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Relaxing at work: does virtual reality work? An exploratory study among employees in their workplace

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Introduction: The development of virtual reality provides new opportunities for conducting relaxing activities in a simulated environment. Although studies on the effects of VR-based relaxation are developing, they have mostly been performed with students, and more rarely with employees.

Methods: This study aimed to examine the effects of VR relaxation exercises with employees. Forty-seven employees were divided into two conditions: Virtual Reality ($n = 25$) and 2D video ($n = 22$).

Results: The results indicate that relaxing activities reduced stress and negative emotions, while increasing perceived restoration using VR and 2D video. The acceptability and user experience were higher only in the VR condition. VR relaxation provides a sense of disconnection from the workplace that allows employees to increase the pleasant experience.

Discussion: The 2D solution, while less immersive, can be an alternative for employees for whom VR is not recommended. The question of inclusive digital tools is a key issue in the quality of working life programs.

KEYWORDS

virtual reality, restorative environment, relaxing activities, wellbeing at work, stress

1 Introduction

Mental health in the workplace is a major concern in many countries. According to the World Health Organization "the lost productivity resulting from depression and anxiety is estimated to cost the global economy US$ 1 trillion each year" (WHO, 2023). Working conditions (e.g., workload, job insecurity and challenging environment) are often linked to occupational stress and burnout. According to various models of stress at work (Hobfoll, 2002; Bakker et al., 2004; Lazarus and Folkman, 2020), stress is the result of an imbalance between the demands of the work situation and the resources available to employees. Both contextual (e.g., social support, family, friends and work organization) and personal resources (e.g., resilience, optimism, self-efficacy and self-control) can be used to cope with organizational demands.

1.1 Interventions to reduce stress at work

Stress management interventions in organizations can be classified into three categories (Cooper, 1994; Holman and Johnson, 2018): primary (i.e., prevent stress by removing the causes), secondary (i.e., reduction and stress management) and tertiary (i.e., rehabilitation). Interventions at the secondary level are generally the most deployed,

and specifically, individual-level interventions consisting in changing the behavior of individuals or coping strategies are more widely used than organizational-level interventions (Nielsen et al., 2013; Tetrick and Winslow, 2015; Fox et al., 2022). Thus, many studies have shown that breaks at work, muscle relaxation, deep breathing exercises, mindfulness, yoga and meditation techniques are beneficial interventions for physical and mental health (Tetrick and Winslow, 2015; Bartlett et al., 2019; Bostock et al., 2019; Fox et al., 2022; Lyubykh et al., 2022; Tavoian and Craighead, 2023). Relaxation techniques can be conducted without a great deal of training, for example with a client self-practice (Naylor et al., 2019). These self-care exercises can enable more employees to take care of their health and wellbeing, with applications available on their own device (e.g., computer, digital tablet or cell phone). However, making self-care techniques available is not enough to reduce the stress of employees who do not have the time to take breaks at work, cannot manage to switch off, or do not follow instructions for relaxation or breathing techniques independently. They need a supportive environment and guidance to carry out these activities (Naylor et al., 2020). In this respect, virtual reality (VR) appears to be an innovative and promising device to reduce stress during breaks at work.

1.2 Reducing stress at work with VR

According to recent literature reviews (Naylor et al., 2020; Riches et al., 2021, 2023; Gentile et al., 2023; Pancini et al., 2023), VR could provide added value for employees by enabling them to disconnect and immerse themselves in relaxation exercises. VR relaxation has been found to significantly reduce stress in different populations such as clinical populations (Veling et al., 2021), children (Nordgård and Låg, 2021) or older adults (Liu et al., 2023), while more generally, VR and other immersive technologies have been used to reduce pain (Nordgård and Låg, 2021) and anxiety, and improve mood (Yu et al., 2018). Due to features of immersion, interactivity and realism (Slater et al., 1994), fully-immersive VR using helmet-mounted displays (HMDs) enables people to be immersed in natural environments that are both physically and mentally healthy (Riches et al., 2021, 2023). The beneficial health effects of natural environments are explained by two main theoretical models. According to the attention restoration theory (Kaplan, 1995; Kaplan and Kaplan, 1995), natural environments have beneficial effects on attention and can improve mental health. On the other hand, the stress reduction theory (Ulrich et al., 1991) posits that being in a natural environment can assist in recovery from stressful situations. The simulation of natural environments in VR is developing and could be a good way for organizations located in urban areas to allow employees to take mental breaks with a virtual immersion in nature (Ojala et al., 2022; Reece et al., 2022; Suseno and Hastjarjo, 2023). For example, VR has been shown to reduce anxiety, depression and stress (Riches et al., 2021, 2023). VR also makes it possible to create relaxing scenarios that can increase wellbeing, engagement in pleasant activities and positive emotions (Yu et al., 2018; Riches et al., 2021; Frost et al., 2022; Pardini et al., 2022; Gentile et al., 2023; Malighetti et al., 2023). A literature review (Frost et al., 2022) revealed that virtual immersion in nature significantly decreased negative affect, while no significant differences were observed for positive affect. The authors concluded that research exploring the use of virtual reality immersion in nature was limited and that further research was needed to improve understanding of its effects on human wellbeing.

