Do Virtual Reality Relaxation Experiences Alleviate Stress in Parents of Children with Autism? A Pilot Study

Abstract

Psychotherapeutic interventions such as cognitive training and psychoeducation tend to be effective for alleviating stress in caregivers of children with autism. However, these interventions are often time consuming and take place outside the home, posing challenges for accessibility. Technology, especially virtual reality (VR) technology, can be used to support a range of digital interventions at home. VR headsets, when used to simulate relaxing experiences, have been linked with stress relieving effects for some caregiving groups. This study builds on this, exploring whether VR simulated relaxing environments engender positive psychological changes for caregivers of children with autism. A total of 18 caregivers were exposed to VR simulated natural environments (e.g., beach, forest) for 15 minutes in a single session. State mood, captured with POMS, was measured at baseline and immediately post intervention. Perceived stress (PSS) was captured at baseline and, to explore intervention effectiveness, at three- and seven-days post intervention. POMS scores for tension, anger, depression, fatigue and confusion were lower, and scores for vigour higher, immediately post intervention. PSS scores at three-and seven-days post intervention, while comparable with one another, were lower compared with baseline. Interacting with simulated natural environments in VR seems effective for improving caregivers' state mood and reducing their perceived stress for up to seven days. Future research should aim to consolidate and expand on these findings with larger samples and longer follow up periods.

Keywords: autism, caregiving, intervention, relaxation, virtual reality

Do Virtual Reality Relaxation Experiences Alleviate Stress in Parents of Children with Autism?

A Pilot Study

Much cross-sectional research links caring for a child with autism with increased psychological distress. Indeed, anxiety, depression, and perceived stress, all commonly used markers of psychological distress, tend to be elevated in the context of caring for an autistic child (Cohrs & Leslie, 2017; Kütük et al., 2021; Likhitweerawong et al., 2020; Scherer et al., 2019). Many caregivers report levels of anxiety and depression that meet standards for clinical mood disorder (Schnabel et al., 2020; Taylor & Warren, 2012). Caregivers' psychological distress, much higher than parents of non-autistic children, also tends to be relatively stable over time. Depression in particular shows little improvement (Barker et al., 2011). Caregivers' emotional responses to acute stressors in the lab also differentiate them from parents of non-autistic children; increases in negative emotions such as anxiety are typically much greater for caregivers (Pattini et al., 2019). Caregivers' concerns about stress, and about how stress might detrimentally impact the quality of the care they provide, have are detailed in several qualitative studies (Topan et al., 2019). Much research links caregivers' psychological well-being with the health and happiness of the autistic child. For example, children of more stressed caregivers typically display more severe autism symptoms (Clauser et al., 2021; Efstratopoulou et al., 2022; Lerthattasilp et al., 2015; Shepherd et al., 2018; Zhou & Yi, 2014). Moreover, children of higher stressed caregivers are less likely to derive benefits, especially in domains of social interaction and communication, from early years interventions (Osborne et al., 2008). Caregivers also report feeling less confident about their ability to provide good quality caretaking when their stress levels are high (Batool & Khurshid, 2015; Wang et al., 2020).

As caregiver stress levels tend to be stable over time, and because caregivers' stress impact quality of life for the autistic child, it is important to develop interventions that alleviate caregivers' stress (Barker et al., 2011). Encouragingly, caregivers' psychological functioning is sensitive to change with intervention. For example, several review articles recently highlighted the beneficial psychological effects of interventions such as cognitive training, mindfulness, and psychoeducation for caregivers of children with autism (Catalano et al., 2018; Da Paz & Wallander, 2017). These interventions, however, tend to be time-consuming and based outside the home. This can make accessing them challenging for caregivers who, often lacking alternative childcare, sometimes find it hard to get out of the house (Fowler & O'Connor, 2021; Griffith & Hastings, 2014; Ludlow et al., 2012). Moreover, these interventions are not always free of charge, and many caregivers of autistic children report financial difficulties caused by surrendering employment to provide full-time caregiving (Sharpe & Baker, 2007). Interventions that can be engaged with at home that demand little time and are relatively cheap are needed for caregivers of autistic children.

