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A virtual reality game designed to enhance empathy and acceptance for individuals with Autism: An experimental study focusing on people in a workplace

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Abstract

People with high-functioning autism are capable of working as effectively as other individuals because they are often reliable, punctual, good with routine, and have a high level of attention to detail. However, it is exceptionally challenging for people with high-functioning autism to work together with the people that do not fully understand autism. This study adopts virtual reality technology to develop a game intervention that aims to educate and enhance autism acceptance and empathy among employees. Using a head-mounted display (HMD), 35 participants between the ages of 18 and 50 were immersed in a virtual world that simulated the experiences of a person with autism. Haye's (2013) PROCESS Model 4 was employed to analyze the data. Results suggest that VR game intervention increased users' autism knowledge, empathy, as well as acceptance for people with autism. The study further illustrates an underlying process of how people develop acceptance for people with autism.

Introduction

Autism spectrum disorder (ASD) is a developmental disability identified by characteristic difficulties in social interaction and communication. People with ASD tend to behave, communicate, interact, and learn in ways that are different from most other people. Their ability to think and act is not as flexible as most people and their perception of sensory stimuli has been found to be different (American Psychiatric Association, 2013). ASD has a broad range of presentation and levels of severity ranging from very limited communication ability, mild learning disabilities, and high-functioning autism. The latest statistics suggest that one in every one hundred children has been diagnosed with ASD (Zeidan et al., 2022) and the number continues to increase as more children are diagnosed in early screenings (The Centers for Disease Control and Prevention [CDC], 2020).

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Nevertheless, it has been found that one in five people with ASD are in employment (Brown, 2021). According to JP Morgan Chase, employees with ASD are 92 percent more productive and 48 percent faster than other employees without ASD when they are assigned to work on detail-oriented, rule-bound, logical, and independent-thinking tasks (J.P. Morgan Chase and Co., 2022). People with high-functioning autism can be excellent employees as they are often reliable, punctual, good with routines, and have a high level of attention to detail (Brunel, 2022). Working with colleagues who do not fully understand autism is one of the biggest challenges of all. In particular, a lack of understanding in the workplace is a significant barrier for employees with ASD (Lindsay et al., 2019) and this could negatively impact their social skills, communication, and possibly even employment turnover rates.

Recently, much research effort has been placed on the development of training programs and interventions to raise awareness of ASD (e.g., Buckley et al., 2021; Dreaver et al., 2020; Remington & Pellicano, 2019). Guidance for employers on how to work with people with ASD could feasibly offer understanding, in particular, how to adjust themselves when working with autistic people (Petty et al., 2022). Previous studies suggest that support from employment services (Muller et al., 2003), vocational training (Migliore et al., 2012), and parenting education (Jones et al., 2008) have been found to reduce stress and anxiety of people with ASD as well as to improve social interactions. More specifically, an understanding of ASD among colleagues is identified as a key in fostering successful workplace relationships (e.g., Preece & Trajkovski, 2017; Westbrook et al., 2012). Knowledge of ASD underpins relationships between employees with ASD and their colleagues, and is fundamental in increasing the confidence of employees with ASD (Dreaver et al., 2020).

Embracing this untapped workforce has the potential to greatly benefit the organization, thanks to the unique blend of talents they bring. Therefore, creating an inclusive work environment for employees with Autism Spectrum Disorder (ASD) is crucial in helping them thrive. Given the increased relevance of digital technology, gamification has been introduced as one type of intervention used to enhance awareness on autism (Davis-Temple et al., 2021). Research on gamification highlights that games potentially motivate people to learn over and above other types of educational interventions (Filsecker & Hickey, 2014). Particularly, the use of virtual reality (VR) as an educational tool has been found to be a motivating tool for learning (Bradley & Newbutt, 2018; Parsons & Mitchell, 2002) as well as improving the difficulties that people with ASD have with their social and emotional skills (e.g., Cheng et al., 2010; Lorenzo et al., 2016; Wainer & Ingersoll, 2011). Lorenzo et al. (2016) suggest that the use of VR is highly useful for the acquisition and development of the emotional competences in students with ASD. Specifically, the immersive virtual reality system helps the students learn through a comprehensive virtual environment, thus triggering cognitive processes that facilitate the development of emotional competences in students with ASD.

With the aim of improving the difficulties that people with ASD have with their social and emotional skills, understanding and peer support from colleagues is also a mitigating factor in reducing work-related stress (Booth, 2016). However, to the best of our knowledge, the study focusing on the use of VR games as an intervention to enhance understanding and awareness among employees is still limited. This is because it requires an investment of substantial resources to make the intervention and the training available and accessible to many workplaces (Buckley et al., 2020). In this study, we developed a game intervention adopting VR technology and examined how it enhances understanding towards basic characteristics of people with ASD. In particular, this experimental study aims examine to what extent VR game intervention can increase acceptance and empathy for people with ASD. Based on the results derived from 35 participants, this study suggests that the immersive experience embedded in a VR game intervention can educate and potentially promote an awareness of ASD to people in the workplace. More importantly, this study is among the first that proposes and illustrates the underlying process of ASD acceptance. Our results reveal that empathy for and acceptance of people with ASD is correlated with knowledge of ASD. The outcomes specifically suggest that immersive and experiential learning provided by VR technology increases people's cognitive knowledge, which consequently triggers empathy towards people with ASD and makes them more open to people with ASD. The results derived from this study serve as a key stepping stone to the future development of VR game intervention, especially for other stigmatized groups (Christofi & Michael-Grigoriou, 2017).

