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Virtual Reality Technology-enabled Educational Approaches for Those With Autism Spectrum Disorder

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VIRTUAL REALITY TECHNOLOGY-ENABLED EDUCATIONAL APPROACHES

FOR THOSE WITH AUTISM SPECTRUM DISORDER

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Abstract

This literature review examines research studies that evaluated the effectiveness of virtual reality (VR) simulated interventions in people with autism spectrum disorder (ASD) including their enjoyment of the process and their ability to transfer VR learning to real-life situations. VR provides a safe and controllable environment that implements realistic computer-based simulated interactions that allow for repeated skill practice and gives participants the ability to progress at their own pace. Most of the research reviewed focused on improving specific deficit areas for those with ASD. Virtual reality interventions were used to increase social and emotional skills involving areas such as: social understanding, positive social competence, social functioning, verbal and nonverbal communication skills, increased social interaction, self-regulation, self-advocacy, and reducing anxiety. Using VR in motor vehicle driving instruction can help assess the abilities of potential drivers and provide an arena for safe driving practice that can be adapted to meet individual needs. Job interviewing and personal interaction skills can be learned and practiced by using simulated VR job interview scenarios. The research findings revealed that VR interventions show positive results for persons with ASD and that further study is necessary.

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CHAPTER I: INTRODUCTION

Virtual Reality Technology

Virtual reality (VR) is a safe and controllable platform that can provide individuals with autism spectrum disorder (ASD) educational opportunities for repeatable practice and exposure to dynamic real-life interactions by using computer-based reality simulations of typical and common everyday-life situations (Kandalaft, Didehbani, Krawczyk, Allen, & Chapman, 2013). VR can provide practically unlimited access to real-life scenarios in various replicated naturalist environments (Kandalaft et al., 2013). VR leverages the common interest of computer technology among those with ASD to increase intervention participation and individual motivation. Individuals with ASD typically can understand, enjoy, and appropriately interact with VR technology (Kandalaft et al., 2013).

Personal Reflection

In my work as a special education paraprofessional and teacher over the past seven years, I have found it interesting the number of special needs individuals who are drawn to various technologies and successfully learn to interact with and manipulate them for educational and recreational purposes.

An article I read stated video games are being used to treat individuals with Attention Deficit Hyperactivity Disorder (ADHD) (Rieland, 2017). This increased my interest in using technology to help special needs individuals learn and prompted me to investigate what other technology platforms are used to teach individuals with special needs. My research introduced me to VR technologies being used to help individuals with ASD. In my. I am working with students with a primary disability of fetal alcohol spectrum disorders (FASD). Since ASD and

FASD have some overlapping characteristics (proofalliance.org, 2019), VR interventions could benefit my students.

The Potential of Virtual Reality Interventions

Preliminary studies suggest that VR technology can improve communication, social interaction, and potentially benefit other inherent challenges of those with ASD (Kandalaft et al., 2013). In the area of communication and social skills, VR was used in a study to improve verbal/non-verbal emotion recognition, Theory of Mind, and conversational skills in young adults with high-functioning autism (HFA) (Kandalaft et al., 2013). A combination of cognitive behavior therapy and a virtual reality environment intervention helped young people with ASD overcome specific crippling phobias (Makey, Lowry, Rodgers, McConachie, & Parr, 2014). For individuals with ASD, learning to operate a motor vehicle using safe driving skills is often difficult due to limited self-monitoring, cognitive flexibility, and planning abilities. For this population, Virtual Reality Driving Simulation Training (VRDST) is providing a simulated safe driving environment which can target specific interventions to practice and improve driving skills (Cox, Brown, Ross, Moncrief, Schmitt, Gaffne, & Reeve, 2017). For young adults with HFA, insufficient job interviewing skills create obstacles to employment. Virtual reality job interview training (VR-JIT) is an intervention showing initial promise in enhancing vocational opportunities for this population (Smith, Fleming, Wright, Losh, Humm, Olsen, & Bell, 2015). While evolving virtual reality technologies are becoming more commercially available and provide enhanced simulated real-life experiences (Newbutt et al., 2016), researchers continue to study the effectiveness of virtual reality interventions in comparison to the more simplistic video modeling platform (Fitzgerald et al., 2013).

This study will explore the question: How are virtual reality (VR) technology-enabled educational approaches used to teach students with autism spectrum disorder (ASD), and do VR technology educational approaches provide measurable benefits?

Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a developmental disorder characterized by deficits in social interaction, difficulties with verbal and nonverbal communication, limited interests, preoccupation on inappropriate things, excessive reliance on routines, overly sensitive to personal environment, and repetitive behaviors. Symptoms of ASD are on a continuum, ranging from mild to severe and will vary between individuals (American Psychiatric Association, 2013). Centers for Disease Control and Prevention (2019) estimate approximately 1 in 59 children are identified with autism spectrum disorder.

CHAPTER II: LITERATURE REVIEW

Overview of Literature Reviewed

The research-based studies for this literature review thesis were acquired by using the Bethel University Library CLICsearch interface, Google Scholar, ProQuest, Eric, Education Source, PsycINFO, Science Direct, Academic OneFile, and ResearchGate online sources. The broad search included all publications from 1990 to 2019. Keywords in the searches included: virtual reality, virtual environments, technology, computer, autism, autism spectrum disorder, ASD, learning disabilities, developmental disabilities, special needs, intellectual disabilities, special education, social skills, interaction, emotional skill, instruction, intervention, education, students, children, adolescents, driving, job, and interview in various configurations. The Bethel University Library CLICsearch interface and Google Scholar were the most effective in searching for research studies. Identical keyword and phrase searches in both of these databases located many of the same articles and additional different research publications. The author found that the research surrounding virtual reality interventions in people with special needs was primarily focused on those with autism spectrum disorder. The final publications referenced in this literature review thesis were narrowed to include only research-based peer reviewed studies. The content in this chapter is divided into seven sections: social and emotional development interventions, phobia interventions, motor vehicle driving interventions, job interviewing interventions, current virtual reality technology, and video modeling vs. virtual reality.

Social and Emotional Development Interventions

Virtual Reality (VR) and Virtual Environment (VE) educational approaches found in research-based publications focused on social and emotional development interventions for people with autism spectrum disorder (ASD). A study by Parsons, Leonard, & Chapman (2006) investigated whether people with ASD enjoyed using a computer-based VE, transferred educational experiences from a VE into real-world situations, and considered the importance of the facilitator in the intervention. Two adolescent boys diagnosed with ASD were used in this study that employed a series of sessions involving a virtual bus and a café environment. A laptop computer provided the students with access to the bus and café VE. The participants navigated the single-user VEs with a joystick and mouse while sitting next to a facilitator. The researchers' record of participant observations and their comments provided the resulting outcome data for this research. The bus and café VEs ranged in multiple levels of difficulty, from a scene with few people to scenes with many characters. In the VE intervention, the participants' learning objective was to choose a place to sit or appropriately inquire about a place to sit. A correct response would resulted in positive pre-programed feedback, and advancing to the next level of difficulty. Mastery and generalization of the learning objectives was determined by participant discussions that referred to video clips from real buses and cafes. A three-month follow-up session checked whether the participants maintained learning.

Researcher observations and positive participant comments indicated that the VE intervention was an enjoyable experience for the students (Parsons et al., 2006). The participants demonstrated the ability to understand and transfer the experience from VE to real-world situations by providing specific examples of learning (Parsons et al., 2006). The participants discussed appropriate social responses with the facilitator nearby. The researchers were encouraged that successful learning occurred in a VE and expected that future improvements in technology would enhance the VE experience for students in the future.