Several researchers have already explored that some home-based interventions can be useful for helping caregivers cope with stress. For example, emotional disclosure interventions, in which caregivers explore their feelings about caregiving, good or bad, using expressive writing techniques, can be done at home, quickly, and without financial cost. Moreover, these writing interventions promote positive psychological changes for caregivers, manifesting as reductions in anxiety. These home-based writing interventions are also positively received by caregivers who describe them as feasible and useful (Lovell et al., 2016). Attrition rates for these interventions also tend to be low (Da Paz et al., 2018). Caregivers also respond well, psychologically, to other home-based interventions. For example, caregivers who engage with social support interventions in their home, accessing them online, report notable reductions in feelings of depression (Clifford & Minnes, 2013; Cole et al., 2017). Educational interventions that provide caregivers more information about autism and making recommendations about how to cope with caregiving struggles, when packaged as a cheap and easily accessible mobile app, also effectively alleviate caregivers' stress (Hemdi & Daley, 2017).

Getting out of the house and into relaxing natural environments (e.g., woodland, forests) has been linked with restorative and soothing psychological effects for a range of populations (Mao et al., 2012; Martin et al., 2020; Tsunetsugu et al., 2010). The Attention Restoration Theory posits that tasks of daily living deplete our mental resources and focus. It goes on to say that time spent in nature, by replenishing these mental resources and restoring focus, alleviates stress (Kaplan & Kaplan, 1989). Caregivers of autistic children have reported that time away from the caregiving experience is extremely important, helping them to recuperate (Mactavish et al., 2007). Several studies capture the importance of leisure time, especially time spent in nature, for caregivers. For example, Rizk et al. (2011) found caregivers who spent more time outdoors, in rural settings, reported fewer mental health problems and better overall quality of life. Therefore, encouraging caregivers to get outdoors, into natural environments, seems important, potentially aiding their psychological recuperation. However, caregivers, often find it difficult to get outdoors due to the demanding nature of their caregiving role (Tathgur & Kang, 2021).

Virtual reality (VR) technology, however, might offer one solution. VR technology uses high-quality computer-generated images and sounds to create immersive simulations. These simulations are so immersive, feeling so real, that our responses to them, emotionally and biologically, match our responses to the same stimuli in the real world (Kalantari et al., 2021). Researchers have started to use this technology to bring the outdoors indoors, simulating relaxing natural spaces with a view to exploring their therapeutic value. Findings in this area have been promising so far. For example, psychological recovery following an acute lab-based stressor

was accelerated for those who, immediately post-stressor, were exposed to VR-simulated green space (Liszio et al., 2018). Other studies found that simulating rural spaces such as forests and woodlands, but not urban spaces, in VR effectively relieved stress in otherwise healthy individuals (Anderson et al., 2017). Similar positive psychological changes have been observed in psychiatric samples. For example, positive mood, especially feelings of relaxation, notably increased in psychiatric patients after they visited VR-simulated natural spaces such as the beach (Veling et al., 2021). Several researchers have concluded that VR-simulated natural spaces engender positive psychological effects for several samples (Riches et al., 2021; Roche et al., 2019). Encouragingly, high-stress samples also seem to benefit, psychologically, from being exposed to simulated natural spaces in VR. Indeed, cancer patients, experiencing high levels of stress due to their physical illness, experienced marked increases in feelings of peace and relaxation, and marked reductions in pain symptoms, following a single treatment with VR-simulated natural environments (Scates et al., 2020).

VR technology is portable, packaged into a lightweight headset, and therefore is easy to access at home. VR technology is also modestly costed and easy to use, requiring no specialized training. Therefore, VR technology, when used to simulate relaxing natural spaces, might be a particularly appropriate digital therapy for use with caregivers of children with autism, helping them psychologically recuperate. This study explored this possibility.

The Present Study

The positive psychological impact of spending time in nature has been observed in a range of populations (Martin et al., 2020). Caregivers of children with autism report that leisure time, especially time spent outdoors, is important, helping them psychologically recuperate (Mactavish et al., 2007). Studies have shown that caregivers of children with autism who spend more time outdoors, if that time is spent in rural environments, report better mental health (Rizk et al., 2011). Encouraging caregivers to get outdoors, therefore, is important, likely improving their psychological well-being. However, caregivers of children with autism typically have few options for alternative childcare, making it challenging to leave the house (Tathgur & Kang, 2021). Virtual reality (VR) technology might provide one solution.