Literature Review

Virtual Reality Technology

Virtual reality (VR) is a computer-generated experience that provides a fully simulated environment (Pelargos et al., 2017). VR is used for various purposes, such as entertainment, education, gamification, military or medical simulations, and training (Theelen et al., 2019). The degree of representational fidelity and interactivity significantly contributes to the sense of presence in the virtual environment (Dalgarno & Lee, 2010). Typically, avatars, which are electronic representations of users, are used to navigate the virtual environment.

Constructivist Approach for Virtual Reality Technology

The rise of VR technology in the past few years offers new ways to educate people as they can enter real-world situations and authentic environments that might otherwise be unavailable to them. This type of learning is generally referred to as "situated learning", where learning is situational (Stahl et al., 2006). VR technology triggers learners with optical and sensory illusions so that people can adopt a specifically designed situation or perspective regardless of how different it may be from their perceived reality (Christofi & Michael-Grigoriou, 2017). In addition, it emphasizes the active role of learners in constructing their own knowledge and understanding of the world through meaningful experiences and interactions. Merriam and Bierema (2013) proposed the concept of constructivism, which explains how people start to learn from constructing meaning of something from their experience. Constructivism is considered to be important to self-directed learning, which suggests that the situation helps to inform learning in individuals (Lave & Wenger, 1991; Merriam & Bierema, 2013).

Considering the constructivism paradigm, learners take an active role in their learning process and connect it with previously assimilated knowledge to construct new knowledge (Huang et al., 2010). This approach focuses on the learning processes of individuals and their attempts to mitigate the gap between new knowledge and their current conception of real-life experiences. A strong sense of presence embedded in the virtual world has been found to motivate and thereby cause the learner to cognitively process the learning material more deeply.

Given the fact that VR's ability is to mediate virtual world exploration and construction, it allows people to act through graphical representations of designed characters or avatars similarly to computer games. A growing body of literature in gamification highlights that by combining computer games into VR learning, individuals are more motivated to learn and try to complete their assigned tasks (e.g., Bradley & Newbutt, 2018; Filsecker & Hickey, 2014; Huang et al., 2010). Huang et al. (2010) found that learning through VR technology let people undertake activities that allowed them to put new understanding and new skills into practice. In their study, people were able to acquire knowledge with less cognitive effort compared to traditional learning processes. They can manipulate virtual objects enabling them to construct their understanding and take ownership of the learning process.

Deriving from a constructivist framework, it can be seen that VR game intervention helps expand learning, trigger cognitive processes, and create more immersive and experiential learning opportunities. Hence, in our study, we speculate that when people are situated in an immersive world of a person with ASD, and in particular take on the role of a person with ASD, this immersive experience will heighten their awareness of ASD, resulting in an enhanced understanding and knowledge of individuals with ASD. The following hypothesis can be proposed:

H1: The use of VR game intervention is more likely to enhance users' knowledge towards characteristics of people with ASD.

Virtual Reality and Empathy for People with ASD

As discussed, people's cognitive knowledge and understanding are enhanced when immersed in the world of VR. Previous studies suggest that VR serves as a powerful tool that increases empathy in the human mind because it can transfer a user to another world and potentially change their sense of self (Christofi & Michael-Grigoriou, 2017). Christofi and Michael-Grigoriou (2017) found that when people are immersed in VR environments, it allows individuals to step into the shoes of others and gain a deeper understanding of their experiences. Hence, in the virtual world, people's empathy can be increased when they comprehend another person's subjective experience and environment (Bertrand et al., 2018). Due to the immersive affordances of perceptual illusions (Bertrand et al., 2018) such as embodiment (Johnson-Glenberg, 2018) and presence

(Slater et al., 2009), users are induced to feel a sense of actually being another person or being within another environment. For example, van Loon et al. (2018) found that immersive experiences derived from VR that place a user within the virtual situation of homelessness can help create longer-term empathy for the homeless. Hasler et al. (2017) found that when light-skinned participants were embodied in a dark-skinned virtual body, they significantly reduced implicit racial bias against the dark-skinned people. The findings emphasize that VR technology is an effective way to reduce negative implicit attitudes towards outgroups.

More specific to the context of people with ASD, Weinel et al. (2018) noted that the use of VR technology conveys subjective consciousness and serves as an emphatic tool. In their study, when users were immersed into the point of view of a person with ASD, the VR tool could deliver the subjective experience of that person with ASD. Based on these findings, we propose that when users take on the role of a person with ASD in a VR game intervention, they tend to perceive the difficulties that the person with ASD has, leading to the enhancement of empathy. Therefore, we formulate the following hypothesis:

H2: The use of VR game intervention is more likely to enhance users' empathy in people with ASD.

