Advance Access publication on 28 November 2019
doi: 10.1093/iwc/iwz033

Augmented Experiences: Investigating the Feasibility of Virtual Reality as Part of a Workplace Wellbeing Intervention

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This exploratory experiment tested the effect of two virtual reality (VR) relaxation interventions on measures of physiological arousal and affect, compared to a control. Forty-nine participants were randomly assigned to one of three conditions, all using the Oculus Rift. Participants wore a heart rate (HR) monitor and completed pre- and post-test surveys, including the positive and negative affect schedule, Likert-type and open feedback questions. Mixed repeated measures ANOVAs revealed significant reductions in HR and affect over time across all conditions, with a significant interaction identified for the breathing condition's effect on negative affect. Participants were able to identify feeling relaxation, as well as influencing factors. Further, the majority expected, and supported, the introduction of VR interventions in their workplace and/or college, with privacy being a common concern. These results demonstrate the potential of VR augmented relaxation interventions with recommendations for further study provided.

RESEARCH HIGHLIGHTS

- VR can potentially provide wellbeing interventions with a uniquely immersive quality
- Results suggest interactive and immersive VR experiences may facilitate relaxation and reduce stress
- Participants believe there may be substantial benefits to having VR wellbeing interventions at work and college.

Keywords: virtual reality; usability testing; sound-based input/output; auditory input; visualisation techniques; psychology

Handling Editor: Timothy Bickmore

Received 18 July 2018; Revised 28 February 2019; Accepted 6 September 2019

1. INTRODUCTION

Globalisation and ever-increasing interconnectivity is pushing many businesses, workers and students towards a 24/7 work-place, with intensified demands for efficiency, evaporating job security and entirely new forms of work and working patterns (deVries and Wilkerson, 2003; Lewis *et al.*, 2007; Todd and Binns, 2013). While some modern developments have brought forward improvements and advantages (e.g. the amount of information freely available on our computers and smartphones instantaneously), there is evidence linking technology to detrimental effects on the 'work-life balance' (WLB) of workers.

The traditional hours of the "nine to five" work week are no longer the norm (Currie and Eveline, 2011). While there was once an obvious spatial separation between "work"—a place full of technical equipment, filing cabinets of documents or the like—and "home", devices like laptops bring most tools of the trade to the living room along with the expectation of continuous availability to work anywhere, anytime (Ladner, 2008; Merecz and Andysz, 2014).

There is now research highlighting WLB concerns in a wide array of jobs and professions ranging from public sector agencies (Todd and Binns, 2013), to education (Yadav, 2014), and online marketing (Ladner, 2008). Similar effects can be seen outside of employment, with tertiary students also being vulnerable to the effects of poor WLB (Lovell *et al*., 2015).

While not always the most influential factor, issues such as long work hours and other work-related stressors are commonly found to be detrimental to subjective wellbeing (SWB). Indeed, in the Australian Psychological Society's 2014 edition of the "Stress and wellbeing in Australia survey", it was found that one-in-four Australians reported moderate-to-severe levels of stress, with 44% of the 1020 respondents rating issues in the workplace as a source of stress (Casey and Liang, 2014). This is in addition to a significant decline in participants' satisfaction with their WLB and overall workplace wellbeing, job interest and job satisfaction, compared to 2011 levels (Casey and Liang, 2014). Lovell *et al*. (2015) found that tertiary students had depression, anxiety and stress scores higher than the population norm, with 39.8% found to be at mild or higher on at least one of the depression anxiety stress scales (DASS-21) subscales.

Management and policy makers have shown an increasing interest in WLB research in recent decades, as a result of factors including the increasing push for occupational health and safety regulation (Cox *et al*., 2007), changing workforce composition and labour shortages (Todd and Binns, 2013). This is to say nothing of the desire to appear to be a modern, "caring organisation" in the public eye (Tehrani, 1994). Considering this, deVries and Wilkerson (2003) point out that because mental (rather than physical) labour will be doing the "heavy lifting" in the world of technology, mental health must be recognised as a business resource with greater breadth than simply productivity. Neglecting to properly nurture, this resource can have a very high price to individual workers, e.g., burnout (Mamidenna and Viswanatham, 2014) and in turn, organisations, with per annum cost estimates of stress in the USA ranging from $42 to $150 billion (Kalia, 2002).

To minimise both the personal cost to employees and the financial costs to businesses, researchers and policy makers have turned to organisational level interventions for instigating the most efficient changes. There are three levels of intervention, which Murphy (1988) defines as primary (e.g. stressor reduction), secondary (e.g. stress management) and tertiary (e.g. employee assistance programs/workplace counselling). In instances where primary interventions are too expensive or unfeasible, organisations will usually turn to secondary interventions.

While often not the "first choice", secondary interventions have been found to play an important role in occupational stress reduction (Cooper and Cartwright, 1997; Murphy, 1984) and wellness maintenance, despite concerns that they only tackle the consequences of work stressors rather than the sources (Cooper and Cartwright, 1997). Some examples of secondary interventions are health education and cardiovascular fitness programs for employees (Cooper and Cartwright, 1997), improved day care and flexible hours for caregivers (Yadav, 2014) and improved or alternate routes for employees to express grievances or discontent (Beauregard, 2014). When appropriate, empirically-supported intervention strategies are implemented in a work culture and climate that is supportive of employees using them, there can be positive gains for the organisation and employees (Smith and Gardner, 2007).

One of the most universal workplace interventions is the break. Hunter and Wu (2015) describe several factors that lead to improved levels of post-break resources, such as preference for break activity and taking earlier, rather than later, breaks. They also provide evidence showing that workers feel less emotional exhaustion and more job satisfaction post-break. This research suggests that the relaxation that takes place during 'break time' is a promising area to investigate.

Relaxation and meditation techniques are found to be beneficial interventions for both clinical and sub-clinical psychological health and wellbeing (Ando *et al*., 2009; Arias *et al*., 2006). Such techniques can be passed on to a client without requiring a great deal of training, with a goal of client self-practise. Clients unable to attend regular relaxation sessions may also see benefit from an easy to learn 'practise by yourself' technique', and those who fear judgement in their workplace may be more likely to take up a less overt intervention over traditional employee assistance programs. Given the benefits, it is prudent then to examine easy to pick up relaxation techniques.

An area of study that is showing potential for supporting wellbeing, and that allows for easy to pick up self-directed techniques, is virtual reality (VR). Valmaggia *et al*. (2016) have conducted an extensive systematic review of the use of VR in psychological treatment, finding that on average, VR is at least as effective as traditional treatments. A prior systematic review by Gonçalves *et al*. (2012) found that VR treatments for PTSD are at least as efficacious as traditional CBT. Anderson *et al*. (2013) also found that improvements shown by participants undertaking a VR social anxiety treatment were maintained at a 12-month follow-up and were in line with benefits shown by participants who received group therapy instead. A recent pilot study trialling a Dialectical Behavioural Therapy (DBT) mindfulness skills training technique using VR found that participants reported significantly less sadness, anger and anxiety, and were significantly more relaxed after using the VR technique for 10 minutes (Navarro-Haro *et al*., 2017). Other clinical uses of VR investigated in recent years vary broadly in topics from the treatment of sexual assault survivors (Loranger and Bouchard, 2017), to the recovery of stroke patients (Lohse *et al*., 2014). Such is the promise of VR therapy that the development of advanced tools is already being undertaken by authors such as Tartarisco *et al.* (2015), who tested a model to provide clinicians with objective measures of user stress.