To support previous research and further explore the potential of VE in social understanding educational interventions in adolescents with Autistic Spectrum Disorders, Mitchell, Parsons, & Leonard (2007) assessed VE as a viable teaching tool for social functioning in people with ASD. Similar to the previous study (Parsons et al., 2006), researchers used a VE café, along with videos of real buses and cafes to teach the social skills necessary to find a seat in a bus or café. This research included four male and three female adolescents with a diagnosis of ASD. One of the male participants was removed from the study due to his continued inappropriate behavior. The purpose of this study was for the participant to find a place to sit or to ask appropriate questions to find a place to sit. A laptop computer provided the students with access to the café VE. The participants navigated the single user VEs with a joystick and mouse while sitting next to a facilitator. The café VE had four levels of difficulty, few people and nearly quiet to nearly full of people and quite noisy. The VE program provided the participants with visual and verbal feedback that instructed them about the best options for finding a place to sit in various circumstances. The facilitator was allowed to provide participants with input or ask questions to assist in learning. All the participants had the same tasks. In order to determine the benefits of the VE intervention compared with the benefits from practice alone; some participants received the VE intervention between videos one and two and other participants received the VE intervention between videos two and three. Independent raters assessed participant responses on a six-point scale from: (1) not at all social, to (6) very social.

The results of this research indicated that the VE intervention improved participants' use of appropriate social behavior in finding a place to sit as demonstrated by their ability to more speedily and successfully complete successive sessions (Mitchell et al., 2007). The VE experience improved participant judgment and reasoning about finding a place to sit in the videos of real buses and cafes. These improvements directly related to the timing of the VE interventions. Participants displayed little gain without the VE intervention during times of repeated practice or testing. Most importantly, participants displayed the ability generalize the VE learning, by transferring what they learned in the café VE to the real, live video scenes in both buses and cafes (Mitchell et al., 2007). The results provided rationale for using VE as a social skills intervention for students with ASD related to personal space, interviewing, and other aspects of communication.

A pilot research study by Cheng & Ye (2010) (National Changhua University of Education, Changhua City, Taiwan) focused on using a VE to help students with autism spectrum conditions (ASC) learn and increase positive social competence, behavioral performance in cognitive and social settings, and increase social interaction, using a collaborative virtual learning environment (CVLE) system. The participants were three children (two male and one female), who demonstrated social competence disorders consistent with ASD. A simulated environment was created using a CVLE social interaction system on a laptop computer which incorporated 3D technology to create a real-life setting. It used two social interaction scenes (one classroom scene and one outside scene) which consisted of social scenarios involving the understanding of verbal and non-verbal communication, and social understanding and expression. Avatars represented and were controlled by the participant and teacher in the simulated environments. The virtual teacher encouraged the participants by providing rewards, increasing the likelihood that participants would continue to respond to rewarded rather than unrewarded conditions. Measurements evaluated the social competence and social behaviors of the participants. Measurements were established at baseline, after the CVLE-social interventions, and at follow-up maintenance. Each of the three participants measured different baseline levels of social competence. After the CVLE-social interventions, each participant's scores increased and consistently trended upward. Maintenance measurements following the intervention indicated that learning was stable over time (Cheng et al., 2010).

The results of this research indicated that using the CVLE-social interaction system markedly improved all of the participants' social competence performance, both within the CVLE-social interaction system and in the ability to maintain the social competence learning over time. The positive effects of the CVLE-social interaction system for participants with ASCs demonstrated the potential value of this VE learning intervention. The CVLE social system provided an environment that simulated real-life scenarios, motivated participants to learn appropriate social skills and provided an opportunity for people with ASCs to improve reciprocal social interaction skills (Cheng et al., 2010).

For individuals with ASD, transitioning into adulthood can be a difficult time. The social challenges inherent with high-functioning autism (HFA) interfere with establishing relationships, assimilating into the workplace, and integrating into the community (Hendricks & Wehman, 2009). Few evidence-based social interventions are available that can directly enhance and provide opportunities for individuals with HFA to practice communication and social skills in real-life scenarios (Moxon & Gates, (2001). For this reason, Kandalaft, Didehbani, Krawczyk, Allen, & Chapman (2013) conducted a study in which they investigated and examined the feasibility of employing Virtual Reality Social Cognition Training (VR-SCT) as an intervention to improve social skills, social cognition, and social functioning in young adults with HFA. They believed that VR environments could provide life-like situations for young adults with HFA to practice and improve communication and life skills.

Eight young adults between the ages of 18 to 25 participated in the study. Each had a primary diagnosis of autism spectrum disorder and average to above average IQ (Kandalaft et al., 2013). Before and after the VR-SCT intervention, social cognition measurement data was collected to assess participants' performance in three areas: verbal/non-verbal emotion recognition, Theory of Mind, and conversation skills. The study used Second Life(TM) version 2.1, which is a three-dimensional virtual world software available to the public. The VR environments used in the VR-SCT intervention resembled common young adult real-life situations involving social interactions with peers, co-workers, and others in the community. Individual avatars simulated each participant and the coach. A therapist used various avatars and voices to play other characters in the scenarios. The VR-SCT intervention was developed to assimilate dynamic and realistic scenarios for the participants to engage in, provide opportunities for repetitive practice, and receive feedback. The VR-SCT intervention provided the participants with a safe environment for social interactions without fear of rejection or making mistakes. Individuals with ASD have demonstrated in other studies the ability to successfully interact and enjoy social interactions using VR (Parsons, & Mitchell, 2002; Parsons, Leonard, & Mitchell, 2004; Parsons, Leonard, & Mitchell, 2006). All eight participants successfully completed the ten one-hour VR-SCT intervention sessions.

The measurement data collected pretest and post-test revealed participant improvement from the VR-SCT intervention. The Advanced Clinical Solutions Social Perception subscales (ACS-SP) indicated a significant increase at post-test in the areas of verbal/non-verbal emotion recognition and social perception. In the area of Theory of Mind, the participants increased at post-test as measured by Triangles (Social Perception Task). Finally, eye interpretation increased at post-test as measured by Reading the Mind in the Eyes, although not significantly (Kandalaft et al., 2013). For conversational skills, social performance scores increased at post-test as measured by the Social Skills Perception Performance (SSPA), although not substantially (Kandalaft et al., 2013).

The researchers concluded that the overall positive results of this study provided evidence to support the potential benefits and the feasibility of continued use and further testing of VR and the VR-SCT intervention to address social skills, social cognition, and social functioning in young adults with ASD (Kandalaft et al., 2013). The authors recognized that the study sample size was small and the study lacked a control group. In addition, the social cognition and SSPA measurements had potential limitations. The follow-up interview may have skewed results due to researcher influence and yes/no question format. Because of the current limitations of VR technology, the avatars did not display facial expressions.

Multiple educational intervention strategies have been found effective in helping children with autism learn appropriate social interaction and communication skills. A research study by Fengfeng & Tami (2013) examined the implementation and impact of a virtual-reality (VR)-based social interaction program on children with Asperger syndrome or high-functioning autism (AS/HFA). The purpose of the study was to determine the impact of a VR-based educational intervention on social interaction and communication in children with autism and identify which specific VR-based components and tasks advanced the participants' social interaction performance. The researchers utilized the Second-Life-based social interaction program in an attempt to answer these guiding questions. The study involved four children from fourth and fifth grade who had a diagnosis of AS/HFA. The Second-Life-based social interaction program included three tasks: (1) recognizing non-verbal body gestures and facial expressions of a virtual avatar communication partner, (2) respond and maintain social interactions in a virtual school cafeteria, and (3) initiate, respond, and maintain social interactions at a virtual home birthday party (Fengfeng et al., 2013). The researchers established individual social interaction, behavior, and communication baselines for all of the participants in the study. During the intervention, the participants and adult facilitators interacted with each other in the Second-Life-based virtual world by directing individual avatars. The adult facilitator initiated contextualized role-played scenarios with each child that were situation-specific and naturalistic. Another adult facilitator was available to help the child with technical and online communication assistance.