Virtual Reality and Acceptance for People with ASD

The acceptance of people with ASD is precluded by the acknowledgement that people with ASD do not need to be cured, but instead accepted as who they are (Kapp et al., 2013). When being accepted by others, especially family and friends, people with ASD tend to have improved levels of stress and depression (Cage et al., 2014; Kim, 2020). In this regard, advocates of ASD increasingly emphasize the importance of acceptance cultivation for people with ASD. Gillespie-Lynch et al. (2015) invited college students to a training session aimed at improving knowledge and acceptance for students with ASD. In their study, pre- and post-assessments were used to measure changes in students' knowledge about autism and their attitudes towards individuals with autism. In the pre-assessment stage, several students were found to often have misconceptions of ASD. However, after undergoing the training, the students displayed increased knowledge of ASD and decreased stigma associated with ASD. Therefore, we formulate the following hypothesis:

H3: The use of VR game intervention is more likely to enhance individuals' acceptance of people with ASD.

The Effect of Autism Knowledge on Empathy and Acceptance of Autistic People

Although studies on increasing the acceptance of ASD through the adoption of VR game intervention are very scarce, we have learned from previous studies that a greater understanding and knowledge of ASD results in fewer negative attitudes towards the individuals with ASD (e.g., Nah et al., 2022; Nevill & White, 2011). Nevill and White (2011) found that students who reported having a first-degree relative with ASD would be more open to ASD-characteristic behaviors than students without a first-degree relative with ASD. Nah et al. (2022) noted that people who are exposed to characteristics of ASD tend to have lower levels of stigmatization towards individuals with ASD, which leads to a greater level of openness.

More specific to the context of role-playing in games, research shows that people can change their views of others (Smiley, 2005) and develop moral reasoning (Huang & Ho, 2018) when adopting others' perspectives. Hence, after users acknowledge the characteristics and limitations of people with ASD from a VR game intervention, they will be more likely to be open to, empathize with, and ultimately accept the symptoms and characteristics of ASD. (See Figure 1). This leads us to the following hypothesis:

H4: The effect of autism knowledge on the acceptance of people with ASD is mediated by individuals' empathy for people with ASD.

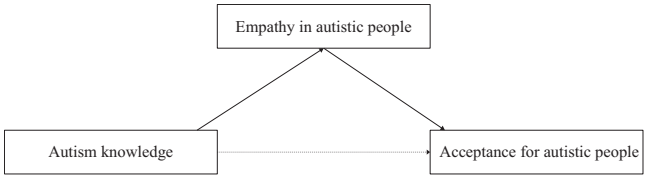

Figure 1 Mediation model of autism knowledge, empathy for, and acceptance of people with ASD

Methodology

Storyline Development of the VR Game Intervention

In collaboration with the Autistic Association of Thailand, we conducted in-depth interviews with eight people, four people with ASD and their parents, via online videoconference. We asked them to tell the stories of their daily lives by describing their typical working

day and the challenges they frequently face at work. In addition, we consulted a professor who has been working with people with ASD as well as families with children with ASD in order to ensure the accuracy of the VR game intervention's story and virtual experience.

A Day in a Life with Ice

The story in the VR game intervention is about "Ice," a thirty year old man with high-functioning autism. He works at a library in Bangkok, Thailand. While immersed in the VR game, players will take on the role of Ice and will assist him with traveling from his home to his workplace. During the game, players will have to cope with evading lights, sounds, and objects that trigger stress. Furthermore, misunderstanding of social cues and unclear tasks at work are also included in the game. The authors chose different locations, including a sidewalk, a bus stop, a library, and a party, as designed situations in which physical and psychological triggers were combined (Figure 2). In the final situation, at an office party, several unavoidable challenges were created to intentionally cause Ice to experience an autistic episode. The game then proceeds to a concluding scene where the main characters that the player had interacted with explain their intentions and roles in the game.

Figure 2 Examples of game scene: A day in a life with Ice (A) Ice walks on a sidewalk, (B) Ice is in a library, (C) Ice is talking to his colleague, and (D) Ice is at a party

Research Instrument Development

Participants viewed the virtual world of a person with ASD using the Meta Quest 2, a head-mounted display (HMD), which allows for three-dimensional stereoscopic views of a fully immersive digitally rendered virtual reality environment. Participants also used two handheld Meta Quest 2 controllers to interact with objects in the virtual environment. The 3D position and orientation of the participant's head and hands are used to update the rendering of the first-person viewpoint accordingly. Haptic feedback in the form of vibrations through the hand controllers was generated when participants interacted with objects to increase immersion in the virtual environment. In addition, the vibrations were also used to emphasize the intensified feelings of the first-person viewpoint. Prior to conducting the actual experiment, the game prototype underwent testing with researchers and professors specializing in Social Sciences. This step aimed to verify the accuracy of the VR game intervention's storyline and virtual experience.