VR headsets use advanced 3D technology to create highly realistic simulated environments. Researchers have started to explore whether spending time in simulated natural environments might engender positive psychological changes. Results have been positive to date. Several studies, involving a range of populations, reported stress alleviating effects of spending time in VR simulated natural spaces (Anderson et al.,

2021; Veling et al., 2017). VR headsets are portable and easy to set up at home, requiring no training, and this makes them particularly appropriate for use with caregivers of children with autism. Whether spending time in VR simulated natural spaces might engender positive psychological changes for caregivers of children with autism has not been explored. It is important, therefore, to pilot this approach. Here we explore whether caregivers' mood, and broader psychological well-being, might be amenable to improvement via accessing natural spaces simulated in VR.

Method

Participants

An a'priori power analysis with GPower (ANOVA repeated measures) indicated that 31 participants were needed to provide adequate power (80%; $a = 0.05$) to detect a moderate ($f2 = 0.15$) effect size (Cohen, 1988). We exceeded this number, recruiting 38 caregivers via adverts posted in caregiving support groups on social media sites. Brief details about the study were included in the advert. Caregivers that were interested in taking part were directed to email the research team to set up a suitable day and time for their visit to the lab. Caregivers were recruited against strict inclusion criteria; these were a) be aged >18 years, b) caring for at least one child aged 3-19 years and living at home full time with clinically verified autism, and c) not providing informal (i.e., unpaid) care for another person (e.g., partner, parent, other child, or friend) with long term illness. We observed a high attrition rate. That is, a total of 18 caregivers, equating to 50% of the sample, failed to provide post-intervention assessments. We removed data for these 18 participants, resulting in a final sample of 18 participants taken forward for statistical analysis.

Caregivers' mean age was 43.7 years ($_{SD}$ = 7.5), with the majority being female (77.8%), partnered (83.3%), employed full or part time (61.1%) and non-smokers (77.8%). Most exercised more than once per week (87.8%), slept at least six hours per night (94.4%) and consumed relatively few alcoholic drinks per week ($_{M}$= 7.8, $_{SD}$ = 9.0). The mean age of the child with autism was 11.7 years ($_{SD}$ = 3.9) and mean age at diagnosis was 6.0 years ($_{SD}$ = 3.4, range = 2-13 years). Most of the caregivers reported caring for at least one other neuro-typical child (66.7%) and had no previous experience with VR (77.8%).

Measures

State Mood

The 65-item Profile of Mood States (POMS) was used to assess state mood (McNair et al., 1971). Participants were asked to report, for all 65 mood descriptors, how they felt at that moment. All items were scored using five-point Likert type scale (1, *not at all* - 5, *extremely*). Subscale scores, available for tension, depression, anger, fatigue, confusion and vigour, were calculated by summing across all relevant mood descriptors. Total scores for each subscale ranged between 7 and 40. Lower subscale scores for tension, depression, anger, fatigue and confusion, and higher scores for vigour, reflected better state mood. POMS subscales achieved good internal consistency in previous studies (Wang et al., 2019), as was the case here (all alphas > .84).

Psychological Distress

The 10-item Perceived Stress Scale (PSS) was used to assess psychological distress (Cohen et al., 1983). Items were scored on a five-point Likert type scale (0, *not at all* - 4, *all the time*). Total scores, generated by summing across all 10 items after reverse scoring (items 4, 5, 7, 8), ranged between 0 and 40. Higher scores reflected greater psychological distress. The PSS achieved good internal consistency in previous studies involving caregivers of children with autism (Lovell & Wetherell, 2015), as was the case here (α > .89).

Potential Confounds

We collected data with respect to a range of sociodemographic (e.g., age, gender, relationship status) and lifestyle (e.g., smoking, alcohol, exercise) variables have shown to be influential for caregivers' psychological well-being (Jones et al., 2013). Data with respect to characteristics of the child with autism (e.g., current age, age at diagnosis) can also affect caregivers' psychological well-being and were also collected, as was information about caregivers' previous experience with VR (Rivard et al., 2014). This data was collected with a questionnaire.

Procedure and Intervention

Consenting participants were invited to our lab and, on arrival, completed baseline assessments of mood (POMS) and perceived stress (PSS). Questionnaires capturing characteristics of the care provider and care recipient were also collected at baseline. Caregivers were then taken to our VR lab and, to help get them comfortable with the technology, given a five-minute demonstration with the VR equipment. A head mounted display (HMD) unit designed by Oculus Rift was used to support the simulated experiences. The HMD consists

