USING VIRTUAL REALITY TO REDUCE STATE ANXIETY AND STRESS IN UNIVERSITY STUDENTS: AN EXPERIMENT

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Abstract:

Background/Objectives: Anxiety is common in the general population and also among university students, affecting their performance. Virtual reality (VR) devices can theoretically help alleviate anxiety pressures faced, by immersing participants in an interactive synthetic environment that is calming. The current study examined whether using a mobile VR device would support this theoretical position and help reduce anxiety levels in university students.

Methods: The study randomly assigned 30 participating university students to two groups: one experimental (VR) group and the other a control (reading task – RT) group. All participants first completed initial surveys (demographics, depression anxiety and stress scale – DASS-21 and a social desirability scale – SDS) and then were administered in turn the Trier Social Stress Test (TSST) to increase stress levels and the State – trait anxiety inventory (STAI-Y) scale to assess the anxiety-stress levels); followed by random allocation into either the VR experimental group engaged in a virtual tour of Hawaii or the RT group which read neutral extracts from a magazine). Following this, STAI-Y was again administered.

Results: There was a significant difference between the VR and the RT groups with highly significant reductions in stress levels being associated with the VR group

Conclusion: The study demonstrated that anxiety levels could be reduced significantly through the use of VR technology. Further studies are needed in terms of suitable intervention scenarios, equipment quality, and in application to other mental health areas and to different community groups.

Key Words: Mental health; State anxiety; Virtual reality; Depression

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Introduction

Anxiety is a growing global health concern; in 2015 it was estimated that the total number of people worldwide suffering from anxiety was 264 million, rising by 15% since 2005 (Vos et al., 2016). Anxiety is an emotion characterised by an unpleasant state of inner turmoil and the feeling of uneasiness (Bouras & Holt, 2007). Anxiety is correlated with performance deficits in cognitive tasks (Tohill & Holyoak, 2000), reduced storage and processing capacity in working memory (Darke, 1988; Sorg & Whitney, 1992), altered decision making (Hartley & Phelps, 2012) and selective attention (Yang et al., 2015). Individuals suffering from anxiety are encouraged to pursue anxiety management techniques. Virtual reality (VR) may be one such management technique. VR devices are available that theoretically can help alleviate anxiety pressures, by helping users become immersed in an interactive yet calming synthetic environment (Freeman et al., 2017). In this study VR technology was used to assess its efficacy as an anxiety management technique within a student population.

Anxiety can be either state anxiety or trait anxiety: state anxiety is triggered when certain personal goals or outcomes are challenged or a sense of uncertainty in created while trait anxiety is more ingrained and threatening situations elicit more long-lasting responses. People with high levels of trait anxiety are likely to have more intense state anxiety than those with lower levels of trait anxiety (Spielberger & Sydeman, 1994).

Contributors and Effects of Anxiety in University Students

The mental wellbeing of university students has increasingly become an area of concern as the prevalence of symptoms of depression, anxiety and stress has increased (Bayram & Bilgel, 2008). In preparation for their professional careers, students are faced with continuous academic, social and financial demands around the world including in the UK (Andrews & Wilding, 2004), Turkey (Bayram & Bilgel, 2008) and Australia (Eckberg, Pidgeon, & Magyar, 2017; Farrer et al., 2016; Mead & Hicks, 2010; Paspaliaris & Hicks, 2010)

Applications of Modern Virtual Reality

VR has sparked a revolution in terms of technological development as it is now capable of completely immersing the users in a virtual environment with which they can interact. The first reported use of VR was in the 1980s where a head-mounted display (HMD), a head tracking system and computer-generated images were used (Slater & Sanchez-Vives, 2016). However, these devices were not accessible then to the general public. One of the very first VR systems used was the Cave Automatic Virtual Environment (CAVE) where a computer projected images on the walls of a room and participants had to wear specialised glasses to view the room in 3D (Cruz-Neira, Sandin, & DeFanti, 1993). The studies that have examined the use of VR in the past have used systems with lower specifications that utilise computer monitor, or projector displays instead of HMDs with limited level of immersion and interactivity (Freeman et al., 2017). There have been few studies conducted using the most recent VR technology.