Initial baseline performance data revealed that all of the participants exhibited a degree of competence in social interaction and communication performance (Fengfeng et al., 2013). Regardless, all of the participants demonstrated increased competence in social interaction and communication skills performance during their intervention sessions. Participants exhibited increased performance in responding and maintaining social interaction, especially in the school cafeteria scenario. Participants exhibited increased performance in the areas of initiating, greeting, and ending social interactions in the birthday party scenario. The study also revealed that participants improved their recognition of non-verbal body gestures and facial expressions following the intervention. In addition, the participants' parents reported positive changes in their child's social interactions at home during and after the intervention sessions (Fengfeng et al., 2013). It appears the naturalistic real-life 3D virtual reality environment provided the participants with a platform in which they could safely explore and experience social communication learning they may not have access to in real life.

Engaging in and maintaining shared reciprocal behavior is difficult for children with autism spectrum disorder (ASD). Parsons (2016) investigated an educational technology that was developed to help children with ASD improve and maintain shared reciprocal behavior skills. A collaborative virtual reality environment (CVE) was designed to support communicative perspective-taking abilities for children with high-functioning ASD (Parsons 2016). The study involved six children (verbal mental age 9) with ASD and eight typically developing (TD) children (age 8). The CVE used a 3-D environment two-player simulation game on a laptop computer with a mouse. A Block Challenge game was used in an attempt to enable reciprocal communicative perspective-taking interactions among the children. Children needed to verbally communicate, collaborate, and understand the perspective of the child with whom they were paired to be successful in the game. The task involved pairs of children (TD-TD or ASD-ASD pairs) who collaboratively chose and stacked virtual dual-colored blocks according to individual target instructions. The children participated in three fixed sessions. The first session assessed the children verbally. The second session assessed the children for their ability to understand others' perspectives. In the third session, Children were paired (according to friendship) and supported by adults when using the Block Challenge game CVE program during a training phase and then when they played the three levels of the main game.

Throughout the Block Challenge game both the TD and ASD pairs communicated with each other in similar ways. The ASD pairs made substantially more communicative game moves, possibly because the ASD children could not make assumptions about their partner's thinking in the same manner of TD children. Interestingly, the TD children reported that they found the Block Challenge game too easy and would have liked it to be harder. Some of the ASD children struggled with the communication demands of Block Challenge game, which required more than twice the adult support compared to the TD children. However, most of the pairs trended in reducing the number of communications needed during the three levels of the game, which indicated improved reciprocal communicative perspective-taking interactions between the children as they became more familiar with the game. This suggests the Block Challenge game effectively targeted the reciprocal communicative perspective-taking interactions desired and with adult support, the children with ASD successfully improved communication skills (Parsons 2016). The limitations of the study included small sample size, some incomplete parent data, and a lack of background knowledge about participants' previous experiences using technology.

Continued improvements in technology provide opportunities for educators to apply new and improved technology-based teaching interventions. This study by Lorenzo, Lledo, Pomares, & Roig (2016) (University of Alicante, Spain) evaluated the effectiveness of an immersive virtual reality system (IVRS) program compared to an earlier desktop virtual reality (VR) program, and sought to determine if these programs provide significant differences in the development and generalization of emotional skills in students with autism spectrum disorder (ASD). The purpose of this study was to train, develop, and improve the emotional skills of students with (ASD) (Lorenzo et al., 2016). The participants consisted of 40 students with an ASD diagnosis (29 male and 11 female) between the ages of 7-12 (Lorenzo et al., 2016). For this study 20 of the students used the IVRS program intervention and 20 of the students used the earlier VR program intervention. Each participant participated in 40 training sessions using the assigned technology, with the first session setting an individual baseline. Both the IVRS and the VR technology used simulated classroom and party environments. The IVRS technology allowed the participant to be fully immersed in a life-like computer-simulated environment that included real-life sound effects (Lorenzo et al., 2016). The IVRS provided safe 3-D environments that were controlled and available for repeated use. Expressive avatars were used in the IVRS simulated environments. The IVRS system adjusted the avatars and other components of the simulated social situation depending on the participant's actions and behaviors. In addition, the IVRS automatically confirmed when the student acted appropriately in the simulated social situation. An emotional script intervention trained students and developed appropriate emotional behavior which improved a student's overall emotional competency.

The results of this study revealed that the IVRS participants learned, developed, and displayed significantly more appropriate emotional behaviors in the simulated immersion environments than the participants who used the earlier desktop simulated VR environments. In addition, participants using the IVRS program also improved emotional behavior in their real school environments during the intervention. The authors indicated that generalization and transfer of acquired skills is possible when learned from the IVRS simulated scenarios (Lorenzo et al., 2016).

Virtual reality technology appears to provide a motivating educational intervention platform for children with autism spectrum disorder (ASD) that safety allows them to practice and rehearse social skills. However, Didehbani, Allen, Kandalaft, Krawczyk, & Chapman (2016) believed that more research needs to be done to substantiate the effectiveness of virtual reality educational interventions. This study extends previous work (Kandalaft et al., 2013) referred to earlier in this literature review, which presented the effectiveness of the Virtual Reality Social Cognition Training (VR-SCT) program intervention when used with young adults. The research in this study examined the efficacy of VR-SCT to improve social cognition in children and adolescents with autism spectrum disorder (ASD).

There were 30 participants in this study, ages 7-16 (26 males and 4 females) all having a diagnosis of ASD, with 13 having a combination diagnosis of ASD and Attention-Deficit/Hyperactivity Disorder (ADHA) (Didehbani et al., 2016). Participants were matched with a same-aged peer and completed ten sessions of VR-SCT training. The study focused on three domains measured pre/post intervention: emotion recognition, social attribution, and attention and executive function (Didehbani et al., 2016).

The study used Second Life(TM) version 2.1, which is a three-dimensional virtual world software available to the public. The VR environments used in the VR-SCT intervention resembled real-life situations: school classroom, school lunchroom, playground, campground, racetrack, fast food restaurant, technology store, apartment, coffee house, sports store, and a park. The VR-SCT social training platform addressed some of the limitations of previous VR programs and provided an interactive intervention program used with both children and adults with ASD. The VR-SCT provided the flexibility to use varied social scenario contexts and complexities to fit various developmental ages. Avatars resembling the peer-matched participants engaged with a confederate clinician avatar and practiced social skills in simulated real-life social situations in an interactive virtual reality (VR) environment with the support of an avatar clinician coach. The confederate clinician used various avatars and voices to play different characters in the VR scenarios. Each different scenario emphasized a specific social learning objective: meeting new people, interacting with a bully, interacting with friends, confronting conflict, consoling a peer, and dealing with a social predicament (Didehbani et al., 2016).

All participants were similarly engaged in the different VR scenarios, and all received equal benefit from the intervention. Improvements were seen in both groups of participants (ASD and ASD/ADHD combined) across all three measured domains: emotion recognition, social attribution, and attention and executive function. These participant improvements demonstrated the effectiveness of the VR-SCT intervention. Limitations of the study include a small sample size, a lack of comparison group, and the inability for the program to display avatar facial emotions. Overall, the study findings suggested that the VR-SCT intervention was a safe, meaningful, and effective platform for improved social cognition in children and adolescents with ASD (Didehbani et al., 2016).

Researchers continued to evaluate the efficacy of virtual reality (VR) educational interventions in children with autistic spectrum disorder (ASD). Of the research studies reviewed, Ip, Wong, Chan, Byrne, Li, Yuan, Lau, & Wong (2018) (Hong Kong) included the greatest number of participants. Although research has shown the VR environment promising for educational interventions, there has been a lack of large-scale trials that provide further support for the effectiveness of VR educational interventions. The study included 94 children with a diagnosis of ASD, between the ages of 6-12 (86 boys and 8 girls, with a mean age of 9 years) (Ip et al., 2018). The researchers hypothesized that the ASD participants would increase their emotional and social adaptation skills after the VR educational intervention program. The VR intervention focused on two primary skills and ability outcomes (emotion expression and regulation, and social interaction) and two secondary outcomes (emotion recognition and adaptive skills) (Ip et al., 2018).