Population and Sample

We contacted academic institutions and organizations in Bangkok, Thailand in order to conduct the study at their locations. Three academic institutions and four organizations accepted our request and were willing to be involved in the study. A total of 40 participants participated in the study by completing the pretest survey and experiencing the VR game intervention. Five of the participants, however, did not complete the posttest survey. After screening the incomplete responses, a total of 35 responses were included in the analysis. The participants were 51.4 percent male, 37.1 percent female, and 11.5 percent LGBTQ+. Participant age groups ranged from 18–30 years old (68.6%) to 31–50 years old (31.4%). Sixty percent of the participants held a bachelor's degree, and 28.6 percent held a master's degree.

Data Collection Procedure

All participants were informed about the procedures and objectives of the study. Before starting the VR game intervention, participants were asked to complete a pretest survey through Qualtrics in which they gave informed consent to participate in the study, as well as indicated their levels of knowledge of ASD and levels of empathy and acceptance for people with ASD. Subsequently, the researchers explained how to use the equipment and helped adjust the HMD to each participant. After becoming acquainted with the equipment and the virtual environment, each participant was immersed into a day in a life of Ice, a person with ASD, by taking on his perspective within a VR environment. The VR game intervention took approximately 15–20 minutes to complete. After completing the VR game, participants were led to fill in a posttest survey, which covers the same questions as the pretest survey.

Measures

Validated scales derived from previous studies were used to measure autism knowledge, empathy for people with ASD, and acceptance of people with ASD. Factor analyses and Cronbach's alphas were computed to assess the applicability and reliability of the measures. All the measures in our samples demonstrated good reliability ranging from .79 to .85.

Autism Knowledge

We adopted the measure of autism knowledge from the study of Tipton and Blacher (2014). Six items were scored on a 5-point scale according to their degree of accuracy (from 1 to 5). Higher scores are indicative of greater knowledge about autism and lower scores are indicative of less knowledge about autism. Examples of the items are, "Autism can be diagnosed as early as 15 months of age," "With the proper treatment, most children diagnosed with autism eventually outgrow the disorder."

Empathy for People with ASD

Participants evaluated their empathy for people with ASD by completing five items on a five-point Likert scale (Wrightsman, 1964) which include: "I enjoy doing things for autistic people," "I try to help autistic people, even if they do not help me," "Seeing autistic people prosper makes me happy," "I really care about the needs of autistic people," and the reverse item: "I come first and should not have to care so much for autistic people."

Acceptance of People with ASD

Participants assessed their acceptance of people with ASD by completing sixteen items on a five-point Likert scale (Kim, 2020). Examples of the items are "Autism is a unique way of being that should be appreciated," "I feel comfortable hanging out with Andy," and "I feel comfortable hanging out with autistic people."

Control Variables

Demographic information (gender, age, educational level) served as control variables in the study.

Data Analysis

To test our hypotheses (H1-H3), paired *t* test was used to analyze the differences between pretest and posttest scores of autism knowledge and empathy for people with ASD. For hypothesis 4 (H4), Haye's (2013) PROCESS was used to test a mediation model. Specifically, PROCESS Model 4 was chosen wherein a mediator (empathy for people with ASD) was proposed to explain the effect of autism knowledge (independent variable) on the acceptance of people with ASD (dependent variable). Following Hayes' (2013) recommendation, the 95 percent confidence intervals (CI) with 5,000 bootstrap samples were adopted when running Model 4.

Results

We examined how the VR game intervention increases individuals' autism knowledge, empathy for people with ASD, and acceptance of people with ASD. Table 1 presents the comparison of pretest and posttest scores of individuals' autism knowledge, empathy for people with ASD, and acceptance of people with ASD as well as bivariate correlation coefficients. The findings of the proposed hypotheses are illustrated below.

The Effectiveness of VR Game Intervention on Autism Knowledge

The first hypothesis stated that the use of VR game intervention could enhance users' knowledge towards characteristics of people with ASD. Regarding a paired sample *t*-test, the results show comparison scores of autism knowledge before and after playing the VR game intervention. As expected, after playing the role of

Table 1 Means, standard deviations, and bivariate correlation coefficients of key variables

Measure	Pretest ($N = 35$)		Posttest ($N = 35$)		1	2	3	4	5	6
	M	*SE*	*M*	*SE*						
Knowledge	3.48	0.34	3.69	0.38	1					
Empathy	3.83	0.58	4.17	0.63	.43**	1				
Acceptance	3.35	0.36	3.58	0.40	.36*	.78**	1			
Gender	-	-	-	-	-.36	.22	.26	1		
Age	-	-	-	-	.16	.35*	.19	-.04	1	
Education	-	-	-	-	-.04	.38*	.30	.01	.72**	1

Note: $^{**}p < .01$, $^{*}p < .05$.

a person with ASDin the VR game intervention, participants' autism knowledge was significantly increased ($M_{pretest}$ = 3.48, $SE_{pretest}$ = 0.34; $M_{posttest}$ = 3.69, $SE_{posttest}$ = 0.38). This improvement, .21 was statistically significant, $t(34)$ = -2.80, p = .008, 95% CI [-.37, -.06]). Therefore, the results supported H1.