The release of modern consumer-grade virtual reality devices, such as Oculus Rift CV1 (Oculus, 2016) and Gear VR (Oculus, 2015) that are compatible with modern smartphones, laptops or desktop computers has provided an opportunity for this technology to be used in entertainment (Schlacht, Del Mastro, & Nazir, 2017), education (Moro, Štromberga, Raikos, & Stirling, 2017) and also as a tool in mental health (Maples-Keller, Bunnell, Kim, & Rothbaum, 2017; Valmaggia, Latif, Kempton, & Rus-Calafell, 2016). The currently available VR devices provide more realistic and immersive experiences, are more portable, have better graphics and are more user friendly (Lindner et al., 2017). The sense of being present in the virtual environment is facilitated through the use of high-resolution HDMs and motion tracking systems that are in place to track and capture the position of the user's head in order to produce a dynamic 3D scene that changes with the position of the head (Freeman et al., 2017).

Virtual Reality in Treating Anxiety and Improving General Wellbeing

Cognitive behaviour therapy (CBT) is a common treatment for anxiety disorders (Hans & Hiller, 2013; Kaczkurkin & Foa, 2015). However, many people avoid seeking mental health treatment for reasons including the stigma of seeking therapy, uncertainty whether the symptoms are considered severe enough (Clement et al., 2015; Eisenberg, Downs, Golberstein, & Zivin, 2009), and financial and time constraints. Despite the availability of treatments for anxiety disorder, only 40% of patients seek out treatment, and of those who do, less than half actually benefit from the treatment (Tiller, 2013).

VR technology has the potential to help these people overcome mental problems in a relatively low-cost environment. One of current clinical uses of this technology is through VR exposure therapy (VRET), where the patient is gradually exposed to a negative stimulus in a controlled and safe environment to reduce anxiety and PTSD (Diemer, Lohkamp, Muhlberger, & Zwanzger, 2016; Maples-Keller et al., 2017). The first documented use of VR in exposure therapy was in 1995 and it focused on the fear of heights (Rothbaum et al., 1995). The results of this study showed VR to be an effective tool in reducing fear of heights and led to further investigations with the technology available at that time. One of the biggest advantages of using VR in exposure therapy is that patients are aware that they are in a synthetic environment and, yet the body and mind still reacts as in the real world (Freeman et al., 2017). That makes patients more willing to face difficult situations in VR rather than in real life and try out different treatment strategies. VRET enables complete control over the design of the exposure stimulus and solves logistic issues that are associated with traditional exposure therapy (Lindner et al., 2017) but research needs to demonstrate that the potential can be achieved. Several studies have supported the value of VR in treatment (see next) though more research is needed in specific context.

A study in Spain with five participants used VR to gradually expose anxious participants to flying. At the end of the treatment all five participants were comfortable with the notion of flying (Botella et al., 2014). VRET has also been used to treat people with combat related post-traumatic stress disorder (PTSD, McLay et al., 2017), in an experiment with 11 participants. PTSD symptoms were assessed one week and 3 months after the conclusion of the treatment, where no significant difference was found between VRET and a

comparison treatment using control exposure therapy (CET). In another study Anderson et al. (2013) found VR to be an effective tool in reducing social fears (with significant improvements evident at their 12-month follow up visit) When compared to exposure group therapy outcomes, VR was found to be equally effective. Overall it seems that VR provides the opportunity to engage with situations that provoke anxiety, in a safe and controlled environment and at less cost than might otherwise be the case (Bouchard et al., 2016).

