



Virtual Reality Social Cognition Training for children with high functioning autism



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ABSTRACT

Virtual reality appears to be a promising and motivating platform to safely practice and rehearse social skills for children with Autism Spectrum Disorders (ASD). However, the literature to date is subject to limitations in elucidating the effectiveness of these virtual reality interventions. This study investigated the impact of a Virtual Reality Social Cognition Training to enhance social skills in children with ASD. Thirty children between the ages of 7–16 diagnosed with ASD completed 10, 1-h sessions across 5 weeks. Three primary domains were measured pre-post: emotion recognition, social attribution, attention and executive function. Results revealed improvements on measures of emotion recognition, social attribution, and executive function of analogical reasoning. These preliminary findings suggest that the use of a virtual reality platform offers an effective treatment option for improving social impairments commonly found in ASD.

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1. Introduction

Individuals with autism demonstrate impairment in social functions including difficulties in social interactions, social communication, and emotion recognition (American Psychiatric Association, 2000; Hooper, Poon, Marcus, & Fine, 2006). The DSM-V characterizes autism spectrum disorders (ASD) into 3 severity levels with level 3 representing the most severe functional impairment in social communication and needing “very substantial support.” Level 3 individuals exhibit severe deficits in verbal and nonverbal communication and extreme difficulty coping with change. The higher functioning, level 1 individuals with ASD, tend to have difficulty processing social cues and as a result may become overwhelmed and anxious in social interactions, especially with unfamiliar individuals (Bernard-Opitz, Sriram, & Nakhoda-Sapuan, 2001; Hobson, Ouston, & Lee, 1989; Volkmar, Cohen, Bergman, Hooks, & Stevenson, 1989). Additional social difficulties include trouble inhibiting thoughts and regulating emotions (Pelphrey & Carter, 2008), both of which are relevant to executive function.

While research has shown that children with high functioning ASD (HFA) perform lower on measures of attention and executive function (Joseph, McGrath, & Tager-Flusberg, 2005; Sanders, Johnson, Garavan, Gill, & Gallagher, 2008), display language abnormalities, and often engage in stereotyped repetitive patterns of interests and/or behavior compared to age-matched typically developing children (Frith, 2003; Hooper et al., 2006), they may demonstrate average to above average intellectual abilities. They may also perform well on explicit social cognitive measures because of compensatory strategies, but often struggle in situations requiring the ability to spontaneously understand emotions of others and predict others' actions (Senju, Southgate, White, & Frith, 2009). This strong contrast between their strong academic performance and impaired social competency can lead to frustration (Hooper et al., 2006; Rinehart, Bradshaw, Brereton, & Tonge, 2001). Consequently, they are at increased risk for social isolation and loneliness compared to their typically developing counterparts (Bauminger & Kasari, 2000; White, Keonig, & Scahill, 2007). Overall, the impairments in social communication, theory of mind, and executive function can negatively influence both peer relationships and schoolwork (DiGennaro Reed, Hyman, & Hirst, 2011; White et al., 2007). Social deficits may impede academic performance in school due to low self-esteem (Welsh, Parke, Widaman, & O'Neil, 2001), despite their average to above average

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intellectual abilities. Therefore, developing and testing the effectiveness of social cognition interventions in children with HFA may contribute to protocols that serve to improve their social interactions and quality of life as they move from childhood to adulthood (DiGennaro Reed et al., 2011).

Recent research highlights the benefits of using virtual reality (VR) interventions, such as computer-based simulations of reality, in which individuals with HFA can practice difficult or individually challenging social interactions in a less-anxiety producing platform (Kandalaf, Didehbani, Krawczyk, Allen, & Chapman, 2013; Maskey, Lowry, Rodgers, McConachie, & Parr, 2014; Parsons & Mitchell, 2002; Wainer & Ingersoll, 2011). VR social training offers several advantages compared to traditional social skills interventions such as simple emotion recognition tasks or role-play. First, it can 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 your birthday party (Kandalaf et al., 2013; Parsons, Mitchell, & Leonard, 2005; Wallace, Parsons, Westbury, White, & Bailey, 2010). It can help reduce the social anxiety as demonstrated by Maskey et al. (2014) with a virtual reality intervention in conjunction with CBT. Second, VR interventions provide the opportunity for repeated practice in dynamic, constantly changing social exchanges. The therapeutic benefit is that there is substantially less focus on rote learning and responses across multiple training sessions since no two social interactions are ever exactly the same. Moreover, this dynamic practice recast in different VR contexts may facilitate the generalization of social skills learned in VR to everyday life interactions (Bellani, Fornasari, Chittaro, & Brambilla, 2011; Parsons & Cobb, 2011; Tzanavari, Charalambous-Darden, Herakleous, & Poullis, 2015). Third, it can provide a supportive environment for individuals with ASD to make social mistakes without the intense anxiety or fear of rejection that is commonly associated with face-to-face social interactions. VR sessions provide a controlled environment to meet the individual's needs with the option of real-time feedback capable of enhancing the learning experience. Finally, computer technology is often highly motivating and rewarding for individuals with ASD, especially children with HFA (Parsons & Mitchell, 2002). Overall, VR offers an engaging, interactive, and individualized platform for training and improving social cognition in children with ASD.