While the study of VR as a mindfulness meditation aid is still a developing one, there have been studies into the creation of dedicated VR meditation software, for example Kosunen *et al.* (2016), which included neurofeedback as a feature. However, many of these kinds of programs are not easily available to the general public, or require specialised equipment such as an electroencephalogram device. Wellness maintenance beyond the realm of clinical interventions has been examined for some time now, with "positive computing" or "positive technology" proponents (e.g. Riva *et al.*, 2012) advocating the examination of how affective quality, engagement and connectedness can be improved or introduced at core design levels of technology itself, rather than as an afterthought or separate product. Beyond clinical applications, VR is being studied in workplaces settings, for example Müller *et al.* (2017) simulated a collaborative hybrid task with a virtual robot collaborator in a VR workplace setting and investigated its impact on stress.

VR interventions can bring something unique to the table: a very strong sense of 'presence' that limits distractions from the real world (Giglioli *et al.*, 2015), resulting in a highly immersive experience (Howard, 2018; Valtchanov *et al.*, 2010). The use of VR stress reduction interventions in workplaces is already starting to be explored in pilot studies such as Ahmaniemi *et al.* (2017), who compared a series of VR nature experiences to an audio only comparisons to test which had the greater relaxing effect. It is important then that behavioural scientists and practitioners, working hand-in-hand with Human–Computer Interaction (HCI) experts, critically examine the unique potential of new technology-based VR tools, not only by using objective measures of stress reduction, but also by collecting qualitative feedback on the user experience to inform best-practice interventions. There is little point, after all, to developing an objectively beneficial intervention if your target population cannot, or will not, take advantage of it.

One recent example of the combination of VR technology and relaxation is the program 'SoundSelf', created by Arnott and Balster (2015a). Inspired by traditional meditation and mind-altering experiences, 'SoundSelf' was created specifically as an interactive meditation-aid VR experience. 'SoundSelf' allows a user to interact with and change the 'tunnels-of-light' and 'impossible shapes or patterns' that appear on the display, either by voicing different sustained tones/sounds/chants, or by being silent. This style of chant-based meditation has its roots in traditions such as Buddhist and Hindu techniques and is suggested by Arnott to aid introspection and facilitate a mindfulness experience (Arnott and Balster, 2015b). 'SoundSelf's ease of use and simple immersive and interactive design means it has potential to be a useful example of a consumer relaxation tool, however, it has yet to be empirically tested.

1. AIM AND RATIONALE

Given the potential for VR as a mindfulness meditation aid (Crescentini *et al.*, 2016), its ease of use and ability to provide a highly immersive and interactive experience (Valtchanov *et al.*, 2010; Howard, 2018), the current study investigated the feasibility of using VR in a break-time intervention aimed at improving wellbeing in the workplace and at college. 'SoundSelf's' interactive "augmented relaxation" design presents the opportunity to investigate whether an immersive VR experience, that is also interactive, can be an effective relaxation technique for improving wellbeing, compared to an immersive, but non-interactive, VR experience. Qualitative feedback on the user experience will address a gap in the literature regarding the suitability of VR interventions in the workplace, and help inform and direct future directions in this area of study.

2. RESEARCH QUESTIONS

1. Is an interactive and immersive VR meditation experience more effective for promoting wellbeing, than a non-interactive, traditional guided breathing exercise, combined with an immersive VR visualisation display?
2. Do either of these conditions significantly improve wellbeing compared to a non-interactive and non-immersive control?
3. What are participants' understandings, expectations and beliefs about the future of VR technology, as a foundation of relaxation interventions?

3. METHOD

3.1. Design

This exploratory study utilised a mixed methods design to examine the effects of an interactive and immersive VR program designed to promote meditative relaxation, compared to a non-interactive traditional breathing exercise with immersive VR elements, and a control (IVs), on participant heart rate (HR) and affect (DVs).

3.2. Participants

Forty-nine adult, non-clinical, volunteers (28 male, 21 female) were drawn from a convenience sample of college students and members of the general public. Recruitment efforts consisted of posting an invitation to participate on an in-college website, and snowball sampling via a social media page (Facebook), which was spread via word of mouth. Participation was subject to the following exclusion criteria: potential participants with serious visual and/or auditory disabilities; conditions that would prohibit taking deep breaths; or any form of visually triggered epilepsy. Participants who met any of these criteria were excluded on the basis of risk to the participant and/or concerns about ability to complete the tasks required of the study. Those under the age of 18 were also excluded due to the population of interest being adults.

Participants who did not meet exclusion criteria were then randomly assigned to one of three groups: 16 (11 male and 5 female) in the 'SoundSelf' condition, 16 (6 male and 10 female) in the breathing condition and 17 (11 male and 6 female) in the control condition. Participant ages ranged from 18 to 50 with a mean age of 27.33 (SD = 6.96) and a median age of 26. The mean age for males was 29.43 (SD = 7.91) and 24.52 (SD = 4. 17) for females, with median ages of 28 and 24, respectively.

3.3. Materials

All sessions took place in a spare office located within the administration area of the college and were finished with everyday office furniture. An Oculus® Rift™ Development Kit 2 (Oculus VR, LLC, Menlo Park, CA, USA) was used in all conditions, in conjunction with a Windows 7 laptop. The 'SoundSelf' condition (see Fig. 1 for a visual example) used a 20-minute version of the interactive and immersive meditation program of the same name (SoundSelf alpha build 2015-06-10). The breathing condition (see Fig. 2) used the audio component of a guided breathing exercise from Cura smile YouTube channel (2013) "relaxation breathing guided", that had been edited in-house, so that it was 20 minutes in duration. This was combined with visuals generated using VisiR (version 0.7.5) from Valynx Studio (2015), to create an immersive, but not interactive, experience. This program created visuals that changed colour and pattern in response to the paired audio (rather than controlled by user input) to create a visual experience of a comparable nature to what can be found in 'SoundSelf' (i.e. both programs involve the user being immersed in a void of colourful lights and sound). Participants in the control condition were shown a portion of the "Rainy Day Office Window" video from Jason Comerford Photography YouTube channel (2015), that had been edited in-house, so that it was 20 minutes in duration (see Fig. 3). The video featured a fixed position 2D view focusing on a tree and its leaves on a rainy day, with a streetscape background. This condition was chosen as it involved participants wearing the same VR setup and being exposed to a relaxing experience (comparable to Valtchanov et al., 2010), without the immersive or interactive VR aspect.