The Cave Automatic Virtual Environment (CAVE) VR program was selected for the intervention to provide: real-life VR immersive scenario environments with extensive details and visual cues, real-life simulated situations encountered by children in Hong Kong, the ability for the participants to easily interact with avatars and objects in the simulated environments, and allowed the trainers to lead and maintain the intervention procedures and intervene if necessary. The VR learning scenarios were designed to maintain a safe, controlled, and real-life environment for the participants to practice and develop their emotional and social adaptation skills when facilitated by the instructor (Ip et al., 2018).

The participants were divided into two groups (Group 1 and Group 2) with 47 children in each. The participants completed pre- and post-assessments (Ip et al., 2018). Group 1 was the training group and received the VR intervention, and Group 2 was the control group and did not receive the VR intervention. The training continued twice a week for 14 weeks for a total of 28 sessions. 3-4 children of similar age participated in the sessions together. One receiving 10 minutes of the VR intervention while the other students observed. While observing, the children were to think about and reflect on the others' responses to the social situations within the simulated environments.

The results of the study revealed that the participants in Group 1, who received the VR training intervention, substantially improved emotion expression and regulation, and social interaction. In addition, observations and assessments were completed away from the VR training in a typical classroom setting, suggesting the generalization of these social skills. The results of the study provide clear support that VR training interventions improved emotion expression and regulation, and social interaction in children with ASD. Additionally, the study demonstrated that the VR platform provided an enjoyable and motivating training program (Ip et al., 2018).

Stichter, Laffey, Galyen, & Herzog (2014) authored the first research study to explore the effectiveness of a curriculum delivered by a 3-Dimensional Virtual Learning Environment (3D-VLE) as distance education (DE) to students with high-functioning autism (HFA) to multiple schools. The iSocial 3D VLE is a DE program which executes the Social Competence Intervention (SCI-A) (Stichter, Herzog, Visovsky, Schmidt, Randolph, & Schultz, 2010). The SCI-A curriculum designed for students with HFA, ages 11-14, was selected considering evidenced-based practices to improve social competence (Stichter et al, 2010). In this study, iSocial's function is to supply an evidence-based curriculum and professional support to students with autism spectrum disorder (ASD) in schools with limited access by using DE.

Three school districts in the same Midwestern state participated in this study. The school district student populations ranged from 4,500 to 18,000, where between 40-70% of the students qualified for free and reduced lunch (Stichter et al., 2014). This study focuses on the viability of delivering an evidence-based social competence intervention to students with autism over the internet in rural areas in need of support.

All three school districts successfully implemented the SCI-A curriculum over the internet using the iSocial 3D VLE program with a high degree of fidelity. The students with HFA made progress in improving social competence. This study established that it is possible to deliver evidence-based intervention programs, which rely heavily on social interactions between students and with the facilitation of an online guide, using DE to achieve positive outcomes for students with ASD (Stichter et al., 2014).

Phobia Interventions

About half of the young people with autism spectrum disorder (ASD) are impacted by anxiety disorders (Simonoff et al., 2008). Of these anxiety disorders, the most common subtype in children with ASD is specific phobias (Joshi, et al., 2010). Maskey, Lowry, Rodgers, McConachie, & Parr, 2014 (United Kingdom) examined a treatment approach for children with ASD by combining cognitive behavior therapy (CBT) treatment with immersion virtual reality environments (VRE) to reduce a specific phobia and improve the management of the real-life phobia-provoking situations.

The study included nine boys, ages 7-13, all diagnosed with ASD with no documented learning disability. Additionally, each of these children had a specific phobia which could be simulated using the "Blue Room" VRE program (Maskey et al., 2014). The VRE provided simulated real-life environments where the participants could experience specific phobias in a safe, controlled setting. The VRE program allowed the participants to navigate the phobia-provoking environment and interact with objects and people in order to learn and practice anxiety management skills (Maskey et al., 2014).

The child and parent versions of the Spence Children's Anxiety Scale (SCAS) measured pre- and post-intervention anxiety (Spence, 1998). Participants received four 20-30-minute VRE treatment sessions over one week that included coaching by a therapist using cognitive and behavior therapy techniques (Maskey et al., 2014). The sessions began with a virtual reality relaxation scene that included soothing sound effects. When the participant was relaxed and ready, the therapist started the VRE intervention program using the simulated real-life environment in which the participants experienced specific individual phobias in safe, controlled settings. During the intervention, each participant was taught various anxiety management techniques. As the participants successfully managed their anxiety, the therapist gradually increased the simulated VRE phobia challenge over four sessions. Parents watched the intervention sessions on a monitor in an adjacent room.

The study revealed that CBT techniques taught by a therapist in an immersive VRE proved effective for specific phobias in children with ASD. Eight out of the nine participants improved their ability to manage specific phobias and four of the participants completely overcame specific phobias in real world situations. In addition, the participant's improvements continued to generalize for 12-16 months post CBT/VRE intervention training program (Maskey et al., 2014).

In 2019, Maskey et al., incorporated a larger sample size, included a control group, and added a more specific phobia anxiety rating measurement tool. The study: (1) evaluated the feasibility and fidelity of the therapist delivered CBT/VRE treatment program; (2) determined the acceptability of the CBT/VRE intervention outcomes to the participants and their parents; (3) examined the participant response to the VRE program; and (4) determined if initial benefits of the CBT/VRE intervention generalized (Maskey et al., 2019) .

The study included 32 participants, 25 boys and seven girls, ages 8-14, randomized into equal groups: a treatment group and a control group (Maskey et al., 2019). Similar to the previous study (Maskey et al., 2014), all participants had a diagnosis of ASD and no diagnosed learning disability (Maskey et al., 2019). Each child had a specific phobia which was simulated using the “Blue Room” VRE program (Maskey et al., 2019). The VRE provided simulated real-life environments where the participants experienced specific phobias in a safe, controlled setting. Participants navigated the phobia-provoking environment and interacted with objects and people and practiced anxiety management skills (Maskey et al., 2019).

The current study added a specific phobia anxiety rating measurement protocol tool, developed by the Research Units on Pediatric Psychopharmacology (RUPP) Autism Network (Maskey et al., 2019), that measured pre- and post-intervention anxiety. Similar to the previous study (Maskey et al., 2014), the child and parent versions of the Spence Children’s Anxiety Scale (SCAS) measured pre- and post-intervention anxiety (Spence, 1998). Each participant in the treatment group received four 20-30-minute VRE treatment sessions over one week, which included coaching by a therapist who used cognitive and behavior therapy techniques (Maskey et al., 2019). The sessions began with a virtual reality relaxation scene including soothing sound effects. When the participant was relaxed and ready, the therapist started the VRE simulated real-life environment intervention program where the participants experienced their phobia in the safe, controlled setting. The control group only received CBT. After a six month follow-up measurement, the control group received the same CBT/VRE intervention program as the initial treatment group (Maskey et al., 2019).

The results of the study supported the previous findings that demonstrated CBT techniques taught by a therapist in an immersive VRE were an effective program for treating specific phobias in children with ASD (Maskey et al. 2014). One-third of the participants in the treatment group increased the ability to manage specific phobias in real-life situations, which was not previously possible (Maskey et al., 2019). In contrast, none of the control group participants displayed any improvement in the ability to cope with specific phobias (Maskey et al., 2019). In addition, after the control group received the CBT/VRE treatment program, the outcome results were similar to the treatment group (Maskey et al., 2019).

Motor Vehicle Driving Interventions

Driving a motor vehicle provides a young person with a means of community mobility. Personal driving provides additional access to education, employment, social recreation, shopping, medical, and other services (Monahan, 2012). Adolescents with autism spectrum disorder (ASD) often experience deficits with executive functions such as: shifting attention, cognitive flexibility, initiation, inhibition, self-control (Hill, 2004), motor coordination (Fournier, Hass, Naik, Lodha & Cauraugh, 2010), and vision processing (Simmons, Robertson, McKay, Toal, McAleer, & Pollick, 2009). Classen & Monahan 2013) examined the differences between adolescent drivers with ASD and healthy control (HC) adolescents. It was expected that the ASD adolescents would perform unfavorably on evaluations of visual, cognitive, and motor skills and would exhibit more driving errors in contrast to the HC. The purpose of the study was to make evident the differences in simulated driving abilities between adolescents with ASD compared to the HC adolescents (Classen et al., 2013).