The Effectiveness of VR Game Intervention on Empathy for People with ASD

The second hypothesis stated that the use of VR game intervention could enhance individuals' empathy for people with ASD. Paired sample *t*-test shows the comparison scores of empathy for autistic people before and after playing the VR game intervention. As expected, after immersing in the virtual world of a person with ASD, participants were more likely to empathize with people with ASD ($M_{pretest}$ = 3.83, $SE_{pretest}$ = 0.58; $M_{posttest}$ = 4.17, $SE_{posttest}$ = 0.63). This improvement, .34 was statistically significant, $t(34)$ = -3.24, p = .003, 95 CI [-.56, -.13]). Thus, the results supported H2.

The Effectiveness of VR Game Intervention on Acceptance of People with ASD

The third hypothesis stated that the use of VR game intervention could enhance individuals' acceptance for people with ASD. Paired sample *t*-test shows the comparison scores of acceptance for people with ASD before and after playing the VR game intervention. As expected, participants were more likely to accept people with ASD after immersing in a VR game intervention ($M_{pretest}$ = 3.35, $SE_{pretest}$ = 0.36; $M_{posttest}$ = 3.58, $SE_{posttest}$ = 0.40). This improvement, .22 was statistically significant, $t(34)$ = -4.15, p < .000, 95% (CI) [-.33, -.11]). Thus, our H3 was supported.

Mediation Effect of Autism Knowledge on the Acceptance of People with Autism

Our hypothesis 4 (H4) predicted that empathy for people with ASD would mediate the effect of autism knowledge on the acceptance of people with ASD. The mediation analysis through Hayes' (2013) PROCESS Model 4 showed that empathy for people with ASD fully mediated the effect of autism knowledge on individuals' acceptance of people with ASD. Specifically, the indirect effect was significant (β = 0.35, SE = 0.17, 95% CI [0.07, 0.73]), whereas the direct effect became non-significant (β = 0.09, SE = 0.14, 95% CI [-.20, 0.38]), indicating the full mediation of empathy for people with ASD. Therefore, H4 was fully supported (Figure 3).

Discussion

This study focuses on the use of VR game intervention as an educational tool to promote employees' autism knowledge, empathy for people with ASD, as well as acceptance of people with ASD. Based on responses derived from thirty-five participants, our results provide several insights that align with earlier research, as well as extending it. The key findings and direction for further research are discussed below.

First, the results contribute to the effectiveness of virtual reality in education by demonstrating that VR game intervention can increase users' knowledge about stigmatized people (Bradley & Newbutt, 2018; Huang et al., 2010) as well as their empathy for those people (Weinel et al., 2018). Our results further extend the use of VR game to examine how the role playing technique embedded in the VR game increases individuals' empathy for people with ASD and their acceptance of people with ASD. In addition to showing the effectiveness of VR game in autism awareness and knowledge, the results indicate that people increase their empathy for people with ASD mainly because they learn from the designed situation reflecting a day in the life of a person with ASD (Stahl et al., 2006).

Second, while the results confirm the effectiveness of VR game intervention in people's knowledge about autism, empathy for people with ASD, and acceptance of people with ASD, we found interesting results that explain the effect of autism knowledge on acceptance of people with ASD. This study is among the first that investigates the underlying process of autism acceptance, which extends previous research on the use of VR technology for people with ASD (Parsons & Cobb, 2011). Our results reveal that empathy for people with ASD explains the effect of autism knowledge on autism acceptance. The outcomes specifically suggest that immersive and experiential learning provided by the VR technology increases people's cognitive knowledge, which consequently triggers their empathy towards people with ASD, making them more open to people with ASD.

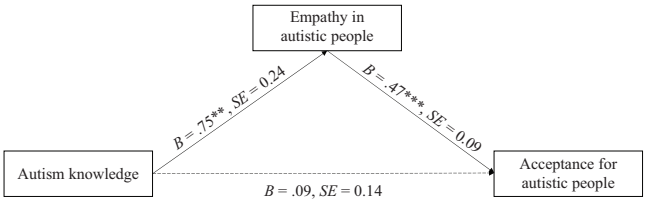

Figure 3 Mediating effect of autism knowledge on the acceptance for people with ASD

This underlying process helps to explain how taking on a role derived from VR games helps people increase their moral reasoning toward people with ASD (Huang & Ho, 2018), resulting in increased openness to and empathy for symptoms of autism and making them more likely to accept people with ASD.