HR was monitored using a Fitbit® Charge HR™ (Fitbit Inc., San Francisco, CA, USA) wearable wireless activity tracker (comparable with Main et al., 2017). HR tracking was important to include as it provides an objective measure of participant arousal during the experiment (Chlan, 1998; Crescentini et al., 2016; Kao et al., 2014). Data points were generated in the form of average HR over each five-minute segment.

Participants were asked to complete pre- and post-test surveys. The pre-test survey contained simple demographic questions (e.g. age, gender), as well as the positive and negative affect schedule (PANAS; Watson et al., 1988). The PANAS is one of the most widely cited and diversely used inventories of its kind (Harmon-Jones et al., 2009). Along with providing normative data, the PANAS reports reliability scores of $\alpha > 0.80$ for both the positive affect (PA) and negative affect (NA) scales, and significant stability in scores even in "moment-to-moment" ratings (Watson et al., 1988). The PANAS was used to measure changes in participant affect, as a signifier of relaxation. A Stroop test was adapted based on the original design by Stroop (1935), using the colours red, blue, green, brown and purple to create an ordered table of 100 answers in tandem with a PowerPoint presentation. The test (i.e. the PowerPoint presentation) itself, was controlled entirely by the investigator: the participant was only required to respond verbally to this task. The use of the Stroop test here warrants further explanation: instead of being used as a diagnostic measure (e.g. examining

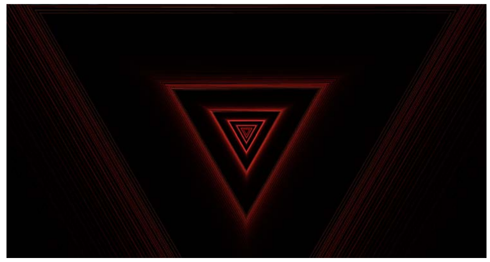

FIGURE 1. Screenshot from the 'SoundSelf' condition.

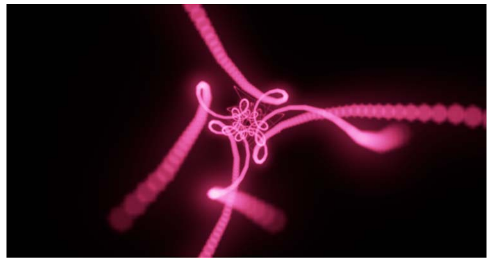

FIGURE 2. Screenshot from the breathing condition.

FIGURE 3. Screenshot from the control condition.

attention or executive function) the Stroop test provided an initial "stressed" pre-test HR benchmark to better examine the effect of the experimental manipulations (similarly used in Kao *et al*., 2014; Reinhardt *et al*., 2012). The results of the Stroop test (i.e. number of correct responses within the 2-minute time limit) were given to each participant, but were not analysed due to the test only serving the function of a stressor.

The post-test survey contained several Likert-type and open-response qualitative questions composed in-house by the authors, asking participants how they felt after using the Oculus Rift (compared to how they felt beforehand), as well as usability-related queries and the use of VR in workplaces and other applications (see online supplemental material for wording of qualitative questions). The PANAS was included a second time for the post-test, however, the instructions were modified to ask participants to consider the time from the start of the VR experience until the present. All surveys were hosted online using Qualtrics® (Qualtrics LLC, Provo, UT, USA) with all data analysed using IBM® SPSS® (Version 23.0 for Windows; SPSS Inc., Chicago, IL, USA).

3.4. Procedure

Each experimental session was conducted by a single investigator in the same office, using the same equipment. All studies took place during weekdays between the times of 11:00 am and 05:00 pm. In all cases, the time spent using the Oculus Rift was strictly kept to 20 minutes. Each participant was seated in an office chair and fitted with the Fitbit activity tracking device and asked to complete the pre-test self-report surveys on a computer. These surveys were hosted online and accessed via a standard internet browser. Once the survey was completed, participants were asked to complete the PowerPoint-based Stroop test.

Participants were then randomly allocated into one of the three experimental conditions: the 'SoundSelf' condition, the breathing condition or the control condition. Participants were not made aware of this selection, or the existence of alternate conditions, until after the experiment. Participants were given a short general briefing on how to comfortably and safely use the Oculus Rift (e.g. "you do not have to sit completely still, you may look around") before being given specific guidance and tips for their selected condition. To ensure greater reliability, all guidance and instruction was based on a script prepared by the authors, however, to avoid an overly artificial experience for the participants, it was not followed verbatim. Participants were fitted with the Oculus Rift headset and headphones by the investigator, and then used the Oculus Rift for the 20-minute duration of their assigned condition while their HR continued to be recorded. The investigator waited outside the room to give participants privacy for the duration of the condition component.

At the end of the 20-minute session, the investigator returned and removed the Oculus Rift and headphones from the participant. Each participant was then asked to complete the post-test online inventory while continuing to wear the Fitbit. Once the participant had completed the post-test survey, the Fitbit was removed by the investigator and the participant was debriefed on the experiment.

3.5. Statement of ethics compliance

Approval from the Human Research and Ethics Committee (HREC) was sought and granted (approval #222040615). All participants gave written consent to take part in the experiment.

4. RESULTS

4.1. Physiological arousal (heart rate)

Averages of participant HR data points were taken for the three parts of the experiment: the pre-test (including the Stroop task), during the intervention (test) and post-test. They were then analysed using a 3 (condition) × 3 (time) mixed repeated measures ANOVAs ($\alpha = 0.05$) with intervention condition as the between-groups factor with three levels: the 'SoundSelf' condition ($n = 16$), the breathing condition ($n = 16$) and the control condition ($n = 17$).

A significant main effect was identified for the differences in HR means across time, as shown in Table 1, with a large effect size of $\eta_p{}^2 = 0.57$. This suggests that participant HR changed over time in a way that was consistent across all conditions, and that the change in HR was not dependent on belonging to a specific condition. Mauchly's test of Sphericity returned a non-significant value of $W = 0.950$ (2), $P = 0.317$, indicating that the assumption of equal variances was not violated.

Pairwise comparisons using a Bonferroni correction for familywise error rate ($\alpha = 0.05$) revealed a significant decrease in HR at pre-test ($M = 85.70$, SD = 12.53) compared to during the intervention ($M = 78.75$, SD = 11.93), $t(46) = 9.99$, $P < 0.001$, $R^2 = 0.68$, and between pre-test ($M = 85.70$, SD = 12.53) and post-test ($M = 78.45$, SD = 10.58), $t(46) = 8.75$, $P < 0.001$, $R^2 = 0.62$. There was no significant difference in mean HR recorded during the intervention compared to post-test.

