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Virtual Reality: Unlocking Employment Opportunities for Autistic Adults?

Sally Whelan (sally.whelan@universityofgalway.ie) - Irish Centre for Autism and Neurodevelopmental Research, University of Galway, Ireland
Geraldine Leader - Irish Centre for Autism and Neurodevelopmental Research, University of Galway, Ireland

Abstract
This chapter explores the potential for Virtual Reality (VR) technologies to enhance employment opportunities for autistic adults. The Chapter will describe VR, review the research literature and evaluate its potential benefits to autistic people. Examples of VR systems are presented that have been investigated for vocational training, along with the evidence regarding their usability and effectiveness. Recommendations are made for good design practices and future research directions.

Keywords: Autism; ASD; Social Inclusion; Assistive Technology; Vocational Training.

Introduction

Globally, the employment rates of autistic adults are significantly lower than their neurotypical (NT) peers. In addition to the socio-economic implications, unemployment impacts negatively on self-esteem, mental health and quality of life. (Chen et al., 2015). Therefore it is problematic that employment rates for autistic adults vary between 40% and 68% (Coleman & Adams, 2018; Frank et al., 2018). Furthermore, even when employed, autistic people frequently experience poor levels of employment retention and may also experience underemployment in poorly paid jobs, volunteering, or with part-time hours (Warfield, 2016).

Vocational rehabilitation training can help autistic people to overcome workplace challenges (Waisman-Nitzan et al., 2021). This training includes three categories of interventions that focus on the skills needed to gain employment and those needed to complete tasks during employment and to retain employment (Seaman & Cannella-Malone, 2016). A review of n=20 studies found that most interventions aim to promote skills for job related tasks, whereas few interventions, focus on pre-employment or job retention skills (Seaman & Cannella-Malone, 2016). This review also identified that 62% of vocational skills are taught through video modelling or prompting, and 21% involve intervention packages or audio prompting. Virtual reality (VR) technologies have been used in the vocational training of autistic adults (Schmidt et al., 2021). VR technologies create a digitally constructed virtual environment (VE) using computer-generated graphics. Human users interact with this VE, controlling avatars and aiming to experience the VE as if it is real through feelings of telepresence.

Training via VR may be beneficial to autistic people because VR can be visually stimulating and intrinsically reinforcing (Schmidt et al., 2021). It is relatively low in cost, increasingly accessible (Chang & Chen, 2017), and it has the potential to be customised to meet individuals' needs, particularly to avoid sensory overload (Morton-Cooper, 2004). VR is able to create repetitive training opportunities that are safe, without the risk of physical danger or social embarrassment. Real-time prompts and user feedback can be provided through animations, pictographs, or verbal cues. Another potential benefit is that virtual scenarios can involve situations that are difficult to create in real life. For example, dealing with difficult customers or working during a thunderstorm.

Types of VR Systems

A recent systematic review found that four VR Systems have been used to investigate employment skills in autistic adults (Whelan et al., under review). The key features of these systems are summarised in Table 1. It can be seen that these VR systems have varied user interfaces and methods to capture and translate the movements of the user into the VE e.g. clicking keyboard/mouse, joysticks, wheels, and movement tracking (Glaser & Schmidt, 2021). Bozgyuikli et al., (2017a) noted that VR systems vary in the degree of immersivity they afford and they can be regarded as having antecedent and consequence components. Antecedents take place before using the learning part of the VR system and include verbal/ written/modelling instructions given by real life job coaches or virtually within the system. Consequence components include the feedback given to users, provided in real-time whilst interacting with the system or after the session. For example, the VR Job Interview Training (VR-JIT) system provides feedback during a simulated interview in which the user interacts with a virtual job coach, and after the session users receive a transcript of the interview, marked by a human coach, to tell them what they did well, and what could be improved. Most research to date has investigated the VR-JIT system.

Table 1 - Key Features of VR Systems used for Vocational Training in Autism

Study IDs	Name of System	Immersivity Level	System Components	Intervention
Bozgeyikli et al 2017; 2018b	Vocational Rehabilitation of individuals with disabilities (VR4VR)	Fully	Head Mounted Display (HMD), Optical motion for real-time tracking component, 2* 180 degree curved screens with cameras, touch screen controls & trainer control panel.	Modules with levels for common job training & transferrable skills. Verbal instructions & modelling, behaviour prompts. Corrective feedback words/pictures
Burke et al., 2017	Virtual Interactive Training Agent (ViTA)	Semi	3 camera pieces for motion capture & scoring of movement & facial expression; a flat-screened monitor for VE, emulating an office space	Coach instructs user on interview strategies, user role plays interview, corrective feedback via VR.
Adiani et al., 2022	Career Interview Readiness in VR (CIRVR)	Desktop None HMD Fully	Closed-loop adaptive interview training. 2 versions Desktop & HMD. VE & avatar on screen. Webcam. Monitor, headset, eye tracking camera, keyboard, & mouse. A wristband to measure stress; Eye gaze, & facial scanning for emotional indicators.	User interacts with virtual human interview. Real-time gaze, facial expression (not validated for autistic people's faces), & stress detection. Feedback to coaches & user.