VR has also been used to reduce anxiety and pain during medical procedures. In the Wiederhold, Gao, and Wiederhold (2014) study, the dentist conducted the first 5 minutes of the treatment without the use of the VR distraction system (VRDS) and then performed the rest of the procedure using the VRDS. The VRDS application consisted of the patient navigating through a virtual location (such as a beach or a garden). Results portrayed a significant decrease in the patients' perceived anxiety levels when using the VRDS which was supported by the biofeedback monitors. It was also further noted that it helped reduce discomfort and boredom. Qualitative data did show some limitations such as the "presence and realism" had to be improved as the image/ auditory quality of the technology was not high enough and more virtual environments would need to be created for this treatment to be effective more broadly (Wiederhold et al., 2014).

In another more recent study published by Sharar et al. (2016) participants received an 18-minute long multimodal pain sequence (thermal and electrical stimulation) while using VR as a distractor (gliding through an arctic canyon). It was found that VR distraction significantly reduced perceived pain intensity as well reduced anxiety levels when compared to the control group. The current study investigated the use of VR in university, as many demonstrate symptoms of anxiety, some with comorbid depression (ABS, 2015; Farrer et al., 2016)

Depression and anxiety

Although depression disorder differs from anxiety, they share similar affective, cognitive, behavioural and physiological elements (Brady & Kendall, 1992). Research suggests that the two disorders occur together more frequently than they appear individually (Brown, Schulberg, Madonia, Shear, & Houck, 1996). There is a clear depression and anxiety disorder comorbidity, where 90% of patients suffering from anxiety disorder have also reported having depression (Tiller, 2013). When depression and anxiety occur together, the symptoms patients experience are more severe compared to when the anxiety occurs alone (Gorman, 1996). It is noted that depression symptoms take longer to resolve, making it more long-term and challenging to treat. The current study controlled for depression so that the effects on anxiety alone could be clearly identified in the sample.

Research rationale

Previous research shows that the difficulties students face when entering university can contribute to increased levels of anxiety and depression which in turn affects their

academic performance (eg., Andrews & Wilding, 2004; McCann & Hicks, 2011; Mead & Hicks, 2010).

Based on these findings, we proceeded to test out the use of VR in relation to anxiety in a university student sample. In addition, little had been established as to the efficacy of reading passages as a means of helping to reduce anxiety, however there is some evidence stating that reading can reduce state anxiety levels (Rizzolo, Zipp, Stiskal, & Simpkins, 2009; Johnson, Jasper, Griffin, & Huffman, 2013).

Aim and hypotheses

To aid in reducing state anxiety levels in individuals based on past studies and theories, the current study evaluated the efficacy of VR and reading as means to reduce state anxiety levels of university students. It was hypothesized that VR would be both effective as a means of reducing state anxiety, and would be more effective in reducing state anxiety than would reading, while controlling for depression.

Method

Participants

A convenience sample of 30 university students was recruited from an Australian University. Participants' age, degree and study area breakdown are presented in Table 1.

Table 1 *Participant demographic information (n=30).*

	Virtual reality (n=16)	Reading task (n=14)	Total (N=30)
Education			
Bachelor	4	6	10
Postgraduate	12	8	20
Area of study			
Humanities	10	13	23
Health sciences	6	1	7
Male % (n)	44% (7)	57% (8)	50% (15)
Female % (n)	56% (9)	43% (6)	50% (15)
Age *M* (SD)	21.56 (1.2)	24.29 (7.3)	22.83 (5.13)

Exclusion criteria. Exclusion criteria for health and safety reasons included participants who were pregnant or had any heart-related disorders, eye infections, previous history of epilepsy and vestibular disease.