The study contrasted the differences between seven adolescents with a diagnosis of ASD when compared to 22 HCs in a simulated comprehensive driving evaluation (CDE) conducted by an occupational therapist-certified driving rehabilitation specialist (OT-CDRS) (Classen et al., 2013). A virtual reality driving simulator offers an acceptable format to assess the driving abilities of potential drivers. Driving simulators provide a safe driving environment by replicating variable driving conditions and interferences that can take place in real-world driving situations.

The participants completed a driving simulation exercise that included a 20-minute orientation in the simulated car cab to become familiar with the steering wheel, turn signals, brake, and accelerator, a 7-minute practice drive, and a 20-minute evaluation drive. During the evaluation drive, the OT-CDRS assessed seven driving errors: speed regulation, lane maintenance, gap acceptance, visual scanning, stimuli adjustment, vehicle position, and signaling (Classen et al., 2013).

The results from the driver simulation exercise confirmed that adolescents with ASD performed significantly unfavorably on all seven of the operational driving skills and totaled more driving errors when compared to the HCs. Additionally, adolescent ASD drivers had a significantly greater number of total traffic violations (Classen et al., 2013). Although the study did not set out to establish correlation relationships between clinical ASD symptoms and the participants' impaired driving abilities, it found that clinical ASD symptoms could potentially explain the conceptual connections to the increased number of driving errors (Classen et al., 2013). Implications of the study suggested that adolescents with ASD may require specialized driving assessments to determine whether they need adapted, specific instruction to become successful drivers. Limitations of the study included a small sample size and the participants' potentially varied ASD severity.

Driving is an important skill that can improve personal independence and increase opportunities for employment and social relationships. Surveys indicate that there is a wide gap between adult drivers with high-functioning autism (HF-ASD = 24%) and that of the general population (75%) (O'Neil, 2012). Because driving is critical to attaining independence, Reimer et al., 2013), sought to gain a greater understanding of the challenges facing drivers with HF-ASD.

This study was designed to examine the visual attention and driving behavior in young adult drivers with HF-ASD compared to a neuro-typical community control sample using a virtual reality driving simulator (Reimer et al., 2013). A simulated driving environment provided controlled realistic driving scenarios, which could be replicated for fidelity that ensured safety and allowed for the assessment of driving skills and behavior of any driver.

The participants in this study included 20 males with a mean age of 20.2 years, each with a valid driver's license and similar driving experience. Ten of the participants were diagnosed with HF-ASD and the other ten made up the healthy community control sample (Reimer et al., 2013). The driving simulator incorporated a 2001 Volkswagen Beetle cab in front of an 8' x 8' projection screen and included appropriate real-life sound effects. The simulated driving procedure included a driving simulator orientation period, followed by a 43-mile virtual roadway that assessed driver capabilities. At two strategic points along the virtual roadway, the participants performed a hands-free cell phone call and a cognitive demand test (Reimer et al., 2013).

The study results indicated no statistical differences in the performance of either the hands-free cell phone call or the cognitive demand test for either group. Both groups had two participants involved in auto collisions while driving the simulated virtual roadway. The HF-ASD group appeared to focus more of their visual attention on the horizon above the active roadway scene, compared to the community control group. Additionally, the HF-ASD participants exhibited an increased heart rate during the assessment compared with the community control group which, although not statistically significant, might be an indication of increased general anxiety (Reimer et al., 2013). Overall, the small sample size did not indicate a significant performance difference between the HF-ASD and the community control group.

In an effort to examine the importance of eye gaze when driving a motor vehicle and to determine if a virtual reality driving simulator can be a successful intervention tool for young adolescents with Autism Spectrum Disorder (ASD), Wade et al., (2017) completed a two-part study. Part one of the study compared differences in eye gaze between adolescents with and without ASD. Part two of the study considered the effectiveness of using a virtual reality driving simulator as a motor vehicle driving intervention strategy for adolescents with ASD. Both studies involved using Virtual Reality Adaptive Driving Intervention Architecture (VIDIA), which provided a virtual driving environment and included a remote eye gaze tracker that monitored eye gaze patterns and related them to driver performance (Wade et al., 2017).

The authors hypothesized that apparent differences in eye gaze attention and driving performance would be apparent between adolescents with and without ASD (Wade et al., 2017). Part one included 14 participants, seven who had a clinical diagnosis of ASD and seven neuro-typical control adolescents. The procedure consisted of one 90-minute period which included: a tutorial, eye gaze calibration, practice driving, and a 70-minute driving trial. The driving session included six consecutive driving tasks, each with increasing difficulty. Participants were given one attempt at each driving task, however, advancing to the next task was not based upon successful completion of the previous task. The system provided immediate feedback when participants failed, explained the driving error, and provided future corrective action. At the end of the trial, participants rated their simulated driver experience (Wade et al., 2017). Eye gaze and performance data examined differences between ASD and control drivers. The results indicated that the ASD drivers made more errors, exhibited slightly longer gaze fixation durations and demonstrated higher vertical and slightly to the right eye gaze. ASD drivers reported significantly less enjoyment in using the system compared to the controls (Wade et al., 2017). The findings supported the outcomes of a previous research study of drivers with ASD (Classen et al., 2013; Reimer et al., 2013).

Part two concentrated on the effectiveness of the VIDIA system as a driving intervention tool (Wade et al., 2017). The study included 20 adolescents with a clinical diagnosis of ASD. Participants were divided into two equal groups: the performance-based group and the gaze-contingent group. Each participant completed six individual 30-minute intervention sessions of increasing difficulty. Session one included a tutorial period with a pre-test and session six concluded with a post-test. The performance-based group used the VADIA system without eye gaze monitoring. The gaze-based group used the VADIA system with eye gaze monitoring. The results of the performance-based group displayed a statistically significant reduction in driving errors pre-test to post-test. Additionally, the gaze-contingent group also demonstrated a statistically significant reduction in driving errors pre-test to post-test (Wade et al., 2017). Limitations of the two-part study include a small sample size, and the participants' previous driving experience was not considered (Wade et al., 2017).

Several challenges reduced the prospect of attaining a motor vehicle driver's license for adults with intellectual disabilities (ID) compared with typical peers (Myklebust & Båtevik, 2009). In a study, Brooks, Mossey, Tyler, & Collins (2013) explored the effectiveness of using an interactive virtual reality driving simulator to teach pre-driving skills to adults with intellectual disabilities. Four young adults diagnosed with ID (two male, two female) and ages 21-23, participated in the study. One participant had a driver's learner permit and limited actual on-road driving experience. The other three participants were in the process of obtaining a driver's learner permit and had no on-road driving experience (Brooks el at., 2013). The study used the CDS-250 (DriveSafety, Inc., Murray, UT) virtual reality driving simulator, which incorporated a partial motor vehicle cab with standard vehicle controls, instrument panel, center console, and adjustable driver's seat. The simulator presented various virtual driving scenarios on a three-screen horizontal display (Brooks el at., 2013).

The participants' training intervention began with three familiarization/training exercises consisting of three scenarios in this order: straight line, curves, and start and stop maneuvers. Each training exercise provided visual and audio feedback. Participants were required to meet specific criteria before beginning the next training exercise. The participants were allowed to repeat the training exercises as many times as necessary to meet the training drive criteria (Brooks el at., 2013). After all three training exercises were successfully completed, the participants engaged in three driving trials utilizing three different tracks. The procedures for the driving trials were the same as the training exercises (Brooks el at., 2013). Additionally, when breaks were needed, the drivers participated in hand and feet motor coordination exercises and reviewed a driving manual (Brooks el at., 2013). The intervention contained five one-hour sessions per week and ended when the first participant successfully passed all of the driving tasks. The study lasted 27 data collection days (Brooks el at., 2013).