4.2. Affect (PANAS)

Participant scores on the PANAS were obtained during pre- and post-test surveys and were then analysed for each subscale using two separate 2 (time) × 3 (condition) mixed repeated measure ANOVAs ($\alpha = 0.05$). The intervention condition was between groups factor with three levels: the 'SoundSelf' condition ($n = 16$), the breathing condition ($n = 16$) and the control condition ($n = 17$).

TABLE 1. Summary of ANOVA results for HR.

Test	Effect	*df*	*F*	*P*	η_p^2
Heart rate	Time	2	59.90	***	0.57
	Condition	2	2.31	0.11	0.09
	Time × condition*	4	1.86	0.12	0.08

$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P \leq 0.001$.

TABLE 2. Summary of ANOVA results for PANAS.

Test	Subscale	Effect	*df*	*F*	*P*	η_p^2
PANAS	Positive	Time	1	11.85	***	0.21
		Condition	2	1.37	0.26	0.06
		Time × condition*	2	1.70	0.19	0.07
	Negative	Time	1	14.26	***	0.24
		Condition	2	1.46	0.24	0.06
		Time × condition*	2	5.60	**	0.20

$^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P \leq 0.001$.

4.2.1. *Positive affect (PA)*

A significant moderate main effect ($\eta_p{}^2 = 0.21$) was found for time and can be seen in Table 2. This suggests that taking part in any condition resulted in a significant reduction in reported PA scores from pre-test ($M = 28.67$; SD $= 7.37$) to post-test ($M = 25.02$; SD $= 7.94$).

4.2.2. *Negative affect (NA)*

As can be seen in Table 2, a significant main effect was found for time. This suggests that, holding the effect of condition constant, there was a significant reduction in reported NA between pre-test ($M = 13.45$; SD $= 2.61$) and post-test ($M = 11.76$; SD $= 2.98$). An interaction effect of moderate ($\eta_p{}^2 = 0.20$) size was identified between condition and time for NA and explored using tests of simple effects, using a Bonferroni correction for familywise error rate ($\alpha = 0.05$). A significant reduction was found between pre-test ($M = 14.56$; SD $= 3.41$) and post-test ($M = 10.75$; SD $= 1.39$) means for the breathing condition, Wilk's $\lambda = 0.664$, $F(1, 46) = 23.24$, $P < 0.001$, $\eta_p{}^2 = 0.34$, but not for the 'SoundSelf' or control condition.

4.2.3. *Frequencies and qualitative questions*

4.2.3.1. Responses describing participants' subjective feelings of relaxation. Upon finishing the 20-minute intervention, participants were asked an open-ended question regarding their experience, in order to gauge their first impressions before they were exposed to any other questions. Common responses were identified using a thematic analysis and combined into themes (see Table 3).

When asked directly to compare how they were feeling before using the Oculus Rift to the present, 44 (89.80%) participants described feeling either slightly or much more relaxed, with only two (4.08%) feeling slightly more stressed after the intervention (Table 4). Broader subjective responses regarding relaxation provided similar results, with 14 (28.57%) responses indicating themes describing "Mixed or small amount of relaxation" and 31 (63.27%) reporting confirmed feelings of relaxation after the intervention (Table 5).

When examining for any feedback that indicated a possible detriment to a participant's ability to relax, two questions were presented: one asking explicitly about any stimuli or parts of the intervention that made participants feel like they wanted to close their eyes, and one more general and open-ended question about any negative influences. The results of these questions have been combined in Table 6.

Participants were given the chance to comment on what, if any, changes they felt could be made to the intervention they experienced to improve relaxation. Several different areas for possible improvement were identified, including a subtheme that developed around the importance of pairing the right style of intervention with the right client and giving users the ability to exercise their preferences (see Table 7).

4.2.3.2. Responses describing participant expectations for the future. Several Likert-type questions were presented asking participants about their thoughts on the future use of VR and similar technologies. Participants were asked about the value of developing 20-minute wellbeing interventions that could be used at work or college, with 31 (63.27%) participants believing it is an area worth developing, and three (6.12%) expressly disagreeing. Response frequencies can be found in Table 8 below.

When asked if they would take up the offer of a free 20–30 minute VR relaxation intervention if it was offered at their workplace or college, 29 (59.18%) participants said yes. This support jumped to 42 (85.71%) if concerns such as

TABLE 3. Themes and frequencies for the "first impressions" question.

Theme	Condition	Frequency	Percent
"Interesting/intriguing/memorable/cool"	SoundSelf	10	62.50%
	Breathing	6	37.50%
	Control	3	17.65%
	Total	19	38.78%
"Positive/good/enjoyable/comfortable"	SoundSelf	5	31.25%
	Breathing	10	62.50%
	Control	4	23.53%
	Total	19	38.78%
"Relaxing/calming"	SoundSelf	7	43.75%
	Breathing	9	56.25%
	Control	11	64.71%
	Total	27	55.10%
"Surreal/mind-altering/time perception"	SoundSelf	6	37.50%
	Breathing	7	43.75%
	Control	2	11.76%
	Total	15	30.61%
"Negative/bad/concerning"	SoundSelf	8	50.00%
	Breathing	8	50.00%
	Control	7	41.18%
	Total	23	46.94%

TABLE 4. Frequencies regarding post-test feelings of relaxation and stress[a].

Likert-type responses	Condition	Frequency	Percent
"Much more stressed than relaxed"	SoundSelf	0	0%
	Breathing	0	0%
	Control	0	0%
	Total	0	0%
"Slightly more stressed than relaxed"	SoundSelf	2	12.50%
	Breathing	0	0%
	Control	0	0%
	Total	2	4.08%
"Roughly even mix of feeling stressed and relaxed"	SoundSelf	2	12.50%
	Breathing	0	0%
	Control	1	5.88%
	Total	3	6.12%
"Slightly more relaxed than stressed"	SoundSelf	7	43.75%
	Breathing	7	56.25%
	Control	9	52.94%
	Total	23	46.94%
"Much more relaxed than stressed"	SoundSelf	5	31.25%
	Breathing	9	56.25%
	Control	7	41.18%
	Total	21	42.86%

[a]Participants were asked "since starting the program on the Rift I have noticed feeling".

TABLE 5. Themes and frequencies regarding achieving relaxation.

Theme	Condition	Frequency	Percent
"Did not feel the condition induced feelings of relaxation"	SoundSelf	3	18.75%
	Breathing	0	0%
	Control	1	5.88%
	Total	4	8.16%
"Mixed feelings/small amount of feeling relaxed"	SoundSelf	5	31.25%
	Breathing	5	31.25%
	Control	4	23.53%
	Total	14	28.57%
"Confirmed feelings of relaxation after intervention"	SoundSelf	8	50.00%
	Breathing	11	68.75%
	Control	12	70.59%
	Total	31	63.27%

privacy could be met. Participants were also asked if they would recommend the intervention they experienced to help deal with stress, with 31 (63.27%) happy to recommend the program they used, even in its prototype form. This figure rose to 39 (79.59%) when combined with responses that would recommend the program after it has been improved and finalised. Moving beyond their own potential uses, when asked if they would support the introduction of VR relaxation interventions in their college or workplace, only one person (2.04%) said that they would object. Full support was indicated by 26 (53.06%) participants, and 22 (44.90%) said that they would support it on the condition that it was offered in a location with privacy in mind.