Finally, as noted by constructivism theory, people start to learn from constructing meaning of something from their experience and associated situation (Merriam & Bierema, 2013). A strong sense of presence embedded in the virtual world has been found to effectively motivate people to learn and deeply associate with the designed character in the virtual environment. In this study, we found that even though people acquired knowledge about people with ASD while playing a VR game, the level of autism acceptance was not increased. In other words, autism knowledge did not directly affect individuals' acceptance of people with ASD. This can be explained by the fact that common knowledge of individuals is isolated from perceptual knowledge, and such common knowledge has no part to play in an individual's vision (Gregory, 1997). When people gain knowledge from information cues, their attitudes can be changed, but their perception and behavior do not (van der Linden, 2015). Research shows that people tend to rely more on affective and experiential processing, potentially through their personal experience rather than only information (Marx et al., 2007). Hence, in the context of employee training, the features of VR may make it especially well-suited for supporting the learning of employees on the autism spectrum, particularly in the realms of life and social skills, which may be difficult to understand in the real world.

Conclusion and Recommendations

While our findings offer significant insights into research on virtual reality technology and autism, this study has a number of limitations, which could be recognized and addressed. First, it is worth noting that our results only represent a small group of participants in Bangkok, and cannot be generalized to the greater population of the country. In particular, our participants have different backgrounds concerning autism knowledge, thus, their background knowledge could have an effect on their empathy and thus should be taken into consideration for future studies. Second, it must be noted that our results derived from only one experimental condition comparing pretest and posttest score of autism knowledge, empathy for, and acceptance of people with ASD before and after playing the VR game intervention. Future research can extend our findings by comparatively investigating whether different training methods using a traditional technique (e.g., lectures, seminars) as well as a virtual reality technology will have the same results. Third, as our results are based only on the underlying process of autism knowledge and acceptance, it remains to be seen whether the results would be the same for other vulnerable groups of people. Future studies examining the effectiveness of VR game intervention on the acceptance of other stigmatized groups such as minorities, disabled people, or homeless people can beneficially extend our research findings (Christofi & Michael-Grigoriou, 2017). Finally, given the limited game length, designed situations in our VR game intervention do not cover all types of autism nor do they cover all characteristics of ASD. Given the fact that there is no one intervention that works for all people with ASD, more innovation such as more game development efforts are considerably needed for further improvement.

Regarding the recommendations for practice, the author suggests incorporating VR game interventions as valuable tools in autism awareness training within workplaces employing individuals with ASD. The goal is to enhance empathy and foster positive attitudes towards people with ASD, thereby improving working conditions and job satisfaction for these individuals. Additionally, the company should consider implementing the VR game intervention during the hiring process, specifically involving individuals in human resources or managerial positions. This approach could provide additional benefits in terms of understanding and accommodating the needs of employees with ASD.

Conflict of Interest

The authors declare that there is no conflict of interest.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). American Psychiatric Publishing.

Bertrand, P., Guegan, J., Robieux, L., McCall, C. A., & Zenasni, F. (2018). Learning empathy through virtual reality: Multiple strategies for training empathy-related abilities using body ownership illusions in embodied virtual reality. *Frontiers in Robotics and AI*, *5*(26), 1–18. https://doi.org/10.3389/frobt.2018.00026

Booth, J. (2016). *Autism equality in the workplace: Removing barriers and challenging discrimination*. Jessica Kingsley Publishers.

Bradley, R., & Newbutt, N. (2018). Autism and virtual reality head-mounted displays: A state of the art systematic review. *Journal of Enabling Technologies*, *12*(3), 101–113. https://doi.org/10.1108/JET-01-2018-0004

Brown, L. (2021). *'Shocking' data reveals only one in five autistic people are in employment*. https://www.peoplemanagement.co.uk/article/1742978/shocking-data-reveals-only-one-in-five-autistic-people-are-in-employment

Brunel (2022). *Supporting and celebrating autism in the workplace*. https://www.brunel.net/en-au/blog/social-issues/supporting-autism-in-the-workplace.

Buckley, E., Pellicano, E., & Remington, A. (2021). Knowing that I'm not necessarily alone in my struggles: UK autistic performing arts professionals' experiences of a mentoring programme. *Journal of Autism and Developmental Disorders*, 1–20. https://doi.org/10.1007/s10803-021-05394-x

Cage, E., Di Monaco, J., & Newell, V. (2018). Experiences of autism acceptance and mental health in autistic adults. *Journal of Autism and Developmental Disorders*, *48*(2), 473–484. https://doi.org/10.1007/s10803-017-3342-7

The Centers for Disease Control and Prevention (CDC). (2020). *CDC estimate on autism prevalence increases by nearly 10 percent.* Autism Speaks. https://www.autismspeaks.org/press-release/cdc-estimate-autism-prevalence-increases-nearly-10-percent-1-54-children-us

Cheng, Y., Chiang, H. C., Ye, J., & Cheng, L. H. (2010). Enhancing empathy instruction using a collaborative virtual learning environment for children with autistic spectrum conditions. *Computers & Education*, *55*(4), 1449–1458. https://doi.org/10.1016/j.compedu.2010.06.008

Christofi, M., & Michael-Grigoriou, D. (2017, October). Virtual reality for inducing empathy and reducing prejudice towards stigmatized groups: A survey. In *2017 23rd International Conference on Virtual System & Multimedia (VSMM)* (pp. 1–8). IEEE. https://doi.org/10.1109/VSMM.2017.8346252

Dalgarno, B., & Lee, M. J. (2010). What are the learning affordances of 3-D virtual environments?. *British Journal of Educational Technology*, *41*(1), 10–32. https://doi.org/10.1111/j.1467-8535.2009.01038.x

Davis-Temple, J., Jung, S., & Sainato, D. M. (2021). *Gamification in Autism*. The UEFA Foundation for Children.