The study demonstrated the unique needs of individual participants who required various amounts of time to master the driving tasks successfully. Participant One successfully completed all of the driving trials in the intervention. Participant Two advanced to the final driving trial. Participants Three and Four advanced more slowly. Participant Three was on the second driving trial and participant Four remained at the first driving trial (Brooks el at., 2013). Throughout the intervention, participants One and Two demonstrated greater consistency in improving driving skills compared to participants Three and Four (Brooks el at., 2013). The virtual reality driving simulator intervention provided a safe learning environment where young adults with ID practiced driving skills impossible to replicate in real on-road situations (Brooks el at., 2013). Imitations of this study included a small sample size.

Learning to drive a motor vehicle plays an important role in the development and functional independence of adolescents. Having a driver's license can increase opportunities for employment and academic advancement. While many young people with autism spectrum disorder (ASD) obtain a driver's license, for others, learning safe driving skills is a difficult process (Classen et al., 2013). Limited studies reflect the additional challenges that adolescents and young adults with ASD have when learning to drive (Classen et al., 2013). Individuals with ASD have trouble with shifting attention, ordering tasks, and coordinating movement and visual perception (Classen et al., 2013). Cox et al. (2017) considered how beginner ASD drivers differ from safe drivers with respect to driving-relevant executive function (EF) and tactical driving skills. The authors also explored how various virtual reality driving simulation training (VRDST) options train beginner ASD drivers and move them towards competent driver performance. The authors believed that beginner ASD drivers had poor general driving skills compared with experienced drivers and that using a virtual reality driving simulator would enable them to improve overall driving performance (Cox et al., 2017).

Fifty-one beginner drivers diagnosed with ASD, ages 15.5-25, participated in the study. Each had a valid learner's permit. Drivers were required to participate in 14 VRDST driving sessions and received driving instruction on public roadways. A control group consisted of experienced drivers ages 25-75 (Cox et al., 2017). The EF and general tactical skills of the ASD beginner drivers was assessed prior to the VRDST and three months post-training (Cox et al., 2017). The study used Driver Guidance System (DGS-78) VRDS, which is available commercially. This VRDS incorporates a practical driver’s compartment, including side and rear-view mirrors. The driver’s range of sight is projected onto a large curved screen. The VRDST intervention used the strengths of virtual reality (VR) to provide recognizable real-life scenarios so the participant experienced and practiced essential driving skills. A safe virtual driving environment allowed for practice repetition and gave participants the opportunity to use progressive training modules that required skill mastery before advanced training (Cox et al., 2017).

EF composite scores were comprised of: dual testing (simultaneous performance of tasks), response inhibition (the ability repress actions that would interfere with knowledge or appropriate behavior), and working memory (a cognitive system with a limited capacity that is responsible for temporarily holding information available for processing) (Cox et al., 2017). Tactical composite scores were comprised of the ability to maneuver a motor vehicle through various driving situations and environments that included 15 tactical variables in the areas of swerving, rolling stops, speeding, and collisions (Cox et al., 2017). Four driver training interventions were used: routine training (following the DMV training manual), standard VRDST (incorporating a human trainer), automated VRDST (using a computer-generated voice providing feedback), and eye-tracking VRDST (using participant eye movement to direct feedback) (Cox et al., 2017). VRDST (Standard, Automated, and eye-tracking) consisted of eight progressive mastery-based training modules, which focused on EF and tactical ASD driver deficits identified in the pre-assessment (Cox et al., 2017).

The measurement data collected pre-assessment and post-assessment revealed participant improvement from the VRDST intervention (Cox et al., 2017). Although beginning drivers with ASD performed worse on general tactical driving and working memory than experienced drivers, VRDST interventions lead to better general tactical driving performance. The VRDST focused on driving-relevant EF improved that ability (Cox et al., 2017). Additionally, VRDST can be enhanced by adding automated feedback and/or eye-tracking (Cox et al., 2017).

The study conclusions supported the benefits and feasibility of using VRDST to improve driving skills in beginner ASD drivers (Cox et al., 2017). The authors recognized the small sample size, that they could not validate participants' additional driving instructions on public roadways, that similar aged neuro-typical drivers were not included in the control group, and lack of assessment data failed to gauge how much training moved the ASD drivers toward improved safe driving (Cox et al., 2017).

Job Interviewing Interventions

Two years after graduating high school, nearly 50% of young adults with autism spectrum disorder (ASD) are not working or engaged in postsecondary education (Shattuck et al., 2012). Reduced employment outcomes for people with ASD are documented and require a closer examination of effective ways to support this population in attaining work (Migliore, Timmons, Butterworth, & Lugas, 2012). Strickland, Coles, & Southern (2013) assessed the validity of an internet-based training program that included comprehensive online instruction and one online virtual reality practice session to teach appropriate job interview skills to young adults with high functioning ASD. The authors believed the training intervention would improve both job interview skills and appropriate personal interaction (Migliore et al., 2012).

The study included 22 adolescent males with a clinical diagnosis of ASD, between the ages 16-19, divided into two equal groups: treatment group (received the intervention) and contrast group (no intervention), facilitated online in the participant's home (Migliore et al., 2012). The intervention incorporated the online JobTIPS employment training program (Do2Learn.com/JobTIPS) and the online VenuGen4 virtual reality office interview environment (venuegen.com) (Migliore et al., 2012). Each participant received a written description, including visual images of the pretend "stock clerk" position. Four clinicians rated each participant's pre- and post-intervention simulated job interview (Migliore et al., 2012). The intervention began with the JobTIPS job interview training program (seven subsections) that provided step-by-step instruction, visual supports, video supports, and printable supplemental materials (Migliore et al., 2012), This was followed by one 30-minute VenuGen4 virtual-reality office-interview-environment practice session that incorporated a remotely located clinician who assumed the avatar role of the interviewer, while the participant assumed the avatar role of the interviewee. During the virtual reality training session, the clinician provided direct positive feedback on areas of strength, gave explicit instruction focused on deficit areas, and provided opportunities for repeated rehearsal. The pre-intervention job interview provided information about the participant's job interviewing strengths and weaknesses to target individual instruction (Migliore et al., 2012).

The study revealed that the participants in the treatment group who completed the JobTIPS training and the virtual reality practice session displayed significant improvement in job interviewing skills compared to the contrast group (Migliore et al., 2012). The intervention package successfully taught job interview skills content to young adults with ASD. However, the intervention package was less effective in teaching appropriate personal interaction skills, specifically associated with nonverbal communication (Migliore et al., 2012). Additionally, the study documented the effectiveness of distance education and illustrated the need for services for people with ASD in underserved locations (Migliore et al., 2012). Limitations of the study included using only male participants. In addition, the participants volunteered, indicating they may be highly motivated and not representative of the general ASD population (Migliore et al., 2012).

Virtual reality simulation instruction programs allow people with autism spectrum disorder (ASD) to learn at their own pace and provide repeated practice to aid in achieving mastery (Smith et al., 2014). In this study, the virtual reality job interview training (VR-JIT) program was employed to test the feasibility and effectiveness of virtual reality role-play simulation to increase job interview skills in adults with ASD (Smith et al., 2014).

The participants included 26 individuals, ages 18-31, with a clinical diagnosis of ASD and a minimum 6th-grade reading ability, who were unemployed or underemployed, and actively seeking employment. Participants were divided into two groups; the VR-JIT intervention group and the treatment-as-usual (TAU) group (Smith et al., 2014). The TAU group completed baseline measurements and two weeks later participated in two standardized role-play vocational job interviews. The VR-JIT group completed baseline measurements, followed by ten hours (5 visits during two weeks) of the VR-JIT training program, and then participated in two standardized role-play vocational job interviews. The standardized role-play interviews served as the study's outcome measurement tool and were rated by two experienced human resource interviewers (Smith et al., 2014).