Materials

Samsung Gear VR (Samsung Gear VR, Samsung AG, Seoul, Korea). The Samsung Gear VR is a virtual reality headset created by Samsung and Oculus in 2016 which employs a Samsung Galaxy S6 edge+ to drive the device. This VR headset consists of geo-sensors, motion-sensors, accelerometer and proximity sensors. Collectively with the Samsung Galaxy S6 edge+ it weighs 345 grams. The Samsung Galaxy S6 edge+ runs on an octa-core processor at a speed of 2.1GHz, has a 5.7-inch quad HD (2560 × 1440) Super AMOLED display and 4GB of RAM (Samsung, 2017). Full specifications can be found on the Samsung website (samsung.com). The purpose of this device is to simulate reality and therein virtually immerse the user into a different environment.

The Hawaiian Island Tour (Framestore VR, New York, NY, USA). This application is a 360-degree VR video played on the Gear VR headset where the user can turn and look all around. This application is free and readily available on the Oculus online application store (oculus.com) The video starts by the user paragliding over four islands. They are then instructed to choose the island they would like to explore. The first island explores a waterfall, the second is a beach with surfers, the third is on a boat with locals and tourists singing and the fourth has an aboriginal group dancing. Then, a local tour guide delivers a personal tour of the chosen island. (It has to be noted that the application was not designed to be used to reduce anxiety levels but simply as a virtual experience of the Hawaiian Islands).

Bose Quiet Comfort 35 Headphones (Bose Corporation, Framingham, MA, USA). The Bose QuietComfort 35 is *a set* of noise-cancelling, surround sound headphones which continuously isolates, measures and reacts to external sounds; then cancels them with opposite audio signals. This allows the user to hear only sounds coming out of the headphones, blocking external sounds. The reason for using these headphones is to reduce cognitive mismatch between what the user views in the VR headset and what they hear. Using these headphones reduces adverse health effects such as dizziness, nausea and cyber sickness as identified in the pilot finding of the current study.

State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). This scale was designed to measure an individual's perceived level of state (transient) and trait (temperament) anxiety. For the purpose of the current study, only form Y1 (STAI-Y; which measures state anxiety) was utilised. This measure was used to test the participants' state anxiety levels before and after the intervention. The STAI-Y consists of 20-items that assess participants' current affective state, including ephemeral feelings of nervousness, discomfort and physiological arousal. The scale consists of items such as *I feel calm* and *I am presently worrying over possible misfortunes*. These are rated on a 4-point Likert scale, ranging from 1 = *Not at all* to 4 = *very much so* where higher scores were indicative of higher levels of anxiety; 10 items are reversed coded. The STAI-Y demonstrates good psychometrics including Cronbach's alpha - reported as .86 by Speilberger et al. (1983). The current study obtained a similar Cronbach's alpha of .91 for the STAI-Y.

Depression Anxiety Stress Scale (DASS-21; Lovibond & Lovibond, 1995). DASS-21 is a 21-item, quantitative measure of distress along the three axes of depression (DASS-D),

anxiety (DASS-A) and stress (DASS-S) over the past week. Each subscale has 7-items. For the purpose of the current study, only DASS-D and DASS-A were used in the analysis. The DASS-A was used to determine the participant's general level of anxiety. Anxiety scores from DASS-A were used to establish a baseline measure checking how anxious the participants were before introducing the intervention. The DASS-D was used to check if high levels of depression are a co-variate in the change of state anxiety levels (pre/ post intervention). The DASS-D subscale included statements such as *I was unable to become enthusiastic about anything* and the DASS-A subscale included items such as *I was always worried about situations in which I might make a fool of myself.* The DASS-21 has demonstrated good psychometrics with Cronbach's coefficients ranging from .82 - .96 for D and A (Brown, Chorpita, Korotitsch, & Barlow, 1997; Henry & Crawford, 2005) and with test re-test reliability ranging from .71- .81 over a two-week period (Brown et al., 1997). The current study observed a Cronbach's alpha of .73 for the anxiety subscale and .86 for the depression subscale of the DASS-21.

Procedure and Study Phases

There was a priming stage, an intervention stage and a debriefing stage. Fist, however, a pilot study stage was employed. The pilot study is described first and then the priming, intervention and debriefing stages.

