autism and that over-reliance on computer interaction could lead to obsessive behavior and a decline in real-world interaction (Parsons & Mitchell, 2002). In addition to this, lack of integration is because of patients' and clinicians' preferences for more familiar and traditional therapy approaches (Laver et al., 2013). Certain known barriers to VR use include lack of time, knowledge, skills and resources, technical issues, and client factors that prevents therapist from adopting VR-based interventions in OT practice (Levac et al., 2016).

VR Technology and ASD: A Good Amalgamation

ASD is a condition that is categorized as a disability because of the cognitive disorders that people with ASD face (Arciuli & Bailey, 2019). Research showed that most people with ASD demonstrate a natural affinity for technology and a good disposition for using technology and learning through the use of computers. This is because the environment and context that these experiences provide are predictable and structured, which helps people with ASD to maintain their routines and repetitive behaviors without an impact on their comfort (Valencia et al., 2019). Screen-based technology use is a primary and preferred discretionary activity for many adolescents with ASD (Hedges et al., 2018). Children with ASD spend more time with electronic screen media than with any other leisure activity (Gillespie et al., 2014; Laurie et al., 2018), suggesting that they are more comfortable interacting with inanimate objects, such as a computer or iPad, than in the real social scenarios. Children with ASD enjoy visual media and are interested in technology programs, which indicates an inclination toward technology. Technology is a motivating learning medium for children with ASD (Hourcade et al., 2011), and children's attention, communication, and social skills improve when computers or tablets are used (Burke et al., 2013). These point toward an inherent motivation to interact with electronic screen media in children and youth with ASD supplemented by their observed imitative behaviors. This could be used to develop concepts and educational skills through their preferred media. Such an approach could be used to leverage technology as a catalyst for both social skill development and social engagement in individuals with ASD as many such individuals are visual learners and have strong technological skills. VR technology accommodates the strengths of traditional SST while allowing for more possibilities in a safe and controllable environment. Mayer (2002) suggested that in the cognitive theory of multimedia, people learn deeper and better from words and pictures together than from words alone, making VR a promising medium for intervention delivery. VR-based intervention could ensure both auditory and visual information be presented coherently while neither of them would cause sensory overload (Mayer, 2002).

Types of VEs Used in SST for ASD

Many studies have developed and used VEs based on the type of user participation, such as collaborative VEs (CVE) and single-user VEs (SVE). CVEs involve more than one user who may inhabit the VE at the same time, even though these users may be physically located at different places. Users control their avatars independently and can communicate directly with each other through speech, movement, and gesture in the virtual space (Crowell et al., 2019; Zhang et al., 2018). On the other hand, in SVE, responses from the environment to these interactions must be pre-programmed where the user interacts with autonomous avatars. A CVE platform combined with game-based collaboration in children with ASD has shown an increasing trend in game performance with group-communication between them (Crowell et al., 2019; Zhang et al., 2018). Engaging a VE system where children with ASD and peers can interact is an effective strategy for improving social and collaborative behaviors in such controlled environments (Crowell et al., 2019; MacCormack & Freeman, 2019; Zhang et al., 2018). SVE would provide structured training with limited choices for appropriate responses, whereas the CVE would represent an unstructured situation in which the users are free to make their own choices as to how they interact with others (Cobb et al., 2010, as cited in Greenwald et al., 2017). Advancements in the VE system can systematically manipulate facial expressions, eye gaze, social distance, vocal tone, and gestures, where such manipulation is easy to perform, repeatable, and is highly controllable, making it a versatile tool for OT practice. VEs for people with ASD are usually implemented in the form of environments displayed on computer screens or immersive displays using HMDs. In either form, VR interventions could be an interactive and visually stimulating approach that can be employed in the clinical treatment of clients with varied deficits. They could serve as a dynamic platform capable of simulating countless social scenarios that uniquely target individuals ranging in age from childhood to adulthood.