of a visor and earphones, is lightweight, and fits comfortably over participants' heads. It is secured in place with adjustable Velcro straps. Earphones are adjustable and placed over the ears to capture sounds, and a visor is placed over the eyes for viewing immersive 3D environments with 360^0 panoramic views. The VR app, 'Perfect', developed by NDreams, was used to simulate relaxing natural environments. Caregivers had the option to explore a simulated tropical beach, snowy mountains, or peaceful woodlands. All participants opted for the simulated tropical beach experience. NDreams were contacted ahead of the study and consented for the app to be used for research purposes. Participants were left alone in a sound proofed room, undisturbed by the researcher, to enjoy the VR experience in a seated position for 15 minutes. The researcher returned after 15 minutes and stopped the simulation experience, immediately asking participants to again complete the POMS (state mood) questionnaire. Three days later, and again seven days post intervention, copies of PSS questionnaire were emailed to participants to capture post-intervention assessments of psychological distress. The study and all its protocols were approved by the Faculty of Health and Life Sciences Ethics Committee, and all participants provided full informed consent to take part. All participants were entered into a prize draw to win an Apple iPad as compensation for their time. No other recompense was offered.

Statistical Analysis

A series of bivariate and, for categorical variables, point bi-serial correlations were used to explore whether caregivers' perceived stress (PSS) scores at baseline might be related to potential confounds. A series of paired *t*-tests were used to assess changes in POMS subscale scores from pre to post intervention. One-way repeated measures ANOVA (violations corrected as required) was used to assess changes in PSS across the follow-up period. Post hoc probing with paired *t* tests was used to compare PSS scores at baseline with those at three days and seven days post intervention.

Results

Preliminary Analysis

Caregivers' perceived stress (PSS) scores at baseline were unrelated to any socio-demographic or lifestyle variables (all *p*s > .07). PSS scores were also unrelated to all characteristics of the child with autism (all *p*s > .55) and to caregivers' previous experience with VR ($r = .38$, $p = .12$).

State Mood

Interactions with relaxing natural environments in VR were effective for improving state mood; scores for POMS subscales of tension ($t(17)$= -4.79, $p < .001$), depression ($t(17) = -3.32$, $p < .01$), anger ($t(17) = -2.84$, $p = .01$), fatigue ($t(17) = -4.12$, $p < .01$) and confusion ($t(17) = -3.21$, $p < .01$) decreased, and scores for vigour increased ($t(17) = 2.08$, $p = .05$), from pre to post intervention. Means and standard deviations for POMS subscale scores pre and post intervention are displayed in Table 1.

Perceived Stress

One-way repeated measures ANOVA yielded a significant main effect of time ($F_{(2, 34)} = 10.41$, $p < .001$, $\eta p2 = .38$), reflecting reductions in PSS scores across the follow-up period. Post hoc probing with a series of paired samples *t* tests revealed PSS scores were lower at three days ($t(17) = 3.79$, $p = .001$), and stayed lower at seven days ($t(17) = 3.61$, $p < .01$), post intervention compared with baseline. PSS scores at three days and seven days post intervention were statistically comparable ($t(17) = -.62$, $p = .54$). Means and standard deviations for PSS scores at all study time points are displayed in Table 2.

Discussion

We sought to explore whether exposure to VR simulated natural environments might promote positive psychological changes for caregivers of children with autism. Indeed, this was the case. That is, state mood (POMS) scores for depression, anger, fatigue, tension and confusion were lower, and scores for vigour higher, immediately post intervention. Caregivers' perceived levels of stress (PSS) were also amenable to positive change via the intervention. Indeed, caregivers' PSS were lower three days, and stayed lower seven days, following the intervention compared with baseline. These findings align with studies involving other stressed populations, which found that relaxation interventions, especially those incorporating natural environments, effectively alleviate psychological distress (Shah et al., 2016; Roche et al., 2019). Findings also align with other studies that found relaxation interventions, when supported with digital technologies such as mobile apps, promote soothing psychological effects for stressed populations, including informal caregivers (Bray et al., 2017; Ploeg et al., 2017). Findings reported here also interface with the Attention Restoration Theory, positing that exposure to relaxing natural spaces reduces stress through replenishing mental resources and restoring focus (Kaplan & Kaplan, 1989).

