Virtual Reality & Augmented Reality Games Executive Summary

The Canadian population of children with autism spectrum disorder (ASD) is currently 1 in 59 (Baio, 2018). Academic reports from the last decade have discussed and predicted favourable outcomes for the future related to the use of virtual and augmented reality for learning and/or therapy of children with ASD (Bellani et al., 2011). Our literature search found 20 articles regarding available virtual reality technology targeting social participation for children with ASD. Of these 20 articles, four of the discussed games are commercially available to download for use at home or in the clinic, which are presented in this executive summary.

Augmented Reality

Games which use augmented reality use a hybrid environment wherein a real environment (e.g., a real classroom) has virtual objects (e.g., avatars) superimposed. *Project Glass*, developed by Google, uses smart glasses to provide social communication coaching to individuals with ASD. Keshav and colleagues (2017) used smart glasses and the *Brain Power Autism System* to study social communication with 21 participants aged 4-21 years with ASD, and found that 19 of the 21 participants found the system tolerable and the glasses comfortable. Liu and colleagues (2017) examined the same system, and used two games to coach emotional recognition, face-directed gaze, eye contact, and behavioural self-regulation on two users aged 8-9 years. *Emotion Game* detects and identifies human emotions, using augmented reality to increase user engagement and interest in human faces. It detects human faces and uses a visual display to prompt the user to correctly identify the facial emotion in the detected human face by presenting them with two emoticon choices. Moreover, *Face Game* helps the user work on direct eye gaze and paying attention to avatars, and uses a points system for correct behaviour. This game detects human faces anywhere in the user's field of view, which are then overlaid with an augmented reality cartoon face in a manner that attempts to engage the user and attract his or her attention. Liu and colleagues (2017) found that these games were accepted by the users, and improved social interactions through non-verbal communication, social engagement, and eye contact. The Smart Glasses system shows the greatest promise for the future of interventions for children with ASD, however, it is a more expensive system, which may make it more suitable for use at the clinic rather than at home.

Virtual Reality

Virtual reality aims at immersing users in a virtual environment. Bozgeyikli and colleagues (2017) published an in-depth review of academic articles published on virtual reality for persons with ASD. Of the articles reviewed, 11 were specific to VR social skills training. The authors of four studies reported on *iSocial*, a collaborative virtual learning environment (CVLE) social interaction system for

persons with autism in clinical settings (Cheng and Ye, 2010; Wang et al., 2016; Stichter et al., 2014). This game has a particularly useful application for enhancing accessibility to high quality remote and rural learning, and only requires the use of a desktop computer. *iSocial* seeks to translate and implement a social competency curriculum in a 3D-CVLE that is based on a framework of cognitive behavioural interventions (Laffey et al., 2009). Using *iSocial*, Cheng and Ye (2010) recruited children aged 7-8 years for an intervention that targeted deficiencies in social competence. Children participated in two social scenes and eight emotion-eliciting questions from social stories. The authors reported positive effects on social performance both within the CVLE-system and in reciprocal social interaction learning. In addition to *iSocial*, the program *Second Life* has also been found to improve emotional recognition in children with ASD. While this game was originally developed for non-autistic persons, Didehbani and colleagues (2016) examined the use of the game by 30 children with ASD (aged 7-16 years). They used *Second Life* to display social scenarios, which were designed to emphasize a targeted social learning objective in varying contexts, such as meeting new people, dealing with a bully, bonding with friends, confronting conflict, consoling a friend, or handling social dilemmas. Their study reported statistically significant improvements in emotional recognition, and other improvements in social attribution, executive functioning, and analogical reasoning. Likewise, Ke and Im (2013) studied the use of *Second Life* with four children with ASD (aged 9-10 years). They gave children three social interaction tasks: recognizing body gestures and facial expressions of a virtual communication partner, responding and maintaining interactions at a school cafeteria, and initiating and maintaining interactions at a birthday party. These tasks took place in a virtual school and at a virtual house party. They found that the program increased performance of responding, initiation, greeting, and positive conversation-ending during the intervention, and improved social competence measures after the intervention.

In addition to desktop virtual-reality games, Xbox Kinect has been found to be an effective medium for teaching social skills to children with ASD. The game *Pico's Adventures* (Maliverni et al., 2016) is a free game that can be used both in the clinic and at home by children aged 4-6 years. Children interact with a friendly alien named Pico to learn social interaction skills, collaboration, and social initiation. The game is recommended to be played along a treatment plan, and throughout the sessions the child eventually learns to play together with another unknown child with ASD. The exploratory study found that the game fostered behaviours such as social smiling, visual contact, vocalization directed toward the other child, the adults, or the character, descriptive gestures, imitation, social expressions, pointing, sharing of emotions, initiation of social interaction, response to social interaction, and collaboration through regulatory and illustrative social interactions (Maliverni et al., 2016).

Conclusion

Although this review only found four reputable games that use augmented or virtual reality to enhance social participation in children with ASD, it does provide indication that there are evidence-based games available that can be used for children with ASD at home or in therapy. However, all of the research that we reviewed scored “weak” on the Quality Assessment Tool developed by the Effective Public Health Practice Project. We suggest the following recommendations for future development of VR and AR gaming for children with ASD: (1) increased sample sizes; (2) using a control group; (3) assessing products from companies independent of the researchers; and (4) studies with greater reporting of controlling for biases and confounding factors.

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