VR Interventions for Social Skills Deficits

Software used for VR interventions represents the social situations pertinent to the focus of the intervention, which allows users to interact with the presented situation without the threat of negative real-life consequences. The literature review for this program included individuals in the age range of 6 to 18 years of age diagnosed with high-functioning autism with different VE intervention software packages. Howard and Gutworth (2020) reported that gamified VR training programs were just as effective as VR training programs with few or no game elements questioning the effectiveness of gamification for the development of social skills. Many researchers used the commercially available VR design package Vizard, from World viz LLC, (https://www.worldviz.com/vizard-virtual-reality-software) to develop the VEs (Lahiri et al., 2014; Saadatzi et al., 2018), while others used publicly available open sources such as Second Life, version 2.1 (Didehbani et al., 2016; Ke & Im, 2013). All studies used software that targeted numerous virtual social scenarios that individuals with autism are exposed to, such as a classroom environment, restaurants and shops (Didehbani et al., 2016), and parties at others' houses (Ke & Im, 2013). Ke and Lee (2016) examined the VR collaborative design quest software where participants worked in partnership with team peers to rebuild a virtual neighborhood devastated by a tsunami earthquake. In this simulation, children could drag and drop 3D architectural models and objects from a virtual reservoir to the virtual neighborhood to be built and then move, rotate, scale, and customize them via the default VR construction tool. A preliminary study by Zhao et al. (2018) used CVE series of interactive games in VR using simple hand gestures to collaboratively move virtual objects in the VE with gaze and voice-based communication. The intervention allowed participants to share and discuss game strategies.

In comparison with desktop-based VR systems, VR training programs using immersive displays were less effective for addressing social skill deficits in participants as reported in Didehbani et al. (2016) and Ke and Im (2013), although this difference was later found to be not statistically significant (Howard & Gutworth, 2020). Some VR interventions also incorporated users' physiological feedback, such as pupil dilation and blink rate, alongside their overt responses (Lahiri et al., 2015), which included communication through natural language, without the use of a mouse or keyboard (Saadatzi et al., 2018). Social stories in a form of VR program with a library of 75 short socioemotional stories illustrating various types and intensities of emotion in three social contexts of home, school, and community were used to motivate children with ASD to participate and make learning more enjoyable (Ghanouni et al., 2018). Combining pictorial cues or presenting social stories through VEs have been shown to facilitate communication among children with ASD (Volioti et al., 2016). With further advancements in VR technology, its application to SST, ranging from varying dynamic social scenarios to using virtual avatars, could be expedited to enable people with autism to perform situation-specific social communication.

Potential Benefits of VR Technology for ASD

VR appears to offer an innovative and motivating platform to practice and rehearse social skills safely for individuals with ASD. Regarding the benefits of VR interventions on delivering SST, VEs designed for children and youth with ASD resulted in significant improvements in social initiations, engagements, and responding with peers, a common result in all the studies in this review (Ke & Moon, 2018; MacCormack & Freeman, 2019). Despite the differences of single-user or collaborative VE, VR-based interventions promoted the social interaction performance of children with autism (Cheng et al., 2015; Ke & Moon, 2018; MacCormack & Freeman, 2019). Facilitated by engaging scenarios presented in an immersive VE, individuals with autism can maintain a conversation, increase eye contact in real-life scenarios, and feel less stressed while interacting in the real-world having already practiced in the VE (Cheng et al., 2015). Role-based cooperative and structured play with support from facilitators could be effective at improving the social competence of individuals with ASD. To illustrate, the role of trained facilitators provided naturalistic and adaptive scaffolding during participants' interaction with VEs with fading of the facilitator's prompting over time, allowing for generalization as illustrated in Ke and Moon (2018). Also, structured play in VE scenarios minimizes the negative effects of extraneous factors enabling individuals with ASD to practice and demonstrate social skills (MacCormack & Freeman, 2019).

Recent research highlights the potential of VR to provide safe, unlimited, and commonly encountered day-to-day contexts to practice social scenarios, such as finding someone to sit with in the lunchroom or inviting someone to a birthday party, and has shown to provide the opportunity for repeated practice in dynamic, constantly changing social exchanges (Didehbani et al., 2016). One major benefit of VR-based intervention as noted in Didehbani et al. (2016) deemed important for addressing challenges of learning in the priority population is that VR focuses less on rote learning and responses across multiple SST sessions as no two social interactions could be entirely similar. This dynamic training approach using a VE to provide different contexts could facilitate opportunities for individuals with ASD to practice diverse responses to simulated real-world scenarios. This could reduce their anxiety concerning the social interaction, allow generalization of social skills learned in VR to general life interactions, and provide a supportive environment to make social mistakes that could arise during in-person real-world social interactions without real-world consequences.

