

The possibility and importance of immersive technologies during COVID-19 for autistic people

Introduction

Towards the end of 2019 and into the early months of 2020 every country on earth was impacted in some way by COVID-19, and on 11th March 2020 the WHO declared a pandemic. Most countries across the world reported significant increases in cases of COVID-19 during the month of March, leading to significant changes in the way we live our lives. During this time, most countries restricted movement and implemented social distancing rules, along with closing public buildings, schools, shops and other places of social gathering. As a result, life for many changed sharply in a very short period of time, leading to many people being impacted in a range of ways. Our intent with the current case study is to draw specific attention to how autistic individuals have been—and likely will continue to be—impacted by COVID-19 and the role immersive technologies might play in ameliorating this.

Challenges commonly associated with autism have been significantly amplified during COVID-19. Emerging reports have established that autistic individuals are in a position of increased vulnerability due to COVID-19 (Centers for Disease Control and Prevention, 2020), in part due to the prevalence of immune disorders and other comorbidities with this population. Further, autistic individuals tend to seek out and rigidly adhere to routines (according to their diagnosis), which, in the face of the massive changes precipitated by the pandemic, have been dramatically disrupted. In fact, 70% of caregivers report that their daily routines have changed (Pavlopoulou et al., 2020). Depending on the level of associated learning difficulties, some autistic individuals may experience problems understanding what is happening and why

(Eshraghi et al., 2020). Indeed, according to Pellicano and Stears (2020), COVID-19 “could have a disproportionate effect on the mental health of autistic people” (p.1). This is mirrored in the words of an autistic adult, “Underpinning much of the fear around COVID-19 is a deep sense of uncertainty [...] like many of us, they [people with autism] will be faced with changes to safe and comfortable routines; anxious and overwhelmed family, friends, and carers” (den Houting, 2020, p. 2). These concerns speak closely to the heightened rates of anxiety in individuals with autism (Kent & Simonoff, 2017; Wood & Gadow, 2010). Pavlopoulou and colleagues (2020) found that 86% of family carers reported the needs of autistic people have not been adequately addressed while 46% of family carers stated that they consider their autistic children or themselves to be at higher risk for COVID-19 than the general population. Unquestionably, the turmoil introduced by COVID-19 has had particularly deleterious effects for this vulnerable population.

Taken together, the range of issues outlined above represent a perfect storm for substantially amplifying the psychological burden that many autistic individuals already experience. Given the recognised increased levels of stress, worry, and anxiety that autistic persons experience, there is a critical and urgent need to provide services and support to autistic individuals in this time. However, with lockdown restrictions, shelter-in-place orders, and alarmingly increasing rates of infection in major first world countries, providing services and support in the current situation represents a tremendous challenge. And even after we have emerged from the current situation, services are likely to remain at-a-distance and not face-to-face for some time. Therefore, remote delivery of services becomes a vital consideration (Cox et al., 2020) for autistic groups, their caregivers and support networks. Central to remote delivery are the technologies and associated infrastructures that make it possible. Therefore, we consider

in the current case study report how focused and intentional application of technology might help increase availability of targeted services for autistic individuals so as to help reduce the psychological burden of COVID-19 and prepare them for the “new normal” in a post-lockdown world.

Technology has long been seen as a viable and effective means of delivering educational and therapeutic services to autistic people. Indeed, Pellicano and Stears (2020) suggest that during lock-down and owing to COVID-19, “some autistic people have welcomed new modes of delivery, with education, therapy and other services delivered into their own homes through video technologies” (p. 1). However, technology alone is no panacea. It must be carefully designed and implemented, which Pellicano and Stears acknowledge: “some autistic people have suggested [technology tools] were poorly set up for them” (p. 1). There is little argument that technology-based services for autistic groups present compelling advantages in general; however, during COVID-19 the potential advantages are nothing short of profound. Bluntly stated, provision of services and support in a manner that observes all recommended precautions for reducing the spread of viral infection is not possible without technology. Hence, there has been enormous increase in provision of services such as telehealth, telepsychology, and other telepractice. Telehealth has an established history (Ferguson, et al., 2019) as an intervention modality for conducting parent training (Tsami, et al., 2019; Unholz-Bowden, et al., 2020), staff training (Tomlinson et al., 2018), functional analysis of problem behavior (Wacker et al. 2013a,b), and more recently direct intervention services (Pellegrino & DiGennaro Reed, 2020). Video technologies and telehealth remain relevant in current research related to autistic groups as we endeavor to uncover efficacious methods and processes for providing services at a distance during these unprecedented times (degli Espinosa, 2020).