Pilot study. A pilot study was first conducted to test the experimental hardware and software, and to assess possible adverse health effects. A sample of 10 participants were employed. Prior to commencement university students were presented with an explanatory statement and consent form. They were then administered the TSST following which they were randomly allocated into two conditions, namely: headphones and no-headphones. Participants were given a walkthrough of the devices and then were allowed 3 minutes to become familiar with the devices. They then watched "the Hawaiian island tour" video. Three of the 5 participants in the no-headphone group reported slight feelings of nausea and dizziness while no participants reported any adverse health effect in the headphone group. Participants in the headphone group also reported lower scores in state anxiety than those in the no-headphone group whose anxiety scores stayed almost constant. Therefore, in the main experiment we maintained the headphones along with the headset. Three out of five participants in the *headset but non-headphone condition* reported symptoms of cyber sickness such as nausea and dizziness after removing the headset. Another five participants were asked to watch the same video using the Bose noise-cancelling headphone. They reported no adverse health conditions even after being prompted about specific negative effects. All participants indicated support for using VR to reduce state anxiety. We continued to the main study.

Priming phase. Trier Social Stress Test (TSST) is a test that increases psychological stress in a laboratory setting. The test was adapted to fit the requirements of the current study and the university's ethics committee requests. Participants were told that they would be recorded for the duration of the priming phase. An audio recording device was then placed on the table in front of them. The administrator then said, "you are to deliver a 5-minute speech describing why you would be a good candidate for your ideal job". The participant had to

speak for the entire 5 minutes. At the end of the 5-minutes speech, the administrator read the following script to the participant: "Now you will have to participate in a 3-minute arithmetic task. You will be asked to sequentially subtract the number 13 from 577. You will verbally report your answers aloud, and be asked to start over from 577 if a mistake is made. Your goal is to try and reach 0. Your time begins now". If the participant made a mistake the administrator prompted them with, “that is incorrect, please start over from 577”.

Intervention phase. Participants were randomly allocated into two groups for 8 minutes, namely: VR condition or Reading Condition (control condition), so as to destress after taking the TSST. In the VR condition, participants used a VR headset and noise cancelling headphones to watch an interactive video on Hawaii. Participants were completely immersed into this virtual reality setting as they perceive a 360-degree view of what is around them by merely turning their head. With the aid of surround sound noise cancelling headphones, participants could hear directional sounds as if they were in the real-life setting. In the reading condition, participants were presented with several neutral extracts from the student and faculty magazine and advised that they had eight minutes to read it but that they did not have to finish reading it and could take their time to browse through the articles. (Research indicates that reading fictitious articles or topics that the reader enjoys can assist in causing a “safe haven” for them as they mentally immerse themselves into the reading, thereby disconnecting themselves from the external real world [Johnson et al., 2013]).

Debriefing. Following the experiment, participants were debriefed and notified that the experiment was testing stress and the effects of VR on stress reduction. They were also informed that they were not recorded and that the priming phase had been aimed at increasing stress levels for the purpose of the study.

Main experiment. Prior to commencement, participants were asked to read the study’s explanatory statement. Those allocated to the VR condition were provided with an opportunity to become familiar with the device. Participants then completed an online-based survey (Qualtrics.com), which contained the consent form, demographic information, the DASS-21 and the MC-SDS. On completion, participants were then administered the priming task (TSST) followed by the State-Trait Anxiety Inventory (STAI-Y) as a pre-test. Upon completion, participants were presented with the intervention. After 7-minutes, participants were asked to answer the STAI-Y this time as a post-test beyond the intervention. They were then debriefed and thanked for their participation in the research study.

Study design and ethics approval.

This experimental utilised a 2×2 mixed design ANCOVA to assess if participants in the VR condition would have significantly lower scores in state anxiety than those in the reading condition at the post test level. The independent variable was the intervention (VR and reading condition) and the dependant variable was the STAI levels (pre/ post). The co-variate was depression. This study was approved by the University’s Human Research Ethics Committee.