A case study by Ke and Lee (2016) examined the effect of collaborative architectural design in a VR-based SST intervention for children with high-functioning autism. The VR environment was implemented by following a naturalistic intervention design. Naturalistic interventions are behavior teaching procedures that occur in the context of naturally occurring activities (Vismara & Rogers, 2010). Naturalistic interventions should take place throughout the day in the context of daily routines and schedules of the learner that could be implemented by clinicians and parents. The results of the study indicated that VR offered participants the opportunities to engage in social interactions and develop partnerships among peers. While engaging in social interactions proactively, participants could build their self and social identities in the virtual world, where self-identity refers to their roles in different social interaction contexts (Moon & Ke, 2019), and social-identity refers to an individual's characteristics shared with members of the various groups to which they may belong. Constructing identity could be a challenging social process for individuals with ASD where they struggle with the process of framing the identity through experience sharing or overt behaviors and have difficulty fitting in or identifying themselves with a group or a community (Bagatell, 2007). The uses of VR allow them to explore and form positive self and social identities (Bagatell, 2007). The opportunity to customize avatars in the virtual world that closely reflect individual preferences are liberating and explore various aspects of their psychologies (Ke & Lee, 2016). Wang et al. (2016) investigated embodied social presence through naturalistic activities in VR for children with autism where they were likely to adopt their avatars' self-identities, which helped them perceive the social contexts simulated in VR. This social embodiment could be achieved when facilitators embody themselves by various avatars and morphing their voices to mimic different social characters. When the learner is presented with stimuli representing the objects in that VE and their own avatar's representation, if the learner engages with these stimuli, the individual will experience an embodied presence. For embodied social presence to occur, learners in 3D CVE must participate in a goal-directed, shared activity mediated through embodied representations in a context. Therefore, although virtual bodies cannot replace real-world bodies, a virtual body can be used as a tool for conveying concepts, meaning, and symbolism in a way that mirrors how learners use their physical bodies in real-world collaborative learning activities (Wang et al., 2016).

Avatars and virtual elements contribute to the training in recognition of facial expressions and body gestures (Bekele et al., 2014; Mesa-Gresa et al., 2018) along with initiation of play, social response, conversational skills (Craig et al., 2016; Mesa-Gresa et al., 2018), enhanced emotional expression, emotion regulation, and social-emotional reciprocity (Ip et al., 2018). Previous work has addressed conversation skills by focusing on different aspects, such as joint attention that requires the user to attend to their virtual nonverbal behavior to complete an interaction, turn-taking or reciprocity in the conversation that occurs through collaborative VR systems and with robots, and etiquette practice through a single-user VE (Rosenfield et al., 2019). People with autism have shown improvement in the measures of emotion recognition, social attribution, and the executive function of analogical reasoning, responding, initiating, greeting, and positive conversation-ending with the implementation of VE-based training (Didehbani et al., 2016; Saadatzi et al., 2018). In all the studies reviewed, VEs offered individuals struggling with interpreting and responding to social situations with more realism and meaningful experiences that are relevant to the individual's needs relative to their challenges.

Preferences of Occupational Therapists Toward Technology

A big factor contributing to the diminished use of VR-based interventions by occupational therapists is their lack of familiarity with VR systems and the benefits of interventions like SST. Laver et al. (2013) reported clinical implications for the introduction of computer technologies, such as VR, into rehabilitation settings. Despite previous studies suggesting that occupational therapists are traditionalists (Laver et al., 2013), the authors found that occupational therapists are more willing to embrace new technologies as part of rehabilitation than other disciplines if the technologies are shown to be effective. Most of the research included in this review focused on people with ASD and their interactions with the VE with no mention of whether or not a therapist was able to operate it effectively and confidently with the participants. Therapists need time to become familiar with the technology and to access resources that support clinical decision-making about the choice of appropriate clients, therapeutic adaptations, and parameters that can be adjusted to meet client needs (Levac & Miller, 2013). As described earlier, VR systems have been shown to have beneficial outcomes in improving social skills, thus justifying their integration into clinical practice. Therapists lack the training to set up and operate the potential advantages of new technologies for rehabilitation such as VR (Liu et al., 2015). The research by Levac and Miller (2013) revealed the necessity of additional training regarding the theoretical framework underlying common features of VR systems and clinical reasoning related to specific VR and intervention goals by experienced clinicians to incite therapist confidence in VR-based interventions to better integrate this novel technology into practice.