Without question, technology represents advantages related to the nature and form of education/training and therapy that can be both transformative and potent. However, there remain significant challenges as to how technology is deployed, monitored and managed in practice.

Specific opportunities for technology deployment and utilisation

One specific form of technology that is poised to potentially impact autistic people is virtual reality (VR) used with head-mounted displays (HMDs) as an immersive technology. Indeed, research supports the use of VR for safe, predictable, and effective interventions with autistic groups (Glaser & Schmidt, 2018; Howard & Gutworth, 2020; Karami et al., 2020; Mesa-Gresa et al., 2018, Riva, et al., 2019). Recent research by Dechsling, et al. (2020) highlights that HMD use by autistic individuals is reported as overwhelmingly positive with over 80% positive HMD-based VR experiences reported across 155 studies surveyed. As such, this technology is increasingly seen as an effective means to deliver training, interventions and support for autistic individuals, with preliminary work suggesting they are safe and acceptable, and are perceived as useful, motivating, and exciting by individuals with ASD (Newbutt et al., 2016, 2020; Schmidt et al., 2019). Research also shows HMDs can offer safe, relaxing, and calm spaces to acquire and practice a range of skills (Cheng et al., 2015; Parsons et al., 2017; Newbutt et al., 2020; Schmidt et al., 2019) while affording the chance to make mistakes and learn without real-life consequences attached.

Mobile-based VR is particularly suited to a specific type of VR content that can be very useful for VR-based exposure: 360-degree videos (Li et al., 2017). These videos, also known as immersive videos or spherical videos, are special video recordings created using a camera with multiple camera lenses or a rig of multiple cameras. The use of different lenses allows the

recording of every direction at the same time, effectively giving a full view of what is around the camera. Using this technique, 360-degree videos virtually transport users into the video recording, allowing them to actively explore its content and see the video from any angle. As recently demonstrated by Li and colleagues (2017), these videos have the ability to induce specific emotions characterised by different levels of valence and arousal.

360 videos can be experienced using a range of technologies, from smartphones to desktop computers to wearable devices (e.g., HMD). Although they can be viewed on desktop computers, this modality lacks the ability of more immersive, wearable technologies to make it seem as if one is “really there,” also known as a sense of presence (Dalgarno & Lee, 2010). Two wearable HMDs are of particular interest. First, the Oculus Quest option provides an all-in-one option with software inbuilt and ready for easy access/use with hand-held devices for input. Second, the Cardboard option provides a form of goggles that have a smartphone inserted to view VR designed materials, such as 360 degree videos on YouTube. There are no hand-held input devices for this option. These modern HMD distinguish themselves from the first generation of VR devices, which were characterised by low display resolution, limited field of view, and uncomfortable designs. These early VR HMDs were also cost-prohibitive, often priced higher than 10,000 USD, and required equally expensive, high-end computers equipped with professional graphics cards. Today, the simplest and cheapest form of VR – *mobile-based VR* – requires nothing more than a pair of magnifying lenses and a sheet of cardboard. Cardboard-based HMDs sell for 15–20 USD, and all-in-one HMD like the Oculus Quest cost 400 USD, with these costs anticipated to drop presently.

Based on the specific affordances of this technology and mode of interaction, consideration of applying it as a therapeutic medium during COVID-19 warrants attention. Riva

and Wiederhold (2020) suggest using HMD-based VR to deploy mindfulness activities, which, in turn, can enhance general psychological well-being. They propose this based on three areas that have been particularly impacted by COVID-19: (1) anxiety; (2) disappearance of places from daily lives; and (3) a sense of community disappearing. The rationale is that dealing with these “three dilemmas at the same time is not easy. [...] however, positive technology can help us through” (p. 1). Given known challenges that autistic individuals face (e.g., anxiety, need for routine, a desire for sameness), these three areas impacted by COVID-19 could be further exacerbated for autistic groups (Riva and Wiederhold, 2020; p.2). We suggest therefore that HMD-based VR—and targeted exposure as described in the work of Riva and Wiederhold (2020)—could hold immense promise and opportunity to deliver mindfulness activities to people with autism and therefore potentially ease the psychological burden of COVID-19 for them. We suggest HMD-based VR could be leveraged in three key areas of autistic people's lives that have been particularly impacted by COVID-19: (1) **education** (and returning to school/education), (2) accessing services that could otherwise limit routes to **employment** (such as job coaching services) and (3) helping to reduce overall **anxiety** (and mental well-being) that provides an overarching context for these groups.