The VR-JIT training program simulation was accessed using a computer either via software or the internet. It provided an avatar interviewer who displayed a wide range of emotions, personality, and memory. Users were allowed freedom and variation in their responses to questions, which created a unique interview each time. An on-screen non-verbal job coach provided users immediate performance feedback, and additional feedback was supplied following each simulated interview (Smith et al., 2014). The VR-JIT improved job interviewing skills by targeting job-relevant interview content and expected interviewee performance (Huffcutt, 2011). In addition to the virtual reality simulation, the VR-JIT program provided supplemental electronic learning instruction on successful job interviewing skills and other job search related topics, such as: resume writing, hygiene, appropriate dress, questions to ask, proper eye contact, and guidance about disclosing a disability (Smith et al., 2014).

Baseline measurements revealed similar background characteristics in the VR-JIT group and TAU group participants. The VR-JIT group participants continuously increased simulated interview scores and reported they enjoyed the training. The VR-JIT significantly increased job interview skills and improved job interview self-confidence post-VR-JIT intervention role-play interview, in comparison to the TAU group. The study provided evidence of the effectiveness and feasibility of the VR-JIT program for adults with ASD (Smith et al., 2014). In addition, the study provided evidence that computer-based VR-JIT program software or internet platforms are valuable tools for people with ASD in areas with limited access to services (Smith et al., 2014). Limitations of the study included small sample size, potential unexpected ASD participant replies that could limit the VR-JIT responses, and only including ASD persons seeking employment which may have created participant selection bias (Smith et al., 2014).

Effective interventions for those with autism spectrum disorder (ASD) that are focused on improving job interviews skills could improve access to competitive employment (Shattuck et al., 2012). A previous research study suggested that individuals with ASD can enhance job interviewing skills by participating in VR-JIT interventions (Smith et al., 2014). However, this study was limited in data that supported whether or not actual vocational outcomes were attained after the VR-JIT program was completed (Smith et al., 2014). This study evaluated previous research (Smith et al., 2014) related to the actual vocational outcomes of young adults with ASD who participated in the VR-JIT program compared to the control group (Smith et al., 2015).

The participants in this study included 23 young adults with ASD from the previous study (Smith, et al., 2014; Smith, et al., 2015). Fifteen of those were VR-JIT trainees, and eight were from the control group. Each had a clinical diagnosis of ASD and was actively seeking employment (Smith, et al., 2014; Smith, et al., 2015). Six months after the prior study, the participants completed a seven-question follow-up survey (Smith, et al., 2015). The data was analyzed and compared actual job acquisition results (Smith, et al., 2015).

VR-JIT participants from the previous study who participated in the six-month follow-up showed role-play performance improvements compared to the control group. The role-play performance scores improved with every trial completed (Smith, et al., 2014). In addition, VR-JIT participants accepted competitive positions in greater proportion (53.3%) over the control group (25.0%) (Smith, et al., 2015). Both the VR-JIT participants and the control group were similar with respect to these; the number of weeks spent seeking competitive employment following the previous study; the number of interviews completed; the number of interviews completed per week; and the proportion of those who either completed an interview or received a job offer (Smith, et al., 2015). These results indicated that VR-JIT participants had increased odds of attaining a competitive position over the control group (Smith, et al., 2015). Findings showed that VR-JIT participants had a 7.82 times greater chance of accepting a competitive position offer over the control group (Smith, et al., 2015).

That initial evidence indicated that VR-JIT is a promising intervention that increases vocational outcomes among young adults with ASD. The authors recognized that the small sample-size limited statistical evaluations and that the participants' competitive positions were not verified through employers or volunteer supervisors (Smith, et al., 2015).

A study by Burke et al. (2018) focused on improving job interview skills in individuals with autism spectrum disorder (ASD) and developmental disabilities (DD) using the Virtual Interactive Training Agent (ViTA) system. The ViTA system incorporated essential elements deemed critical for improving interview skills: adjustable difficulty levels, repeatable practice, specific feedback, real-world relevance, and motivating instruction (Lange et al., 2012). The VITA system is an interactive job interview program designed to reduce anxiety and build competence in young adults with ASD and DD by providing simulated exposure to challenging real-life job interviewing situations where they can practice appropriate interview responses (Burke et al., 2018). The Dan Marino Foundation currently utilizes ViTA to support the transition from post-secondary education to employment (Burke et al., 2018).

The study involved 32 adults, ages 19-31, mostly male, 70% diagnosed with ASD, 65% learning disabled, and 25% with other disabilities, confirmed through medical records (Burke et al., 2018). The ViTA sessions used a 70-inch high-definition flat screen monitor to simulate seven different real-life job interview settings and provided six avatar interviewers of various age, sex, and ethnic backgrounds (Burke et al., 2018).

The intervention consisted of coursework that provided explicit instructions on core interviewing skills before and during the ViTA sessions, four ViTA sessions, and a concluding face-to-face interview. The participants met twice a week over a period of 14-weeks. The last five sessions involved the ViTA program in conjunction with the coursework and the final face-to-face interview. A baseline was created for each participant during the initial ViTA session (Burke et al., 2018).

The study findings indicated that the ViTA system was an effective intervention tool for helping individuals with ASD and DD successfully prepare for face-to-face job interviews. The participants made statistically significant improvements in job interviewing skills. They learned to identify personal strengths, self-promote, self-advocate, and respond appropriately to questions in job interview situations (Burke et al., 2018). Limitations of the study included small sample size, lack of a face-to-face baseline data, a single rater scoring system, and examiners possible bias due to familiarity with the subjects (Burke et al., 2018).

Current Virtual Reality Technology

Virtual reality technology (VRT) has evolved and improved over time, enhancing the visual nature of simulated real-life experiences (Newbutt et al., 2016). Most current versions of VRT employ a head-mounted display (HMD) (Newbutt et al., 2016). With the HMD's becoming increasing commercially available, Newbutt et al., (2016) researched the acceptance of HMD's in adults with autism spectrum disorder (ASD) and whether their use potential could be beneficial (Newbutt et al., 2016).

The study began with 29 adult participants, with a mean age of 32, each having a clinical diagnosis of ASD, the majority male, and approximately half had an intellectual disability (IQ score < 70) (Newbutt et al., 2016). The study incorporated the use of Oculus Rift™, a commercially available HMD VRT (Newbutt et al., 2016). Data collection included participant questionnaires, the Independent Television Commission-Sense Presence Inventory: special presence, engagement, ecological validity, and negative effects (ITC-SoPI; Lessiter et al., 2001), digital video recordings, and trained research assistant observation reports (Newbutt et al., 2016).

Phase I of the study included all 29 participants and examined the initial acceptance of an HMD VRT by employing three short, simple VR scenarios in a 10-minute session (Newbutt et al., 2016). After completing Phase I, the participants were asked if they wanted to return for Phase II, which included longer more intense VR simulation. Six declined to continue, two due to time restraints and four because of negative impacts (dizziness and tiredness) caused by the VR. Of the remaining participants, 11 were randomly selected to continue with Phase II, which included two longer intense VR scenarios in a 25-minute session (Newbutt et al., 2016).

The results showed that all participants were willing to wear the VR-HMD. Eighty-six percent of the 29 participants in Phase I completed all three VR scenarios. One hundred percent of the 11 participants in Phase II completed both of the VR scenarios (Newbutt et al., 2016). In the questionnaire, participants rated their enjoyment level a mean of 4.32 out of five and their likelihood to use VR-HMD in the future a mean of 3.92 out of five (5 reflects high positive effect). Research assistant observations recorded mostly positive verbal and nonverbal responses from the participants. ITC-SoPI scores for Phase II revealed high levels of special presence, engagement, and ecological validity, with low negative effects. Comparing participant IQ scores less than 69 and greater than 70 showed no significant difference in VR-HMD acceptance or the VR experience (Newbutt et al., 2016).