Participants were given the option to select any number of four categories of workplace relaxation intervention types that they would engage with at work or college if given the chance: traditional relaxation activities conducted either alone or in a group, or VR-based relaxation conducted alone or in a group. A one-way chi-square test revealed a significant preference for interventions conducted alone over those in a group setting, χ^2 (1, $N = 110$) = 10.51, $P = 0.002$; however, there was no significant difference in preference between VR and traditional interventions. A two-way chi-square analysis revealed no significant associations between the choices. Participant feedback on these choices was analysed and three main themes and their frequencies have been presented in Table 9 below.

5. DISCUSSION

In the most general terms, the results presented in this exploratory study indicate that all experimental conditions had a positive effect on participants' level of physiological arousal, but it cannot be conclusively stated that VR was the primary causal factor. Research questions 1 and 2 asked which of the interactive and immersive conditions were more effective and whether either was more effective than the non-interactive and non-immersive control condition. While there was support for the breathing condition being more effective in reducing negative affect, neither research question could be definitively answered by the quantitative results. In answer to research question 3, participants reported subjective feelings of relaxation in all conditions and were generally positive about the potential for VR relaxation interventions in the workplace. Detailed discussion of the quantitative and qualitative results follows below.

5.1. Physiological arousal (heart rate)

HR was found to decrease significantly from pre-test levels, compared to during the intervention, and continue at a significantly lower level until post-test for all three conditions. A raised HR is an indicator of physiological arousal and is often experienced alongside feelings of psychological stress and strain (Chlan, 1998; Kao *et al.*, 2014; Reinhardt *et al.*, 2012). It is therefore reasonable to argue that a reduction in HR represents lower stress, or greater relaxation. Based on HR data points collected and participant verbal feedback, the Stroop test did appear to be an effective aid in the establishment of an elevated pre-test HR, which was theorised to help the investigation of any relaxing effects of the interventions (i.e. it would not have been possible to demonstrate any relaxing effects of an intervention if the participant was already completely relaxed).

The non-significant effects of condition on HR may suggest that the 'SoundSelf', breathing, and control interventions were comparatively equal in their ability to lower physiological arousal. However, in light of the strong effect size for the main effect for time, it must also be acknowledged that this study is unable to definitively state that the reduction in HR is a result of the intervention, instead it may have been caused by some other factor (e.g. sitting in a chair for 20 minutes). It is

TABLE 6. Themes and frequencies for negative influences on achieving relaxation.

Detriment	Theme level	Theme	Condition	Frequency	Percent
Eye-closing	Themes	"Did not close eyes (other than natural blinking)"	SoundSelf	5	31.25%
			Breathing	5	31.25%
			Control	2	11.76%
			Total	12	26.53%
		"Wanted to or closed eyes for negative/discomfort reasons"	SoundSelf	6	37.50%
			Breathing	5	31.25%
			Control	2	11.76%
			Total	13	26.53%
		"Wanted to or closed eyes for positive/relaxation reasons"	SoundSelf	2	12.50%
			Breathing	3	18.75%
			Control	3	17.75%
			Total	8	16.33%
		"Wanted to or closed eyes for mixed or no explicitly positive/negative reasons"	SoundSelf	3	18.75%
			Breathing	4	25.00%
			Control	10	58.82%
			Total	17	36.73%
Negative reasons	Subthemes	"Colour/light/brightness"	SoundSelf	4	25.00%
			Breathing	2	12.50%
			Control	1	5.88%
			Total	7	14.29%
		"Boredom/fatigue"	SoundSelf	0	0%
			Breathing	0	0%
			Control	8	47.06%
			Total	8	16.33%
General detriments	Themes	"Yes: program/visual/audio based detriments"	SoundSelf	3	18.75%
			Breathing	1	6.25%
			Control	4	23.53%
			Total	8	16.33%
		"Yes: physical equipment/environment based detriments"	SoundSelf	6	37.50%
			Breathing	5	31.25%
			Control	13	76.47%
			Total	24	48.98%
		"No detriments to relaxation"	SoundSelf	7	43.75%
			Breathing	10	62.50%
			Control	3	17.65%
			Total	20	40.82%

however reasonable to conclude that the reduction in HR over time is evidence that wearing the VR equipment did not inhibit relaxation, despite the bulky, novel and prototype nature of the device.

5.2. Affect (PANAS)

As reported earlier, there was a significant reduction in mean PA and NA between pre- and post-test measures. The drop in PA shown in all conditions over time may, at first,

TABLE 7. Themes and frequencies for participant suggested changes to interventions.

Theme level	Theme	Condition	Frequency	Percent
Themes	"Changes to program"	SoundSelf	12	75.00%
		Breathing	9	56.25%
		Control	10	58.82%
		Total	31	63.27%
	"Changes to environment"	SoundSelf	6	37.50%
		Breathing	4	25.00%
		Control	4	23.53%
		Total	14	28.57%
	"Changes to physical equipment"	SoundSelf	1	6.25%
		Breathing	3	18.75%
		Control	8	47.06%
		Total	12	24.49%
	"No changes suggested"	SoundSelf	1	6.25%
		Breathing	2	12.50%
		Control	2	11.76%
		Total	5	10.20%
Subthemes	"User choice/preferences"	SoundSelf	2	12.50%
		Breathing	5	31.25%
		Control	4	23.53%
		Total	11	22.45%

TABLE 8. Themes and frequencies regarding the value of developing VR interventions for use in workplaces.

Theme	Condition	Frequency	Percent
"There is value in developing work/college VR relaxation interventions"	SoundSelf	9	56.25%
	Breathing	10	62.50%
	Control	12	70.59%
	Total	31	63.27%
"No/little value in developing work/college VR relaxation interventions"	SoundSelf	1	6.25%
	Breathing	1	6.25%
	Control	1	5.88%
	Total	3	6.12%
"Good idea but there are concerns around its practical use"	SoundSelf	6	37.50%
	Breathing	5	31.25%
	Control	4	23.53%
	Total	15	30.61%

seem strange in the face of claims of improved relaxation. Watson *et al*. (1988) defined low PA scores as potentially indicative of "sadness and lethargy". As no responses suggest that participants felt an increase in feelings of sadness, a possible explanation could be the "lethargy" component. It would make sense that the continued vocal efforts of the 'SoundSelf' condition could result in feeling drained and lethargic, and the control condition's lack of engagement with the user would do little to stimulate. Indeed, 47.06% of participants in that condition reported feelings of boredom or fatigue. However, given the lack of significant difference between conditions, it stands to reason that the cause of the decrease is linked to a common factor across conditions that possesses similarities to lethargy, which in this experiment is likely to be feelings of relaxation. Once again though, more testing is needed to tease out the effects of VR versus simply sitting for 20 minutes.