Education

Education and schools play a vital and important part of any young person's life and this is of course equally true for autistic individuals. In addition, education systems (and in some cases schools) in many regions around the world unlock access to specific supports and interventions received by autistic people in addition to providing ‘statements’ of learning support. These supports and services are an area many autistic people have lost access to during

COVID-19. Moreover, there are many factors facing people with autism in educational contexts, ranging from returning to school with new ‘rules’ and procedures, transitioning from year to year or even to a new school (depending on their age), meeting new pupils/staff, friendship groups and keeping in touch, and the specific nature of locating new routines for their daily lives. Hill et al., (2020), in a guidance document for the *British Psychological Society*, suggest that “some children with additional needs may find it hard to return to school [and children] with autism may require specific support to help them adjust to changes in their school routines and environment” (p. 7). This is coupled with recommendations to schools that they “should focus on their internal planning for children returning to school in new ways” (p. 8). For all pupils this could include “a psychological perspective [that] can help support the mental health and psychological wellbeing of children” (p.3).

In one specific example of an immersive technology that sought to address the notion of returning to a new normal and supporting transition back into schools (and/or entering a new school for the first time) the lead author co-developed a HMD-based VR tour of an autism-specific school in the U.K. The purpose of this was to develop a visual and highly immersive experience of the entire school that could be viewed on a HMD (i.e., Cardboard HMD) or even a computer monitor (see Figures 1 and 2). This experience was designed to provide a tour of the school with social distancing measures in place. Firstly, yellow lines on the floor indicate a 2-meter separation (Fig. 1) and secondly, the classroom views provide a view of spaced tables; indicating reduced class sizes and how a classroom during COVID-19 will appear (Fig. 2). In addition to the spacing and classroom views, users also are able to tour the school grounds to identify a range of places and spaces well in advance of returning to, or joining, the school (i.e. soft play area, quiet rooms, teaching/staff rooms). The school is using this to help alleviate

pressures of entering the “unknown” and “unexpected”. This has implications for anxiety, as well (discussed in a later section).

***** INSERT FIGURE 1 HERE *****

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Another example of how immersive technologies could be deployed to reduce barriers and improve access to education could be by helping to reduce the psychological burden of COVID-19 when transitioning back to education. The overarching idea here is to reduce barriers, provide support, and ease transition to education for autistic individuals during and after the pandemic. As described and developed by Riva & Wiederhold (2020) we suggest that the use of a low-cost spherical, video-based virtual reality (SVVR) mindfulness intervention could reduce the psychological burden of COVID-19 for autistic people, alongside a developed package of at-home educational and support materials to empower families/caregivers delivered via an online eLearning platform to support effective implementation. This use, and at-home deployment of HMD-based VR stands to promote positive mental health and support a family-based tool that could significantly help reduce worries, concerns and other barriers back to education.

Employment

Employment is specifically important to consider, both generally and especially as a result of COVID-19. Even before the pandemic took hold, autistic people faced significant challenges with and barriers to employment. For example, in adults with ASD and no co-occurring intellectual disability, “studies show high rates of unemployment [of] up to 60%”

(Frank et al., 2018: 2). This is a statistic that unfortunately gets worse for individuals with co-occurring issues and in some cases can rise to 85% unemployment in autistic adults. To be expected, these data are different all across the world. For example, studies report greater success in Australia, where up to 42% of adults with ASD participate in employment (Scott et al., 2019). These figures get worse in the United Kingdom, where only 15% of adults with ASD are in full-time paid employment and “only 34% (aged between 21–48) have ever participated in ‘some’ form of employment” (Howlin et al., 2004: 212). Fifty-eight percent of autistic people in the United States (aged 18-25) have worked for pay, while only 21% are in full-time employment (Scott et al., 2019).

When we take these data and couple them with issues exasperated by COVID-19, there is the potential for further challenges facing the autistic community. During COVID-19 unemployment rates are increasing across the globe for everyone; autistic or not. In the United Kingdom (June 2020), over 12,000 people were set to lose their jobs in announcements over two days alone (BBC News, 2020) In the United States, unemployment has risen from 3.5% (Feb 2020) to 14.7% (April 2020) (Trending Economics, 2020). This is of course a trend that will be seen in most countries around the globe and we don’t yet know how much COVID-19 will impact the already limited opportunities for autistic people seeking employment or returning to work.

Autistic people can often work in unstable jobs that include “fixed-term contracts or in the gig economy, both of which are likely to be severely impacted by COVID-19” (Heasman, 2020). Heasman goes on to suggest that: “Due to concerns about health or OCD, autistic people may feel particularly conflicted about the desire to self-isolate versus the desire to be economically independent [and] therefore disrupt the stability of the small percentage of autistic

people who have secured employment”. These are issues and dilemmas that can, and most likely will, lead to mental health concerns including anxiety and depression (we return to this later in the anxiety section below).