Results

Data cleaning. The dataset was checked for errors, and missing data. No changes were needed to meet ANCOVA conditions. The DASS-21 pre-test showed relatively high levels of depression (M = 12.43, SD = 4.64) and high levels of anxiety (M = 11.17, SD = 3.29)

The main hypothesis that VR would be more effective in reducing state anxiety than RT, was supported. A repeated measure analysis of covariance (ANCOVA) was employed to compare each participant's state anxiety levels between Time 1 and Time 2 on the VR and reading conditions. The covariate of depression was included so as to control for its effects on the post-test scores.

The ANCOVA indicated that, after controlling for depression, a significant main effect occurred of time on STAI-Y scores, $F(1,27) = 5.30$, $p = .029$, $\eta^2 = .164$. A non-significant interaction was observed between time and depression, $F(1,27) = 0.16$, $p = .901$, $\eta^2 = .001$. A significant interaction was observed between time and group, $F(1,27) = 431.14$, $p < .001$, $\eta^2 = .410$.

Univariate analyses were then run to break down the significant interaction of time and allocation as a means to check where the differences lay. At time 1 no significant difference was noted between the VR (M = 48.45, SD = 3.30) and RT (M = 47.48, SD = 3.54) conditions on STAI-Y scores, $F(1,27) = 0.04$, $p = .84$. At time 2 a significant difference was found between the VR and RT conditions, $F(1,27) = 5.64$, $p = .025$ where the VR group showed significantly lower levels of state anxiety (M = 33.56, SD = 9.17) than the RT group (M = 44.00, SD = 13.00). Therefore, the hypothesis that the VR condition would significantly reduce state anxiety levels compared to the reading task was supported (Figure 1 shows the results graphically). The hypothesis, that VR would significantly help reduce anxiety, was strongly supported, while reading RT also showed a significant reduction in anxiety.

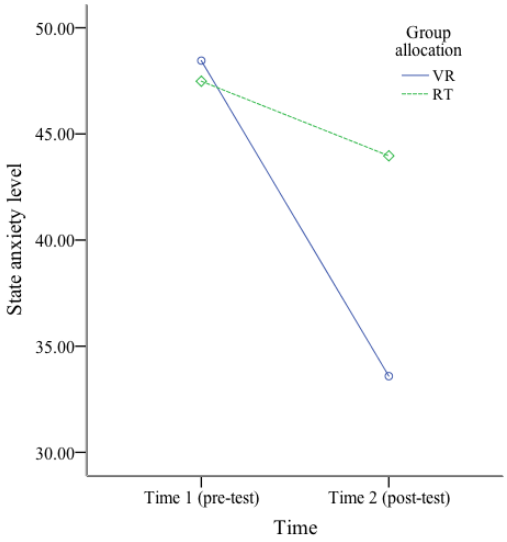

Figure 1. Change in state anxiety levels (pre/post) between the two conditions (VR and RT).

Discussion

The current study examined whether VR can offer an alternative approach to managing anxiety, more specifically, state anxiety while controlling for depression. The main hypothesis tested whether VR is more effective in reducing state anxiety than reading while controlling for depression. It was observed that both conditions (VR and RT) resulted in significantly reduced state anxiety levels, although, when the difference in anxiety reduction between the two conditions was compared, it was evident that VR caused a significantly larger decrease in anxiety levels than that of the RT. Considering that the RT was the control condition, a significant decrease in anxiety levels was still achieved. This decrease was not an expected result in the current study.

A possible reason for the difference in anxiety scores between the two groups could be because using VR and noise cancelling headphones allows the user to become completely disconnected from their surrounding environment as opposed to being partially disconnected as in the case of reading.