Interestingly, the significant interaction between condition and time on NA for the breathing condition provides insight into potential differences between the conditions that have otherwise not been demonstrated. It is quite simple to follow the logic that a relaxing breathing exercise could reduce feelings such as "nervousness and fear" (Watson *et al*., 1988) in participants in that condition, and indeed, that is likely what

TABLE 9. Themes and frequencies regarding individual/group/VR/non-VR relaxation.

Theme level	Theme	Condition	Frequency	Percent
Themes	"Concerns around group relaxation, including privacy/stigma"	SoundSelf	6	37.50%
		Breathing	5	31.25%
		Control	6	35.29%
		Total	17	34.69%
	"Disinterested/concerned about VR relaxation interventions"	SoundSelf	5	31.25%
		Breathing	4	25.00%
		Control	2	11.76%
		Total	11	22.45%
	"Interest/enthusiasm about new technology"	SoundSelf	8	50.00%
		Breathing	7	43.75%
		Control	5	29.41%
		Total	20	40.82%

transpired. On a broader level, the breathing condition may represent a kind of 'sweet-spot' among the types of interventions presented.

5.3. General qualitative feedback

As reported previously, 91.84% of participants felt at least slightly more relaxed after the intervention. In addition, 79.60% of participants, over all conditions, could see themselves recommending a finalised, polished, non-prototype version of the interventions to friends or colleagues as an aid to relaxation. Most of the feedback was quite positive:

> *"Yes I would, I found it a relaxing and enjoyable experience and now feel considerably more relaxed than I did before". (SoundSelf participant).*
>
> *"Yes, I felt much more relaxed and even more focused for the rest of my day to come. I think students or employees would benefit from a program such as this to complement their sometimes stressful routines". (Breathing participant)*

However, there were those who were less convinced of the benefit:

> *"No, just because in the long run people will become dependent on this device. It will just become a quick fix or a Band-Aid to the true issue at hand". (Breathing participant).*

Ultimately, the subjective feedback suggests that the majority of participants felt the interventions were beneficial, so much so that most would recommend them to others.

5.4. Key intervention characteristics

Given the results demonstrating a reduction in NA scores for those in the breathing condition, and supposing that relaxation is linked to a reduced score on PA measures, a case can be made that the breathing condition is an example of a relaxation type with similarities to the effort-recovery model (Hunter and Wu, 2015; Meijman and Mulder, 1998), in that it gives users time away from cognitive load to allow their physiological and affective systems to return to pre-stressor levels (i.e. recovery). It is suggested here that the difference between conditions may have been due to two variables: how active or passive the participant was required to be, and what level of engagement the program brought to the user. Following this logic, each condition can be broken down thusly:

- Control: Users were left largely passive as the program offered little engagement
- Breathing: Users could follow and engage with the program or be passive
- SoundSelf: Users were required to actively engage with the program.

Given this, in the case of the breathing condition, the program was permissive in its engagement with the user, in that unlike the 'SoundSelf' condition, the experience did not rely on their interaction and allowed them to just watch the display passively if they preferred. It may be the case that the lack of engagement offered by the control group could not facilitate the disengaging of participants from their stressful cognitive load. In contrast, the 'SoundSelf' condition may have required too much engagement—either with the novel psychedelic nature of the task, or strain resulting from the required vocalisations. Concerns over the possibility of being overheard, and the physiological similarities between fear and excitement, may have further inflated NA responses. There may be, however, another explanation for those who found 'SoundSelf' relaxing.

Sonnetag and Fritz (2007) discuss "diversionary strategies" that lead to psychological detachment from work (i.e. more than ceasing the physical act of working). They go on to propose that while many people find relaxation in activities that require little physical or intellectual challenge, there are those who find beneficial distraction from work in “mastery experiences”, which “challenge the individual without overtaxing his or her capabilities” (Sonnetag and Fritz, 2007, p. 206). It is argued that despite the additional demands on the individual, there is an overall gain in internal resources. Examples of mastery experiences include taking a language class or learning a new hobby. It is possible that learning the ins and outs of a novel intervention such as those in this study would constitute a similar “mastery experience”. The idea that a more engaging relaxation style can have benefits has some support from the experiment feedback:

> *“...in fact I felt compelled to “interact” with the program to see what sort of visual/auditory feedback it provides”. (SoundSelf participant)*

This may also help further explain why the completely passive control condition did not result in greater relaxation. Despite requiring more effort and engagement, the more “active” ‘SoundSelf’ condition appeared to fit the requirement of separating users from both physical and mental work activities (Sonnetag and Fritz, 2007; Hunter and Wu, 2015), as one user explained:

> *“I definitely feel the use of wearable eye piece and headphones is useful in stopping other thoughts and day to day noises from intruding which would help people to relax and become more aware of their body”. (SoundSelf participant)*

The results of this experiment suggest that an effective relaxation intervention must be actively engaging enough to turn users’ thoughts from their stressors, while ensuring it is not so exciting, or taxing, that it becomes a drain on energy rather than a replenishment. But, future developers must also be mindful of users who prefer their relaxation activities to come with a challenge or chance for “mastery experience”.

5.5. Breakdown of participant feedback

It is important to examine what factors promoted and hindered feelings of relaxation to inform future research. Looking at the “first impressions” responses in Table 3, there is a difference between conditions on the frequency of the themes. A majority (62.50%) of SoundSelf users described their experience in ways that fit the theme of “interesting/intriguing/memorable/-cool”, which was much higher than those in the other two groups. This may be a result of people getting something different out of the more active condition than passive relaxation. The majority (62.50%) of those in the breathing condition gave their first impression using language from the “positive/-good/enjoyable/comfortable” theme, highlighting the merit of future investigation into a possible ‘sweet spot’ in terms of required versus permitted user activity. Even though most (56.25%) participants in the breathing condition described their experience as “relaxing/calming”, a greater proportion of those in the control group (64.71%) expressed this kind of sentiment. This difference will likely require a greater sample size to fully tease apart, as well as exploring in deeper ways how participants use words like “relaxing” and “calming”. Over half (55.10%) of participants, regardless of condition, explicitly included “relaxing/calming” themes in their first impressions feedback. This helps built merit to the claim that participants are getting something more from the intervention than simply sitting for 20-minutes, but factors like the placebo effect cannot currently be ruled out.