Dreaver, J., Thompson, C., Girdler, S., Adolfsson, M., Black, M. H., & Falkmer, M. (2020). Success factors enabling employment for adults on the autism spectrum from employers' perspective. *Journal of Autism and Developmental Disorders*, *50*(5), 1657–1667. https://doi.org/10.1007/s10803-019-03923-3

Filsecker, M., & Hickey, D. T. (2014). A multilevel analysis of the effects of external rewards on elementary students' motivation, engagement and learning in an educational game. *Computers & Education*, *75*, 136–148. https://doi.org/10.1016/j.compedu.2014.02.008

Gillespie-Lynch, K., Brooks, P. J., Someki, F., Obeid, R., Shane-Simpson, C., Kapp, S. K., & Smith, D. S. (2015). Changing college students' conceptions of autism: An online training to increase knowledge and decrease stigma. *Journal of Autism and Developmental Disorders*, *45*(8), 2553–2566. https://doi.org/10.1007/s10803-015-2422-9

Gregory, R. L. (1997). Knowledge in perception and illusion. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *352*(1358), 1121–1127. https://doi.org/10.1098/rstb.1997.0095

Hasler, B. S., Spanlang, B., & Slater, M. (2017). Virtual race transformation reverses racial in-group bias. *PloS one*, *12*(4), 1–20. https://doi.org/10.1371/journal.pone.0174965

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford Publications. https://doi.org/10.1111/jedm.12050

Huang, H. M., Rauch, U., & Liaw, S. S. (2010). Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. *Computers & Education*, *55*(3), 1171–1182. https://doi.org/10.1016/j.compedu.2010.05.014

Huang, W., & Ho, J. C. (2018). Improving moral reasoning among college students: A game-based learning approach. *Interactive Learning Environments*, *26*(5), 583–596. https://doi.org/10.1080/10494820.2017.1374979

J.P. Morgan Chase and Co. (2022). *Autism and employment statistics – Update 2022*. https://mydisabilityjobs.com/statistics/autism-employment/#:~:text=J.P.%20Morgan%20Chase%20and%20Co,more%20productive%20than%20their%20peers

Johnson-Glenberg, M. C. (2018). Immersive VR and education: Embodied design principles that include gesture and hand controls. *Frontiers in Robotics and AI*, *5*(81), 1–19. https://doi.org/10.3389/frobt.2018.00081

Jones, G., English, A., Guldberg, K., Jordan, R., Richardson, P. & Waltz, M. (2008). *Educational provision for children and young people on the autism spectrum living in England: A review of current practice, issues and challenges*. Autism Education Trust.

Kapp, S. K., Gillespie-Lynch, K., Sherman, L. E., & Hutman, T. (2013). Deficit, difference, or both? Autism and neurodiversity. *Developmental Psychology*, *49*(1), 59. https://doi.org/10.1037/a0028353

Kim, S. Y. (2020). The Development and pilot-testing of the autism attitude acceptance scale: An instrument measuring autism acceptance. *Autism in Adulthood*, *2*(3), 204–215. https://doi.org/10.1089/aut.2019.0066

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Lindsay, S., Cagliostro, E., Leck, J., Shen, W., & Stinson, J. (2019). Employers' perspectives of including young people with disabilities in the workforce, disability disclosure and providing accommodations. *Journal of Vocational Rehabilitation*, *50*(2), 141–156. https://doi.org/10.3233/JVR-180996

Lorenzo, G., Lledó, A., Pomares, J., & Roig, R. (2016). Design and application of an immersive virtual reality system to enhance emotional skills for children with autism spectrum disorders. *Computers & Education*, *98*, 192–205. https://doi.org/10.1016/j.compedu.2016.03.018

Marx, S. M., Weber, E. U., Orlove, B. S., Leiserowitz, A., Krantz, D. H., Roncoli, C., & Phillips, J. (2007). Communication and mental processes: Experiential and analytic processing of uncertain climate information. *Global Environmental Change*, *17*(1), 47–58. https://doi.org/10.1016/j.gloenvcha.2006.10.004

Merriam, S. B., & Bierema, L. L. (2013). *Adult learning: Linking theory and practice*. John Wiley & Sons.