There is a lack of resources for occupational therapists to implement VR-based interventions (Levac et al., 2016). Most of the studies that did employ technology-based interventions were not performed by occupational therapists and were highly specific in terms of characteristics of the target population, making them difficult to generalize. This gap between available SST interventions and resources for their widespread adoption by occupational therapists indicates a need for a resource that could serve as an evidence-based tool to facilitate the use of appropriate technology-based interventions when working with clients. As described in earlier sections, literature exists on VR systems being used with a variety of populations in numerous ways to promote positive outcomes. However, there is a lack of knowledge and access to this literature to guide clinicians to employ such interventions, severely inhibiting clinicians from using VR as an adjunct to conventional SST. Despite this major limitation, the results of the studies included in this review indicate the need for developing a comprehensive educational resource to aid occupational therapists in using dynamic VR environments for people with ASD.

Limitations of the Evidence

Beyond the evidence in support of the VE-based interventions and the various types of environments used in different populations focusing on the SST for ASD, the studies included have some common limitations. It is difficult to say with certainty that all VR programs are effective interventions, despite the positive results found, for numerous reasons outlined here. Several studies did not include control groups composed of subjects diagnosed with ASD that received other traditional therapies to compare differential effects of exposure to VR (Didehbani et al., 2016; Fasilis et al., 2018). Taking this into account, results obtained could be considered preliminary and limited from the standpoint of OT clinical practice. Another limitation of the studies is the small sample sizes (Crowell et al., 2019; Ke & Im, 2013; MacCormack & Freeman, 2019; Zhang et al., 2018), which tend to increase the likelihood of a type II error, resulting from a decrease of power of the analyses. Another issue that makes it difficult to extrapolate the results is the gender ratio of the sample. As based on prevalent research, ASD affects more boys than girls (3:1 ratio) and a large number of studies were conducted only with boys, which may limit the generalizability of the conclusions drawn across genders (Mesa-Gresa et al., 2018). Although results from all studies showed some positive benefit, the type of studies and related limitations point toward using the intervention cautiously for the desired population.

Bridging the Gap

VR-based interventions leverage the visual learning capacity of individuals on the spectrum. As supported by prevalent research literature, individuals on the spectrum are often visual learners and thus benefit from visual, tactile, and kinesthetic learning opportunities (Cardon, 2016). Visual supports are those things that enhance the communication process and can be an effective aid for children learning about the world around them (Hayes et al., 2010). Interventions to support individuals with ASD include the use of a wide variety of visual tools where the use of words, images, and tangible objects may reduce the symptoms associated with cognitive, communicative, and social disabilities. Presenting information visually consistently and predictably allows the individual to process information concretely and to develop routines for both learning and response (Cardon, 2016). Technology can make visual images more accessible to the individual with ASD and graphics generated in a computer can help maintain their attention.

Professional training avenues for occupational therapists will serve as a tool for imparting knowledge on the use of VR in practice, giving them the ability to choose the appropriate VR systems and games as interventions for their clients. Because VR technology is novel in the field of OT, it would be imperative to provide comfort, demonstration, and training on using this type of technology to therapists for effective adoption in clinical practice. This would instill confidence, a greater understanding of the intricacies of VR, and an advanced ability of decision making in providing the appropriate challenge to clients with ASD to enhance their social competence.

To this end, adoption of VR in OT practice could be facilitated with a clear understanding of how VR must be used by the clinicians by mediating the potential approaches, such as (a) the development of an evidence-based manual to inform about VR and its constructs suitable for ASD leading to possible acceptance of VR technology in OT practice and (b) experiential learning training avenues for occupational therapists in using VR for SST.