5.6. Factors aiding relaxation

One potential factor has been identified as assisting participant relaxation: the feeling of separation from the world, which aligns well with Sonnetag and Fritz’s (2007) diversionary strategies and is highlighted as a feature of VR by authors such as Giglioli *et al*. (2015), Valtchanov *et al*. (2010), and Howard (2018). This separation can be seen in participant feedback:

> *“I felt as though the experience helped me to relax because it was like I was alone with my thoughts and the stimuli provided. When the sounds changed to soft tones and the images were light blue or lighter in colour I found it more relaxing than when the sounds were loud and/or fast paced and red or deeper in colour”. (SoundSelf participant)*
>
> *“Sitting back in the chair and being ‘in the zone’, with the headphones on I couldn’t hear any background noise and didn’t get distracted from the noises I was making or what was happening on the screen. Not having interruptions of other thoughts or background noises that I normally get when I try meditation or mindfulness”. (SoundSelf participant)*
>
> *“Within the first few seconds, with the encouragement of the man’s soothing voice, the relaxing music and the visual pull and fall of the visual "journey", I was able to gently sway and flow into a restful, blissful place and spiritual connectedness. I found that restful place and was able to let go and simply enjoy the present. Melting. Slowing down. At ease”. (Breathing participant)*
>
> *“This program definitely did help me relax. So much so that, once you lose the awareness of the physical ocular headpiece that you are wearing, you almost begin to feel the sensations from the video. It has you feeling completely immersed in the moment”. (Control participant)*

5.7. Factors hindering relaxation.

As seen in Table 5, 26.53% of participants reported closing their eyes (or wanting to) due to negative or discomfort reasons. A few factors were identified to have hindered participant relaxation. Participants expressed concerns such as brightness:

"There was only a few times when the lights were too bright and I needed to close my eyes". (SoundSelf participant).

Feelings of claustrophobia:

> *"It was mostly good, the visualiser sometimes felt claustrophobic, when the lines were directly in front of my face, but was mostly relaxing". (Breathing participant)*

And boredom:

> *"I wanted to close my eyes perhaps towards the end, it got a bit tedious, and I felt very relaxed". (Control participant)*

Many of the 48.98% of participants who reported physical detriments to relaxation singled out the VR headset itself, with several commenting on the weight or bulk of the device:

"The rift felt a little heavy towards to the end". (SoundSelf participant)

> *"Wearing the actual head gear quite uncomfortable and this would be my only reservation about doing something like this more frequently. Watching on a screen might be better suited to me if it would have the same effect". (Breathing participant)*
>
> *"The Rift hardware pressed unpleasantly against the bridge of my nose, and was optically quite sub-par, and due to the inherent nature of the device (cables trailing down my neck, optic device strapped to my head) the weight was rather distracting. The Rift itself, due to the incomplete immersion, actually felt somewhat confining; it required conscious effort not to become anxious due to this". (Control participant)*

To further explore any hindrances to relaxation, participants were asked what changes they would make to the intervention to improve it. This was a way to tap into what participants felt was missing or lacking in a more positive frame than expressly asking about detriments. As was seen in Table 6, proposed changes can largely be grouped into "changes to program", "changes to environment" and "changes to physical equipment". Participants suggested several changes to the intervention programs such as:

"Possibly less intense visuals and less bright colours". (SoundSelf participant)

> *"Flying through a field of flowers as the visual stimulus would be nice". (Breathing participant)*
>
> *"The Rift's greatest strength is its immersion. For a true relaxing experience, I truly believe it would be best to utilise a 360 degree environment with relaxing symbolism and complimentary high quality audio. For example a 360 degree view of forest trees gentle rain, water running, birds chirping. A true 4D experience! With the current program it was most definitely more similar to going into the cinemas to watch a short film". (Control participant)*

For changes to the experimental office, room environment participants suggested modifications such soundproofing, air conditioning and lighting, as can been seen in the following examples:

> *"Sound proof room so that the user can fully relax and vocalise". (SoundSelf participant)*
>
> *"The room is a little stuffy, maybe some fresh air might have helped a little. The program itself I found relaxing". (Breathing participant)*
>
> *"If the room was dark or had dim lighting that may make a difference before and after the Oculus Rift experience". (SoundSelf participant)*

Participants reiterated thoughts on updating the VR hardware, as well as other changes (e.g. the furniture):

"Maybe make it more lighter [sic] than what it was". (SoundSelf participant)

> *"I would say that perhaps a more reclined position, such as a comfortable, well-padded recliner chair, could help, especially if there was support for the head so that one could focus directly on what they were looking at". (SoundSelf participant)*
>
> *"If you had the ability to lay down, it may help induce a more relaxed state". (Control participant)*

One subtheme that has been mentioned both in this question and elsewhere has been the need for any intervention to come with a choice of available programs. In response to this question participants made comments such as:

> *"The visual components were mainly [sic] relaxing, (especially cooler hues like greens and blues), but I think I would of preferred white noise like rain, or maybe less talking from the audio recording, could of just been me not personally liking that meditative track". (Breathing participant)*
>
> *"There should be the preference of a female/male voice. Past trauma involved a male for me. A woman's voice would have been more relaxing for me". (Breathing participant)*
>
> *"I would have like to see a bird on the nest on the tree or a butterfly flapping around or something like a bunny hopping on the grass. Otherwise, it was relaxing as it is. dripping water had a soothing sound of relaxation. I enjoy dusky weather with a little bit of rain in general. I find such climate relaxing, kind of foggy, dusky kind. I am not a big fan of very hot day". (Control participant)*
>
> *"Maybe a transitional mode of different relaxing concepts such as a vivid green field or other nurturing warm environments to help apply to varied individuals that may particularly like certain conditions for sleeping such as the feeling of being warm". (Control condition)*

Choice regarding intervention programs is an important issue, not only in terms of encouraging use by the target audience, but also in light of the effect that different types of relaxation may have on potential users, which will be discussed in more detail below.

When taken together, most of the reported negative aspects identified by participants can attributed to the prototype nature of the interventions. One participant described these issues during the debrief as “teething problems of new technology”. While consumer level VR is still very new, wireless devices like the Oculus Go or Samsung Gear VR are now available in the mainstream, boasting lighter, more compact designs with better visual quality. New software, designed specifically with VR in mind, will likely address issues such as those raised here, as developers continue to increase accessibility and user enjoyment. Concerns such as soundproofing and air conditioning would be fairly simple fixes should the intervention be deployed in a workplace. Limitations regarding program sophistication, selection, and the Rift hardware are not insurmountable, as discussed below. Qualitative feedback collected in this study was able to shed light on what factors of the interventions were beneficial and detrimental to relaxation, and these responses will be useful for any future developments of this nature.