Migliore, A., Timmons, J., Butterworth, J., & Lugas, J. (2012). Predictors of employment and postsecondary education of youth with autism. *Rehabilitation Counseling Bulletin*, 55(3), 176–184. https://doi.org/10.1177/00343 55212 438943

Müller, E., Schuler, A., Burton, B. A., & Yates, G. B. (2003). Meeting the vocational support needs of individuals with Asperger syndrome and other autism spectrum disabilities. *Journal of Vocational Rehabilitation*, *18*, 163–175. https://content.iospress.com

Nah, Y. H., Neo, Y. F., & Chen, A. S. H. (2022). Do labels matter? The effect of specific and generic labels on university students' openness towards autistic peers. *Research in Autism Spectrum Disorders*, *97*, 1–9. https://doi.org/10.1016/j.rasd.2022.102020

Nevill, R. E., & White, S. W. (2011). College students' openness toward autism spectrum disorders: Improving peer acceptance. *Journal of Autism and Developmental Disorders*, *41*(12), 1619–1628. https://doi.org/10.1007/s10803-011-1189-x

Parsons, S., & Mitchell, P. (2002). The potential of virtual reality in social skills training for people with autistic spectrum disorders. *Journal of Intellectual Disability Research*, *46*(5), 430–443.

Pelargos, P. E., Nagasawa, D. T., Lagman, C., Tenn, S., Demos, J. V., Lee, S. J., & Yang, I. (2017). Utilizing virtual and augmented reality for educational and clinical enhancements in neurosurgery. *Journal of Clinical Neuroscience*, *35*, 1–4. https://doi.org/10.1016/j.jocn.2016.09.002

Petty, S., Tunstall, L., Richardson, H., & Eccles, N. (2022). Workplace adjustments for autistic employees: What is 'reasonable'?. *Journal of Autism and Developmental Disorders*, 1–9. https://doi.org/10.1007/s10803-021-05413-x

Preece, D., & Trajkovski, V. (2017). Parent education in autism spectrum disorder - A review of the literature. *Hrvatska revija za rehabilitacijska istraživanja*, *53*(1), 118–128. https://doi.org/10.31299/hrri.53.1.10

Remington, A., & Pellicano, E. (2019). 'Sometimes you just need someone to take a chance on you': An internship programme for autistic graduates at Deutsche Bank, UK. *Journal of Management & Organization*, *25*(4), 516–534. https://doi.org/10.1017/jmo.2018.66

Slater, M., Lotto, B., Arnold, M. M., & Sánchez-Vives, M. V. (2009). How we experience immersive virtual environments: The concept of presence and its measurement. *Anuario de Psicología*, *40*, 193–210. https://doi.org/10.1344/%25x

Smiley, E. (2005). Epidemiology of mental health problems in adults with learning disability: an update. *Advances in Psychiatric Treatment*, *11*(3), 214–222. https://doi.org/10.1192/apt.11.3.214

Stahl, G., Koschmann, T. D., & Suthers, D. D. (2006). Computer-supported collaborative learning: An historical perspective. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences*. (pp. 409–426). Cambridge University Press.

Theelen, H., Van den Beemt, A., & den Brok, P. (2019). Classroom simulations in teacher education to support preservice teachers' interpersonal competence: A systematic literature review. *Computers & Education*, *129*, 14–26. https://doi.org/10.1016/j.compedu.2018.10.015

Tipton, L. A., & Blacher, J. (2014). Brief report: Autism awareness: Views from a campus community. *Journal of Autism and Developmental Disorders*, *44*(2), 477–483. https://doi.org/10.1007/s10803-013-1893-9

Wainer, A. L., & Ingersoll, B. R. (2011). The use of innovative computer technology for teaching social communication to individuals with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *5*(1), 96–107. https://doi.org/10.1016/j.rasd.2010.08.002

Weinel, J., Cunningham, S., & Pickles, J. (2018). Deep subjectivity and empathy in virtual reality: A case study on the autism TMI virtual reality experience. In *New Directions in Third Wave Human-Computer Interaction: Volume 1-Technologies* (pp. 183–203). Springer, Cham. https://doi.org/10.1007/978-3-319-73356-2

Wrightsman Jr, L. S. (1964). Measurement of philosophies of human nature. *Psychological Reports*, *14*(3), 743–751. https://doi.org/10.2466/pr0.1964.14.3.743

Van der Linden, S. (2015). The social-psychological determinants of climate change risk perceptions: Towards a comprehensive model. *Journal of Environmental Psychology*, *41*, 112–124. https://doi.org/10.1016/j.jenvp.2014.11.012

Van Loon, A., Bailenson, J., Zaki, J., Bostick, J., & Willer, R. (2018). Virtual reality perspective-taking increases cognitive empathy for specific others. *PloS one*, *13*(8), 1–19. https://doi.org/10.1371/journal.pone.0202442

Westbrook, J. D., Nye, C., Fong, C. J., Wan, J. T., Cortopassi, T., & Martin, F. H. (2012). Adult employment assistance services for persons with autism spectrum disorders: Effects on employment outcomes. *Campbell Systematic Reviews*, *8*(1), 1–68. https://doi.org/10.4073/csr.2012.5

Zeidan, J., Fombonne, E., Scorah, J., Ibrahim, A., Durkin, M. S., Saxena, S., Yusuf, A. & Elsabbagh, M. (2022). Global prevalence of autism: A systematic review update. *Autism Research*, *15*(5), 778–790. https://doi.org/10.1002/aur.2696