Practical Implications

Findings reported here have implications for the caregiver-care recipient dyad. Indeed, children of higher stressed caregivers tend to have poorer quality of life outcomes, displaying more problematic behaviours and struggles with social interaction and effective communication (Rodriguez et al., 2019; Shepherd et al., 2018). Children of more stressed caregivers are also less likely to benefit from early years interventions designed to remediate communication and behavioural issues (Osborne, 2008). VR technology, when used to simulate natural relaxing spaces, appears to be effective for improving caregivers' state mood and, for up to seven days, reducing their perceived levels of stress. These positive psychological changes for caregivers might engender positive changes for their autistic children, manifesting as reductions in problem behaviours and better social and communication outcomes. This seems probable given that several studies found the relationship between caregivers' psychological well-being and symptom severity in the autistic child to be bidirectional (Rodriquez et al., 2019). This might be explored in future studies.

The efficacy of relaxation-based interventions such as this one are variable, working for some sub-groups better than others. More emotionally expressive individuals, better in tune with their emotions, tend to derive the most benefit from these kinds of experiences (Holmes et al., 2018). Caregivers of children with autism, however, are renowned for having difficulties expressing their emotions, scoring much higher on alexithymia compared with parents of non-autistic children (Griffin et al., 2016). Several studies have shown that alexithymia moderates the effectiveness of home-based interventions for caregivers of autistic children (O'Connor & Ashley, 2008). Therefore, it is important that future researchers consolidate and expand on the findings reported here, determining for which subsets of caregivers, and under what conditions, VR simulated relaxation experiences promote positive psychological effects. These findings might also have implications for the way healthcare professionals support caregivers and their children. For example, caregivers of children with autism tend to be quite young, and younger caregivers are less likely than their age matched, non-caregiving counterparts to use technology for healthcare purposes (Kim et al., 2017). It tends to be older caregivers, caring for partners with dementia, who are kore amenable to using technology for assisting with their caregiving experience (ref). Therefore, healthcare professionals might encourage younger caregivers (of children with autism) to use digital technologies, especially VR, to help cope, psychologically, with the caregiving experience.

Strengths and Limitations

The small sample size, absence of control group, and short follow up period are noteworthy. Future researchers might recruit larger samples and, to ascertain whether intervention effects are sustainable beyond

seven days, use more prolonged follow up periods. The findings reported here should be interpreted cautiously until corroborated with the inclusion of a control group. Indeed, the positive psychological changes observed here might be non-specific. That is, it might be that any interruption to the burden of caretaking, and not specifically VR simulated relaxation, produces positive emotional changes. This should be explored in future studies given the link between access to respite services and lower reported levels of stress in caregivers (Whitmore, 2016). Therefore, future researchers are encouraged use randomised control trials, and with larger samples, to ascertain whether the intervention promotes positive psychological changes above and beyond those elicited by respite alone.

The current study observed a high attrition rate, with 50% of the sample failing to provide any post-intervention assessments. However, the high attrition rate should not overshadow the very encouraging finding that all caregivers who consented to take part found time amidst the heavy demands of caregiving to visit our lab and engage with the intervention in full. This is clearly a strength of the research, demonstrating that caregivers of children with autism are willing and motivated to seek out interventions, even those outside the home, that might forestall their feelings of stress.

Conclusions

In conclusion, interactions with relaxing natural environments simulated in VR are effective for improving state mood and, for up to seven days, reducing perceived stress in caregivers of children with autism. Whether this intervention is effective for improving quality of life outcomes for the autistic child, and whether this occurs indirectly via improvements in caregivers' psychological well-being, might be the target of future research. Whether the psychological soothing effects of the intervention can extend beyond seven days, and whether the magnitude of the beneficial psychological effects can be increased with more sessions, might also be explored in future. VR technology can negate some of the practical barriers prohibiting caregivers of children with autism accessing interventions and can be effective, when simulating relaxing natural spaces, for improving state mood and alleviating longer term stress. Healthcare professionals might do well to recommend VR technology to this population.

Data Availability

The provided ethical approval for the IRIS study does not allow publication of individual participant level data. Requests for a de-identified dataset require a Data Transfer Agreement that is in accordance with the European Union´s General Data Protection Regulation (GDPR).

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Table 1

Means and (Standard Deviations) for POMS Subscale Scores at all Study Time Points

POMS subscales	Baseline	Post Intervention	
	M (SD)	M (SD)	*p* =
Tension	2.12 (.79)	1.34 (.34)	< .001
Depression	1.68 (.94)	1.05 (.21)	< .01
Anger	1.64 (.79)	1.17 (.26)	.01
Fatigue	2.82 (1.11)	1.82 (.72)	.001
Confusion	2.35 (.79)	1.84 (.46)	< .01
Vigour	2.51 (.64)	2.81 (.59)	.05