Study IDs	Name of System	Immersivity Level	System Components	Intervention
1. Genova et al 2021; Schmidt et al., 2021; Smith et al., 2014; 2015; 2017; 2020; 2021** 2. Ward et al., (2019); Humm et al., (2014)	1.VR Job Interview Training (VR-JIT) 2.VR-JIT with Molly Porter developed by SIMmersion LLC	1 & 2 None	1 & 2 User interacts with virtual human through internet or computer software. 2. Commercially available internet software programme	1 & 2 Self-guided e-learning on interview strategies and process, interview with virtual interviewers. Feedback non- verbal from VR job coach & prompts, real-time coach, interview score, transcripts review & participant given feedback colour coded responses user & reward tokens**.

Satisfaction and Challenges using VR systems

The VR-JIT system has been regarded as relatively uncomplicated to use (Schmidt et al., 2021), and enjoyable to use (Ward et al., 2019) and 75% to 90% of participants have rated it as having moderate to high usability (Smith et al., 2015, 2021, 2022). The feasibility and usability of the Career Interview Readiness in VR (CIRVR) was assessed involving autistic (n=9) and NT (n=8) people (Adiani et al., 2022). In this study, both participant groups reported they were satisfied with CIRVR. However, the autistic group had higher stress levels using the system and they regarded usability as being ''okay'' whereas it was regarded as ''good'' by the NT group.

However, some researchers have emphasised the need for human facilitators (Schmidt et al., 2021). In addition, problems with cyber sickness and feelings of disorientation have also been reported. Cyber sickness particularly occurs when several visual stimuli are introduced or with prolonged head-mounted display (HMD) use (Glaser et al., 2022).

Effectiveness of VR for Interview and Employment Skills Training

Twelve studies have investigated VR technologies for interview performance training (Whelan et al., under review). Several of these studies found that VR-JIT was effective in improving skills (Genova et al., 2021; Schmidt et al 2021; Smith et al., 2014; 2015; 2017; 2020; 2021). For example, Smith et al. (2014) conducted a single-blinded, randomised controlled trial (RCT). This involved n=16 autistic adults, with no intellectual disability (ID) who used the VR-JIT for approximately 20 sessions, and n=10 participants who had training as usual (TAU). They found that the VR-JIT users felt more prepared for future interviews and they had greater improvement than the TAU participants when role-playing real-life job interviews (p=0.046).

The use of the VR-JIT improved eye gaze and conversational reciprocity (Ward et al., 2019), whereas training through the CIRVR improved verbal responses to interview questions (Adiani et al., 2022). Training using the Virtual Interactive Training Agent (ViTA) during four sessions coincided with an improvement in mean interview scores, pre-post usage by 0.58 units (Burke et al., 2017). This improvement was statistically and clinically significant (Burke et al., 2020). There is also evidence that sociability and social skills can be improved through training via the Vocational Rehabilitation of Individuals with Disabilities (VR4VR) (Bozgeyikli et al., 2017b).

A few studies have found that training using the VR-JIT can translate to improved real-world interview skills, and improved job offers. For example, six months following the initial training, vocational outcomes were followed up with 23 out of 26 participants (Smith et al., 2015). Using logistical regression, they found that autistic VR-JIT users had greater odds of obtaining a position than those in the TAU group (OR 7.82,p\0.05). Another study identified that the number of conducted virtual interviews, predicted enhanced post-test interviewing skills, and the latter predicted job offers after subsequent in-person interviews (Smith et al., 2017). These results concurred with those of Genova et al., (2021), who found that the likelihood of being hired increased in participants who used the VR-JIT, compared to participants who did not use the system.

Bozgeyikli et al., (2017a, 2017b) investigated the effectiveness of using VR for training for self-efficacy, whilst undertaking specific employment tasks, including stocking shelves, loading trucks, cleaning, and money management. These researchers found that all skill levels improved after using the VR4VR.