The findings generally support that adults with ASD willingly accepted and completed all VR scenarios using the VR-HMD technology, enjoyed the VR sessions with minimal negative effects or sensory issues and that IQ level is independent in regards to personal participation or experience using the technology (Newbutt et al., 2016). When compared to VR screen-based technologies, the VR-HMD resulted in participants' increased sense of presence and ecological validity suggesting experiences were life-like which could aid in generalizing skill development (Newbutt et al., 2016). Limitations of the study included small sample size, the lack of targeted outcome, participant self-report questionnaires, and limited scenario exposure time using VR-HMD (Newbutt et al., 2016).

Video Modeling vs. Virtual Reality

Video modeling (VM) incorporates videotaped presentations of a model demonstrating a target behavior or task and has proven to be an effective intervention for students with autism spectrum disorder (ASD) (De Bruin, Deppeler, Moore, & Diamond, 2013) and holds promise for adults with ASD (English et al., 2017). In this study, Fitzgerald et al., (2013) compared the effectiveness of VM and virtual reality (VR) interventions in adults with ASD.

The participants of this study included two adult males, Jackson (pseudonym) 31 and Luke (pseudonym) 27, both with a clinical diagnosis of ASD. Jackson had no previous experience with either VM or VR and minimal experience in paper folding. Luke had previous experience with VM, no previous exposure to VR, and his interest included origami (Fitzgerald et al., 2013).

Four paper folding projects were used as the learning tasks; two defined as easy (maximum time limit five-minutes) and two classified as intermediate difficulty (maximum time limit 10-minutes (Fitzgerald et al., 2013). The task of paper folding was chosen because it involved the combination of visual information and fine motor operations (Fitzgerald et al., 2013). The VM videos were displayed on a 13-inch Apple MacBook Pro, the VR videos were viewed using an Oculus Rift™ consumer version head-mounted display (HMD). A different paper folding project was presented in each format (Fitzgerald et al., 2013). Measurement data was recorded based on each paper folding project's task analysis, and the participants participated in an exit interview (Fitzgerald et al., 2013).

As a result, Jackson achieved mastery by successfully completing both easy paper folding tasks (one using VM and one using VR) within two trials. He achieved mastery by successfully completing both intermediate paper folding tasks (one using VM and one using VR) within five trials (Fitzgerald et al., 2013). Using VM, Luke achieved mastery by successfully completing the easy paper folding tasks within six trials, however, he could not achieve mastery using VR. No data was provided in the report about Luke's trials with the intermediate difficulty paper folding tasks (Fitzgerald et al., 2013). The authors reported that Luke had a higher rate of learning (ROL) using VM compared to VR. Exit interviews indicated that Jackson felt the format of the videos was immaterial, and Luke rated both formats as equal, however, he was initially disoriented with the VR-HMD and it took him time to adjust (Fitzgerald et al., 2013).

VM proved an effective intervention for mastering paper folding skills for both participants. In comparison, VR was a successful intervention with only one participant (Fitzgerald et al., 2013). Limits of the study included small sample size, Luke's previous experience with VM and interest in paper folding, and the relatively simple tasks (Fitzgerald et al., 2013).

CHAPTER III: DISCUSSION AND CONCLUSION

Summary

Effective intervention programs incorporate essential elements deemed critical for improving skills: adjustable difficulty levels, repeatable practice, specific feedback, real-world relevance, and motivating instruction (Lange et al., 2012). Virtual reality (VR) is a safe and controllable platform that can provide individuals with autism spectrum disorder (ASD) educational opportunities for repeatable practice and exposure to dynamic real-life interactions by using computer-based reality simulations of typical and common everyday-life situations (Kandalaft et al., 2013). VR can provide practically unlimited access to real-life scenarios in various replicated naturalist environments (Kandalaft et al., 2013). VR leverages the common interest of computer technology among those with ASD to increase intervention participation and individual motivation. Individuals with ASD typically can understand, enjoy, and appropriately interact with VR technology (Kandalaft et al., 2013). Interventions using computer-based VE and VR simulated platforms are effective interventions that transfer learning into real-world situations (Parsons et al. 2006).

VR training interventions improved emotion expression and regulation, and social interaction in children with ASD (Ip et al., 2018). Participants in another study exhibited increased performance in responding and maintaining social interaction, increased performance in the areas of initiating, greeting, and ending social interactions, and improved their recognition of non-verbal body gestures and facial expressions following a VR intervention (Fengfeng et al., 2013). The combinations of cognitive behavior therapy (CBT) and virtual reality environments

(VRE) were an effective program for treating specific phobias in children with ASD (Maskey et al. 2014). The Virtual Reality driving simulation training intervention yielded improvement in post-assessment driving skills for young adults with ASD. Evidence indicated that virtual reality job interview training (VR-JIT) is a promising intervention that increases vocational outcomes among young adults with ASD (Smith, et al., 2015). Virtual reality technology appears to provide a motivating educational intervention platform for people with ASD that offers safety and repeated practice to help them improve various skills.

Professional Application

Although the most widely available research in the area of VR interventions involves participants with ASD, I believe that VR platforms could be expanded to help people with intellectual disabilities, emotional behavior disorders, and fetal alcohol spectrum disorders. It is possible that the opportunities to effectively use VR interventions to help people with special needs could be almost limitless.

Flexibility, safety, and motivation are important attributes of VR interventions that were mentioned in all of the studies researched. VR enables participants to engage in dynamic and realistic simulated educational scenarios that can be tailored to meet the specific needs of individuals. VR provides opportunities for adjustable difficulty levels, repetitive practice, and immediate feedback. It provides instruction opportunities that free them from the fear of being rejected or making mistakes in a motivating platform. These are all important aspects of successful interventions.

The VR intervention is a platform that can be accessed via the internet or by using computer software. This potential provides an increasing opportunity for educators to access VR intervention programs.

Limitations of the Research

This literature review contains only researched-based, peer-reviewed studies. The studies included were limited to virtual environment (VE) or virtual reality (VR) simulation educational interventions, concentrating mostly on ASD participants. Other research studies whose purpose was not specifically based on the effectiveness of VE/VR educational interventions were excluded.

Available research was primarily limited to studies involving persons with ASD, in the areas of social and emotional development, phobias, motor vehicle driver training, and job interviewing. Not surprisingly, most of the available research studies were within the last 15 years. It was hoped that the available research surrounding VR interventions in people with special needs would have included more people with intellectual disabilities.

Implications for Future Research

Future research studies surrounding the effectiveness of VR educational interventions need to include larger participant sample sizes. Small sample size was a recurring limitation in most of the research studies included in this literature review. People with intellectual disabilities could be included in studies. There was a need in some of the studies to include a control group to validate findings. Studies could include more specific measurement tools. The cost-effectiveness of VR interventions could be analyzed.

There could be further research to determine the quantity, duration, and frequency of VR interventions that will result in the most skill improvement, and research to determine the separate benefits of the additional coursework instruction or facilitator involvement to the VR intervention.

Further study should focus on VR intervention's actual real-life generalization of learned skills. Social and emotional VR interventions could include more various social situations, an increased range of emotions, and avatar enhancements to promote generalization. Research is needed to discover how to effectively generalize VR driving skills to public roadways. Additional follow-up studies should collect data regarding participants' actual success in getting a driver license or securing appropriate employment.

Conclusion

This study explored the question: How are virtual reality (VR) technology-enabled educational approaches used to teach students with autism spectrum disorder (ASD), and do VR technology educational approaches provide measurable benefits?

The findings of this literature review proved that virtual reality technology-enabled educational approaches are in the initial stages of development. The primary focus of virtual reality educational interventions for people with ASD are in the areas of social and emotional development, motor vehicle driver training, and job interviewing instruction. Virtual reality interventions effectively improved skills with generalization noted across settings. It seems that further research in the study of virtual reality technology-enabled educational approaches is justified and that future technology advancements will continue to improve the effectiveness of these interventions and broaden their usefulness.

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