Either way and as we have previously outlined, issues related to employment could manifest in increased anxiety, concerns related to disrupted plans (and routine) and very limited access to services/provision supporting routes to employment (with the potential of cuts in services). Finally, employment can mean so much for people with autism, including a “sense of purpose and meaning in life; empowerment and contribution; financial independence; supporting family; self-belief; self-esteem; and pride” (Hedley et al., 2017). Therefore, the role of employment and the longer-term impact is vital for many autistic people and their families.

In terms of the challenges ahead, and in a specific example, providers who help link companies and autistic individuals with work opportunities and support the development of work-based skills have already encountered issues related to social distancing and even being able to work in close proximity (as is often required when learning specific job-related skills). Project SEARCH (<https://www.dfnprojectsearch.org/>) is one specific example, and are currently facing challenges related to providing in-person support for their clients.

We would suggest this is just one example where enabling technologies, such as video modelling (VM) or virtual reality (VR), could play a vital role. This example relates to the acquisition of job-related skills (how to perform a specific tasks) but can also relate to connecting individuals to job coaches and resources to support transitions into their first job, or even as they return to a place of work with specific changes afoot (i.e. social distancing ‘rules’, clearing activities, personal hygiene, etc...). While this can of course be achieved in part, through video conferencing (Zoom, Skype, etc..) it is also true that the unique and immersive

characteristics of HMD-based VR could hold specific promise in delivering opportunities for people with autism (Newbutt et al. 2016; Schmidt et al. 2019). Specifically, these could relate to:

1. Job coaching via in-world avatars (Newbutt 2019; see Figure 3);
2. Skills development (job-specific skill acquisition) (Smith et al., 2014);
3. Social skill / interview support (Smith et al., 2014);
4. Travel training (travelling to a place of work) (Schmidt et al., 2019; Simões, et al., 2018).

***** INSERT FIGURE 3 HERE *****

In applying the above ideas, and via the medium of HMD-based VR, the potential to test, practice, work at their own pace, and rehearse skills and interactions could support faster and greater opportunities for autistic people to learn at home. Low cost HMD-VR could also provide opportunities to rehearse and practice skills such as job interviews. Using a 360-degree camera (i.e., Garmin VIRB) and a live broadcast, job interview simulations could be easily deployed to a HMD via VR to help provide a simulated space to develop a range of practices. Employers could even use this technology to help work with autistic employees as they return to work; creating 360 tours of the new working space with social distancing in place; helping autistic employees know what to expect (as in the example outlined above at a U.K school). This could extend to making reasonable adjustments for autistic employees.

This is also true for travel training. Providing training for use of public transit systems remains among the most cited barriers to accessing community and employment settings for autistic people. However, using low-cost HMDs could provide a platform in which a route to

work could be virtually travelled, thus helping overcome challenges autistic people might encounter in this context, for example, knowing what to expect, mapping a predictable route, knowing where to go, and planning for uncertainties. A promising example of this is Schmidt and colleagues' (2019) multi-stage VR system for training autistic adults to use public transportation. Their approach leverages 360-degree video, viewed in a headset, to provide modeled guidance for checking schedules, mapping a route to the bus stop, estimating when the bus will arrive, determining if it is the correct bus, and boarding. While still in a proof-of-concept stage, preliminary research suggests that autistic users found the VR HMD to be enjoyable, engaging, and easy-to-use. All participants in their study were able to complete all tasks successfully, and all participants expressed a desire to return and use the technology again. This work supports the feasibility of the 360-video training approach for this unique population.

Anxiety

As discussed above, COVID-19 is heightening rates of anxiety in individuals with autism (Kent & Simonoff, 2017; Wood & Gadow, 2010). A first source of stress is generated by the worry and concerns about personal health and the health of friends and family members, which is amplified by the heightened vulnerability of this population to COVID-19. Stress and anxiety are further aggravated by living in quarantine, restrictions on movement and social interaction and other stressors, such as having inadequate basic supplies, insufficient clarity around guidelines regarding what actions to take and the duration of quarantine, the interruption of professional activities and the related financial loss (Brooks et al., 2020). From this perspective, any strategy aiming to reduce stress and anxiety related to COVID-19 is urgently needed (Holmes et al., 2020). Crucially, given the mandatory loneliness resulting from lockdown measures, easy-to-use, inexpensive, and scientifically validated self-help solutions could provide much-needed relief.