This result adds to the growing body of research supporting the use of VR towards wellbeing, specifically anxiety (e.g. Maples-Keller et al., 2017; Wiederhold et al., 2014). The VR methodology is a positive tool that is more affordable and more readily available than traditional therapy- and can be a useful aid in reducing anxiety.

Feasibility of mobile VR integration in mental healthcare

With the cost associated with owning smartphones decreasing over the years, it is probable that the use of VR as a treatment for various mental disorders will increase in future, providing high quality treatment programs and opportunities for experimental research (Maples-Keller et al., 2017).

Some of the disadvantages associated with the use of VR were identified and subsequently discussed in this study. First, only Samsung phones released after 2015 are compatible with the mobile VR headset, Gear VR. That makes the target population limited, as there is a large proportion of people using smartphones that are currently not compatible with any VR headsets. However, as the technology continues to improve, it is predicted that companies will create more smartphones compatible with different VR headsets and therefore make it accessible for all smartphone users in the future.

The second issue is the cost associated with running mobile VR. Whilst the headset itself is not overly expensive, in order to power the device, the user has to own a compatible smartphone that costs around $600 USD. However, where the smartphone is owned, the associated cost of purchasing a VR headset is not high when compared to the price of a computer-run or stationary VR.

The third issue is the health side-effects that users can experience whilst using the headset. Although none of the participants exhibited any of the symptoms associated with cyber-sickness (e.g. nausea, dizziness) in the current study, previous literature has identified this as a factor regarding the feasibility of incorporating this device in daily lives. The noise-

cancelling headphones may moderate these effects. As cyber-sickness is thought to occur due to sensory mismatch between what the user sees and hears, noise cancelling headphones were utilised in the current study to try and prevent this mismatch. The headphones aided in cancelling out noise from around the user completely substituting it with auditory stimuli solely from the VR headset, which appears to have assisted in preventing the user from experiencing sensory mismatch.

Limitations and future research

One limitation of the current study was that trait anxiety scores were not controlled for in the current study when measuring state anxiety. As the current study assessed the capability of VR in reducing state anxiety in participants, controlling for trait anxiety would have helped provide a clearer result in regard to the state anxiety change.

The current study demonstrated the efficacy of using VR to reduce anxiety among university students and hence warrants further research on this topic using larger samples. This study utilised an "experience" application where the user was able to explore different islands of Hawaii. Although the video showed a significant decrease in participant anxiety levels, it was not developed for the purpose of decreasing anxiety. This information could be used to develop an application specifically for people suffering from anxiety. Further, future research could focus of creating different environments and testing whether the applications (videos) contributed to the decrease in anxiety levels and if so, identifying how much of this decrease was accounted for by the application as opposed to the device. Future research could also compare VR to the more traditional treatment options, such as mindfulness or cognitive behaviour therapy. Outcomes of such a result could be especially beneficial for those reluctant to seek out professional help.

Applications and value of the current study

The current study identified a working method using VR to reduce state anxiety levels in university students based on information achieved from the pilot and main study. The results achieved in the current study suggest that VR has the capability of being integrated into university students' lives and through more research in a clinical setting. The use of VR in clinical settings could benefit clinicians and clients if it proves to be as effective as it was in the current study. Creating guided and interactive self-help activities which the patient can work through independently wherever they are would be a useful tool to tackle anxiety (Hoifodt et al., 2013). The use of VR technology would also make it more appealing for the general population suffering from mental health issues who may avoid seeking out professional help due to stigma associated with mental health, or financial and time constraints.

Conclusion

The current study demonstrated VR to be an effective tool to help reduce state anxiety levels and it did this while controlling for depression. VR decreased state anxiety levels significantly, and significantly more so than participants in the reading condition. This study adds to the growing body of evidence supporting VR as an effective tool to use in terms of

improving individuals' daily life and wellbeing. More studies are needed on the use of VR in wider populations but there is strong evidence in the reported study showing the potential value in its use. VR methodology looks set to make a highly significant contribution to increased positive mental health.

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