Further evidence concerning the efficacy of VR is supplied by two recent systematic reviews. Skjoldborg et al. (2022) reviewed studies (n=8) to evaluate the efficacy of VR interventions using HMDs for social and practical skill improvement in autistic individuals. They found that one study reported statistically significant results, one reported no change in abilities, and in the remaining six studies there were varying degrees of improvement. Overall Skjoldborg et al., (2022) concluded that the studies examined were not of strong methodological quality and therefore, firm conclusions about the efficacy of VR could not be drawn.

Carnett et al. (2022) also evaluated the role of VR in behavioural interventions designed to support independent functioning for autistic adults by synthesizing studies (n=10) that targeted vocational skills. Two of the studies reviewed were classified as methodologically strong, and eight studies were classified as adequate. These authors concluded that using VR to teach autistic people interview and driving skills can be considered an evidence-based practice.

Good Design Practices

Table 2 presents the characteristics of VR systems that autistic users have preferred.

Bozgeyikli et al., (2018) explored the impact of user interfaces with autistic users without ID (n=15) and a control group of NT people (n=15). Using a task in which participants identified the quality of boxes on warehouse shelves, they tested five aspects: instruction methods, clutter, motion, view zoom, and visual fidelity. They found that good design practices using VR included avoiding verbal instructions, unnecessary clutter or motion, and using animated instructions, low visual fidelity, and normal view zoom. They also recommended that wearable equipment be securely fitted as participants fidgeted with unsecured equipment indicating their discomfort. In addition, Bozgevikli & Bozgeyikli (2017b) also recommended that designs should build on the strengths of autistic individuals, who may pay close attention to detail and have a strong visual memory and that designs should accommodate the need for the user to feel in control. This means that games should not move backwards as a penalty, or have a blank screen for over 5 seconds (Bozgevikli & Bozgeyikli, 2017b).

Table 2 - Summary of Design Recommendations

Study ID	Recommendation
	General recommendations
Bozgeyikli et al., 2017; Smith et al., 2021	Human sounding avatars with human voices rather than computer-generated voices. Bright colours. Encouraging rather than negative words Object alignment in backgrounds should remain consistent to reduce distraction. Emphasis on the repetition of tasks. Clearly explained task instructions and prompts. Goals and objectives need to be clearly stated. Consistency in routine and structure throughout the training levels regarding relationships and rules.
	Recommendations to prevent Cyber sickness
Glaser et al., 2022; Schmidt et al., 2021	Simulation realism may be preferred but this may increase the risk of cyber sickness with HMD. Gradually acclimate user to VR system to minimize cyber sickness. Avoid concurrent multiple stimuli.

Future Research Directions

There are large variations between the VR systems and these impact the examination of learner interactions, how learning takes place, and its potential benefits (Glaser & Schmidt., 2021). To date, desktop applications have been frequently investigated and because these don't offer an immersive experience to users, it has to be questioned whether they are actually VR systems (Glaser & Schmidt 2021). Future research should develop a consensus in relation to the definition of VR.

One potential strength of VR technology is its ability to be individualised. This potential has not to date been fully exploited. Several VR training systems include levels of difficulty, but Skjoldborg et al. (2022) found no studies where the amount of sensory input into HMDs was adjusted.

Future research needs to investigate VR with individuals who have more severe autism and other co-occurring conditions including ID. This work should be undertaken by assessing and responding to the needs of individuals and employing a strength-based approach (Urbanowicz et al., 2019). This means the training content, process, and job opportunities should be matched to a person's identified strengths and skills.

Several studies have reported using iterative phases of development guided by user feedback. The use of user-centered design (UCD) processes needs to continue. Potential research-practice gaps will be reduced by close collaboration between all stakeholder groups from the outset and throughout the research. Indeed, the quality of UCD processes can now be measured using a validated instrument: the User-based Information in Designing Support (UIDS) (Zervogianni et al., 2020, 2023).

It is essential that research continues to examine the assumption that behaviour learnt in a virtual world will be used in real world situations. Therefore outcome measures of VR training in real life settings are needed to ensure that the VR learning processes have ecological validity (Skjoldborg et al., 2022).

Conclusion

This examination of the literature has found that the VR systems used with the aim of promoting workplace inclusion for autistic adults vary hugely regarding their levels of immersivity. Therefore the definition of VR needs clarification. The evidence concerning the efficacy of VR training in this context is currently inconclusive and RCT's are needed that include real world employment outcomes and involve larger sample sizes. Future research also needs to employ USD principles that are informed by both the strengths and needs of individual autistic people.

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