Recently, some researchers have explored the possible use of consumer-ready, gamified self-help VR exposure-based therapy (VRET) applications using Mobile-based VR (Lindner et al., 2017). Exposure-based therapies, according to the American Psychological Association's guidelines for empirically supported treatments (APA., 2006), can be considered as a reference treatment for the treatment of anxiety disorder. Indeed, a recent meta-analysis confirms strong treatment effects for VRET for anxiety disorders (Carl et al., 2019). However, only a small group of individuals with anxiety disorders receive this treatment (Olatunji et al., 2010). VR technology therefore presents promising opportunities to increase the number of patients treated with this approach (Fernández-Álvarez et al., 2020).

A randomized controlled study by Freeman and colleagues (2018) compared an automated VRET protocol for fear of heights versus a control group receiving usual care. The automated psychological intervention delivered by immersive VR was highly effective at reducing fear of heights. In a second randomized controlled trial, Lindner and colleagues (2019) compared the efficacy of therapist-led VRET for public speaking anxiety with self-led, at-home VRET. Both VRET formats led to significant improvements in the level of anxiety. Moreover, the improvements achieved by the self-led arm were maintained at the six-month follow-up, and patients undergoing the therapist-led arm also continued to improve at the twelve-month follow-up. These results support the use of mobile-based VRET solutions like the COVID Feel Good weekly self-help protocol for overcoming the psychological burden of the coronavirus (Riva et al, 2020). Using this protocol, the user engages every day for one week with a 10-minute guided VR mindfulness activity (Figure 4) that is further enhanced through a range of different daily social tasks aiming at facilitating a process of critical examination and eventually revision of core assumptions and beliefs.

***** INSERT FIGURE 4 HERE *****

The VR experience and its associated protocol are available in eight different languages - *English, Spanish, French, Brazilian/Portoguese, Italian, Japanese, Korean and Catalan* - and are freely downloadable from the web site: www.covidfeelgood.com.

Summary

With a range of significant challenges impacting people with autism on a daily basis during COVID-19, we have outlined several areas here in which VR might positively impact autistic people. We have suggested three key areas where immersive technologies in the form of low-cost, HMD-based VR could play a role in supporting autistic individuals and groups: (1) education; (2) employment; and (3) anxiety. We suggest that the unique nature of HMD-based VR *could* help to remove individuals from the ‘real’ and into a world they can feel comfortable, relaxed and happy to engage in a range of activities. While it was not our intention to provide specific examples in detail, we do highlight here a variety of examples in which immersive technologies show promise or have proved to be effective in helping to reduce barriers and obstacles that autistic people may experience, especially as a direct result of COVID-19.

Already stretched services and provision for many people with disabilities are currently at risk. Providing a sense of what a post-COVID-19 world looks and feels like could be vitally important for autistic people who often identify with routines and having a clear idea of what to expect. Returning to a school with new rules, classrooms changed to account for social distancing and new ways of interacting, such as working collaboratively but retaining two meters distance, could amplify issues experienced by autistic groups. Taken together, we argue there is a

unique and important role immersive technologies could play. We by no means suggest these technologies will replace classroom activities or even that they need to be used in classrooms—yet (Newbutt et al., 2020)—but they might be used at home and as a way to stage a return from COVID-19 in ways autistic people can feel safe and secure with. We feel a similar rationale applies to both employment and anxiety contexts too.

While we position herein HMD-based VR as a promising technology, this claim is based on the premise that VR technology is used to deliver an intervention, experience, or learning opportunity that has been well-designed with the intent to support people. This means such technologies must be intentionally designed to support specific, measurable outcomes. In addition, and to be clear, we do not position VR technology alone as having any intrinsic properties that might impact COVID-19 challenges. VR and immersive technology are merely the media used to deliver the underlying experience, intervention, or opportunity. As such, the quality of design of the underlying technology is critically important. Further, while we have emphasized VR technologies in the current article as a means to approach immediate practical challenges in light of COVID-19, our position is not without theoretical ramifications. Underlying our central proposition is the theory of executive function in autism (Hill, 2004), an omnibus term that encapsulates a variety of functions such as planning, working memory, impulse control, inhibition, set shifting, and self-monitoring. Research suggests careful design of VR experiences can positively impact executive functioning, particularly along the dimensions of behavioural regulation and self-monitoring (Rajendran, 2013). With ramifications for both research and practice, we urge others who might be working in the area of VR for autistic groups (whether now or in the future) to carefully consider the position presented in this article and to

seek the input of autistic persons in developing and deploying immersive technologies such as those described here.

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Figure 1



Figure 2



Figure 3



Figure 4