Several studies have examined the feasibility and effectiveness of VR as a treatment option for individuals with ASD (Bernard-Opitz et al., 2001; Mitchell, Parsons, & Leonard, 2007; Ozonoff & Miller, 1985; Parsons, Mitchell, & Leonard, 2004). As summarized in a review article by Wainer and Ingersoll (2011), 12 studies focused on the use of technology to train children and adolescents with ASD. The majority of the articles focused on teaching emotion recognition and simple language skills such as learning vocabulary words and receptive language. Only four of the studies described in the review reported evaluations of training social skills and social awareness. Bernard-Opitz et al. utilized static pictures to teach problem solving and asked children to choose an appropriate solution to a social conflict. Results indicated that children with ASD between the ages of 5–8 years were able to increase the number of possible solutions to problems from an overall average of less than one to more than three. Beaumont and Sofronoff (2008) used a “Junior Detective” computer game to teach emotion recognition and social problem solving and found improvements on knowledge of emotion recognition in children with Asperger's syndrome. Parsons et al. (2004) used a VR café with 12 adolescents with ASD between the ages of 13–18 years to teach social awareness and then conducted a follow up study with six adolescents between the ages of 14–15 (Mitchell et al.). Upon completion of the VR café training, participants showed improvement in their social understanding in

these settings (i.e., choosing appropriate seats, knowing when to initiate a conversation) as measured by their interactions and responses to the video questions. Separate case studies have also shown that participants with ASD can enhance their social understanding using a VR social training platform (Cheng & Ye, 2010; Herrera et al., 2008).

Although these studies provide support for VR as an effective platform to practice and teach social skills for individuals with ASD, there are limitations. Most platforms train specific subskills of social competency in isolation (e.g., emotion recognition, spatial awareness, problem solving). Another drawback is that generalization of learning to untrained measures or real life has not been adequately addressed in previous VR interventions designed for ASD (Parsons & Cobb, 2011). This is often due to the limited skills trained in the VR studies which often incorporate one specific social skill such as recognizing emotions repeatedly in a rote manner. Only a handful of prior VR studies have examined performance in social environments that are representative of the conditions that individuals typically encounter in daily life. Another constraint is that many VR designs involve passive social activities that are not initiated by the individual and the interactions can be overly scripted without encouraging the spontaneity of natural communication. The participants are not typically engaged in a “live” social interaction with other participants along with a “coach” who can provide immediate feedback. Schilbach et al. (2013) discussed the importance of using real-time social interactions that involve emotional engagement by the individual in order to enhance social cognition learning. This “second-person” approach, which incorporates multiple people engaged in real time, is needed to understand and improve social cognitive deficits. Schilbach, Eickhoff, Cieslik, Kuzmanovic, and Vogley (2012) distinguished the differences between being engaged in a social situation (online social cognition) versus passively observing an interaction (offline social cognition). They noted that “online” social cognition involves an integrative understanding of social perception and reciprocal communication, which is difficult for students with HFA who often succeed at “offline” social cognitive tasks (i.e., making social judgments based on static stimuli or observation). Another limitation of existing VR social training is the single-user virtual environment design (SVE), which makes it difficult to practice social interactions that occur on a day-to-day basis. Few studies are investigating the potential to train social cognitive skills for HFA in a multi-user or collaborative virtual intervention environment (CVE) such as the isocial platform, a virtual reality environment used for social training (Schmidt, Laffey, Schmidt, Wang, & Stichter, 2012; Stichter, Laffey, Galyen, & Herzog, 2014) and the use of Second Life by Keet et al. (2015). The CVE design from the above mentioned studies report promising results from small sample sizes. The multi-user design warrants investigation since it allows for a more realistic and engaging interaction that can help teach social skills for individuals with HFA.

Finally, most of the VR interventions are designed to train either young children, adolescents, or adults, without describing potential implications of utilizing one VR platform across all ages. Whereas interventions should accommodate specific developmental stages; the design of a single platform has potential to reach a wider age spectrum. Overall, VR appears to offer a promising, innovative, and motivating platform to safely practice and rehearse social skills for children with ASD. However, the evidence to date is subject to limitations in elucidating the effectiveness of VR interventions because of limited sample size, lack of generalizability and standardized outcome measures and single user design.

The Virtual Reality Social Cognition Training (VR-SCT) was designed to address some of the limitations of previous VR interventions by providing a social training platform for both children

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