Theoretical Approach to Bridge the Gap

Experiential Learning Theory

The experiential learning theory (ELT) refers to the learning by doing approach whereby the learner actively engages cognitively, affectively, and behaviorally to assimilate and apply the presented learning material to create new knowledge (Kolb & Yeganeh, 2011). ELT is one of the most widely accepted learning theories (Kolb & Kolbe, 2012) where learning is defined as the process whereby knowledge is created through the transformation of experience (Kolb, 1984). ELT is based on experience that all genuine learning comes about through the construction of knowledge from experience (Dewey, 1964). It includes beliefs that people learn best from experience if there are multiple senses involved in the activity and if the experience has direct real-life consequences (Newes & Bandoroff, 2004). The principles of ELT could be used to bridge the gap between the existing literature regarding the potential of VR and putting the evidence into OT practice through widespread adoption. The experiential learning avenues, such as hands-on training provided via in-person workshops, graduate research, and exposure to VR-based interventions could allow occupational therapists to learn critical thinking skills before engaging in the demands of real-life clinical practice. Time, space, and conversation for collective learning, knowledge development, and problem-solving, where all contributions matter, are essential to learning (Billingsley et al., 2011). Based on the learning needs of occupational therapists, experiential learning and hands-on training would provide a fostering and supportive atmosphere. This would enhance the understanding and improve the personal and professional attributes and skills needed to be effective clinicians. Many researchers have found experiential learning methods to be an effective adjunct to conventional academic programming (Benson et al., 2013). Hands-on practice and learning experience have the potential to engage learners in the application of theory to practice while developing professional behaviors (Falk-Kessler et al., 2007). The provision of hands-on experiential learning delivered through platforms, such as in-person workshops could open avenues for occupational therapists to gain continuing education units to maintain the competency. This marks the necessity of practical experience for developing critical reasoning and planning the intervention for people with ASD.

The Unified Theory of Acceptance and Use of Technology

The unified theory of acceptance and use of technology is a model for user acceptance of information technology toward a unified view that explains user intentions pertaining to technology and subsequent usage behavior (Venkatesh et al., 2003). The theory states that there are four key constructs: (a) performance expectancy, (b) effort expectancy, (c) social influence, and (d) facilitating conditions (Venkatesh et al., 2003), where the first three are direct determinants of usage intention and behavior, and the fourth is a direct determinant of user behavior. Gender, age, experience, and voluntariness of use are posited to moderate the impact of the four key constructs on usage intention and behavior. In addition to the three direct determinants of behavioral intention to use technology, Venkatesh et al. (2003) defined performance expectancy as the degree to which an individual believes that using the system will help them to attain gains in job performance. However, effort expectancy is defined as the degree of ease associated with the use of the system, whereas social influence is defined as the degree to which an individual perceives that important others believe they should use the new system (Venkatesh et al., 2003). The most important factor in determining therapists' acceptance and adoption of technology is by knowing how it can help therapists work with clients (Liu et al., 2015). Taking this theoretical basis into account, it can be conjectured that providing therapists with knowledge about the potential of such technology, how its adoption can impact their clients and improve outcomes, in addition to facilitating an environment for professional growth, might lead to an increase in the adoption of VR in clinical practice.

Conclusion

There is a need for resources to aid in the additional professional development of occupational therapists to enable them to be active participants in VR-based SST interventions. Therapists need to focus their efforts on learning empirically supported techniques that have the most versatility and are easily implemented in the naturalistic setting to address the limited adoption of VR in OT practice. It would be of value if there were resources to impart knowledge and train occupational therapists that summarize empirically supported VR interventions to teach social skills to people with ASD. There could be potential benefits if efforts are made to address the problems, such as: (a) improved socials skills in children and youth with ASD, (b) increased familiarity of therapists with VR technology aided by therapist-friendly resources that would instill treatment integrity in their daily work routines to achieve desired goals, (c) the addition of valid and reliable results regarding the use of VR from rigorous studies, (d) integration of evidence-based treatment protocols for SST, and (e) use of VR with the long-term goal of formulating a more rigorous protocol for technology-based SST for ASD. Adoption of VR-based training programs as an adjunct to the traditional therapy approaches would not only benefit professionals to become proficient in using VR-technology but also broaden the scope of OT practice.

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