5.8. Understandings, expectations and beliefs about the future of VR

Participants were asked about their views on the use of VR wellness maintenance interventions in workplaces, and 63.27% of participants were in favour. Participants explained their views on the potential values of work and college interventions with comments such as:

> *“I believe that developing such programs may increase productivity, while reducing stress and possibly absenteeism or burnout”. (SoundSelf participant)*
>
> *“YES. YES PLEASE. I think there is a significant opportunity for such meditation programs to be used by people in a non-clinical setting. Stress levels in students can be really high especially when exams start and I can see the potential for something like this is reducing those stress levels – promoting better wellbeing for students across the world. I also feel this would have value in a workplace setting (but I have less experience with those)”. (SoundSelf participant)*
>
> *“The benefits of such an experience could be quite profound, a portable relaxation “station” would allow employees to regroup and refocus if stress was negatively impacting their work”. (Breathing participant)*

Participants were also asked if they would use a VR wellness maintenance intervention at work, to which 85.71% responded that they would as long as their concerns were met. Concerns included matters such as time out of the work day, for example:

“If it didn’t impede on your lunchbreak I would use it”. (SoundSelf participant)

Other concerns included requiring dedicated rooms to help control privacy and stigma, hygiene and security measures to be put in place, and controls to limit chance of addictive or maladaptive behaviour forming around using the intervention.

> *“I would prefer these experiences to take place in a private area of the workplace, much like the conditions of today’s experience”. (Control participant)*

While this line of investigation bares similarities to earlier questions, these results show that a majority of participants would use VR wellness maintenance interventions in the work or college environment.

When asked for their preferences on using group relaxation activities or private ones, a preference for privacy and concerns about stigma were again highlighted:

> *“I don’t feel the presence of others would help in this situation especially if you were wearing the Rift and I would not feel comfortable completely relaxing and making noises in the presence of others”. (SoundSelf participant)*
>
> *“... I wouldn’t want to be wearing the Oculus rift in the same room as others as I feel it puts me in a vulnerable state; even today just knowing I could be walked in on without me being able to see the person or control how I was perceived made me a bit anxious. I’d need somewhere private where nobody would interrupt me – maybe with a timeout rather than a personal wakeup call, y’know [sic]. I’d need to know I was alone and safe. It’s an instinctual thing”. (SoundSelf participant)*
>
> *“I find that I’m more relaxed in solitary environments, free from distractions”. (Control participant)*

The frequency of these concerns and the significant preference for non-group interventions suggest that they should be given a priority during the design of any future interventions. The 40.82% of feedback showing interest and enthusiasm for the new technology and its possibilities for relaxation is promising for future developments, especially in light of the fact that this was many participants’ the first exposure to VR. The level of enthusiasm for VR relaxation over traditional relaxation activities was unexpected. There are several possible interpretations for this result. This could be an indication that, after seeing the potential of VR, participants were keen to use it more. Perhaps the young adults who make up most of the sample population find adapting to new technology less daunting than the general population. It may well be that participants simply did not have a preference for break activities, as long as it is spent in privacy. Obviously, more focused questions would need to be asked to further explore the reasons for these preferences.

Participants in this research have demonstrated that they believe VR wellness maintenance interventions are areas worth investing in, and that there are (in their mind) substantial benefits to having interventions like these at work and college.

5.9. Limitations and future study

The Fitbit activity tracking device is not a medical grade HR monitor, and despite the advantage of being wireless and unobtrusive, HR data were only available to be accessed as an average over 5-minute segments. While this allowed for a consistent four data points for the intervention period, the fact that participants varied in how long they took in the pre- and post-tests periods necessitated the need for averaging across a variable number of data points for these periods, and thus more impoverished data. However, given the exploratory nature of this study, and the use of similar wireless photoplethysmography devices in previous studies, such as Main *et al*. (2017) and Reinhardt *et al*. (2012), it is reasonable to take these results as an indication of a potential effect that must be better explored with more accurate equipment, especially in concert with the participant qualitative responses received.

In addition, while the available computing hardware was able to perform the required tasks, it could be argued that the participants in this study were not exposed to the full capabilities of the Oculus Rift as the programs/experiences in each condition were very basic. While a high-end computer setup is not required, the visual quality of this experiment could be improved with some more powerful hardware. The Oculus Rift itself, while once cutting edge, has now been surpassed by more powerful and less bulky designs. Testing the limits of what modern VR technology and graphical processing can do, in conjunction with a new intervention program, is something to be explored in future studies.

In terms of participants and location, while the study did take place in an office room of an administration area, it was not the participants' own workplace. Similarly, while some of the participants were office workers, others were from other professions or were students. To more completely test the feasibility of a VR workplace intervention, future efforts should endeavour to test office workers in situ. Participants were not asked about recent or habitual consumption of substances (such as caffeine) that may have had an impact on their HR or other responses. Future studies should look to ensure potential participants' use of coffee or other stimulants (or depressants like alcohol) are accounted for.

Despite these limitations, there may have been unexpected advantages to the current study. While this experiment was unable to show users breathtaking life-like vistas in full 3D, it did have the advantage of minimising any VR-induced nausea. The simpler design may have also given the experiment a 'less-is-more' quality, with the minimalistic visuals aiding relaxation in a way that a more visually complex experience may not have.

Several areas for future research have been identified as a result of this exploratory study. Further investigation into effects such as program choice, the differences between active and engaging interventions versus more passive ones, and the testing of what dedicated, top-shelf VR technology and computer processing can do in combination with a relaxation program. This could be expanded to include the use of peripheral functions such as head-tracking, eye-tracking and/or a respiration monitor. Furthermore, repeating and expanding the study with greater participant numbers could help build a stronger evidence base, and varying the design to include a second session may help identify if any kind of "novelty factor" is in play.

6. CONCLUSION

The quantitative results of this experiment have demonstrated that both a dedicatedly designed VR intervention and a traditional breathing exercise, paired with a visualiser, do not inhibit relaxation and may have the potential to induce a positive effect on participant wellbeing, as measured by changes in affect. In their qualitative feedback, a majority of participants were able to explicitly report that they felt they were able to relax, in addition to explain what helped or hindered this process. Participants also demonstrated a strong support for the development and use of VR interventions in workplace settings, even beyond their own use. These results contribute to the emerging literature regarding the use of VR as a relaxation tool in the workplace, particularly around the importance of user experience factors such as privacy and preferred levels of interaction.

While technology is contributing to stress and feelings of low SWB in workers and students (Ladner, 2008; Merecz and Andysz, 2014), this study suggests that technology could also play a part in the solution, appealing to organisations who are looking for new cost-effective ways to provide stress relief for their employees. Interdisciplinary collaborations with psychologists, HCI researchers and other experts working in a positive computing framework (Calvo and Peters, 2013) will be vital to the creation of the required interventions. Any potential intervention must consider user needs, such as privacy and user choice, which were identified as potential areas of concern in this study. If relaxation techniques can be kept simple and therefore easy to pick up, then clients may be able to take the program home with them and continue use on a home device. Instead of taking work stress home, workers could be taking home the treatment. This would represent an investment not just in institutional wellness maintenance, but an investment in employees' lives outside of the workplace as well.

SUPPLEMENTARY MATERIAL

Supplementary data are available at *Interacting with Computers* online.

ACKNOWLEDGEMENTS

The authors would like to thank Jennifer Mason and Tabitha Reichel for their assistance with proofreading and compliance checking. This research was supported by the Sydney Informatics Hub, a Core Research Facility of the University of Sydney.

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