To our knowledge, studies on the effects of VR-based relaxation on stress and wellbeing have often been conducted in the laboratory involving students as participants, and more rarely employees in their workplace (Naylor et al., 2019; Mattila et al., 2020; Karacan et al., 2021; Riches et al., 2023). Some recent studies on the effects of VR-based relaxation concern healthcare professionals during the COVID-19 pandemic (Nijland et al., 2021; Bodet-Contentin et al., 2023; Horan et al., 2023). According to Bodet-Contentin et al. (2023), "the introduction of a nature-immersive VR session during work shifts seems promising," but "given the limited number of studies and methodological limitations in this promising area, future research is vital and it needs more empirical investigations with different employees" (Riches et al., 2023, p.18). Furthermore, while the effects of VR-based relaxation have mostly been tested on physiological and mental aspects (i.e., cardiac level, stress, anxiety and emotions), studies on the effects of fully-immersive VR on acceptability (i.e., satisfaction, usefulness, efficiency and intention to use) or user experience (i.e., enjoy experience, immersion and discomfort) are limited. Yet it seems important to consider these aspects related to acceptability and user experience. In fact, there could be a barrier to using these VR devices in workplaces with employee populations not necessarily familiar with VR. The question then emerges as to the added value of such a VR device compared to less immersive augmented reality or 2D systems.

1.3 Objectives of the present study and hypotheses

The current study aimed at investigating the effects of deep breathing exercises in fully-immersive VR or in 2D video simulated natural environments on perceived restoration, emotions and stress level among employees. It also aimed to explore the effects on acceptability and user experience (i.e., sense of immersion, usability and intention to use the technology) in order to understand the conditions of use of VR or 2D systems in the workplace. Several studies have compared the effects of VR and 2D video. Compared to 2D systems, VR was more effective in inducing positive emotional responses, by facilitating the immersive experience and sense of presence, and producing lower stress level (Ding et al., 2018; Elsey et al., 2019; Yeo et al., 2020; Pratviel et al., 2024).

Based on previous studies reviewed in the literature, we tested the following hypotheses:

- **Hypothesis 1**. A short break during the workday with deep breathing exercises in fully-immersive VR or in 2D video leads to perceived restoration, positive emotions and feeling of energy after the intervention.
- **Hypothesis 2**. Given than VR simulated environments produced more immersive experience and sense of disconnection than 2D video, we expected that the stress level was lower in fully-immersive VR condition than in 2D video.

2 Materials and methods

2.1 Participants

In total, 47 full-time employees took part in the study, of which 34 were female (72.3%). Participants ranged in age from 20 to 64 years ($M = 43$, SD = 11.5). They were employees from a co-working space ($n = 12$) and from a French university ($n = 35$). Regarding the job types, 21 were office workers, 14 were middle managers or technicians, and 12 were senior executives. They were recruited through posters in their workplace and an email sent by the human resources department to university employees. Those who had any medical condition that would be triggered or worsened by using the VR headset (i.e., risks of epilepsy, balance disorders, oculomotor disorders or intense motion sickness) were excluded from the study. Participants included in the study were over 18 years old and full-time employees. Data of three participants were removed because of incomplete data in the questionnaires or since they were not full-time employees. Participants were randomly assigned to the virtual reality condition (VR, $n = 25$) or 2D video condition (2D, $n = 22$).

This study was conducted in line with the principles of the Declaration of Helsinki. Ethical approval was granted by the Ethics Committee of the University (#2022-014). All the participants were provided with a written informed consent form and agreed to the study conditions described in this form. They also gave their consent for their data to be used for scientific purposes. All the data were anonymized.

2.2 Study design and procedure

The study design is illustrated in Figure 1.

Participants were first briefed, which included obtaining informed consent and explaining the questionnaires and the task. Before beginning, participants performed an attention task. The aim of this task was to put them in a relatively stressful work situation before the relaxation phase, using a similar procedure to Naylor et al. (2019) who administered a Stroop test. For the present study, we chose an extract from the NV5R cognitive aptitude test (Thiébaut and Bidan-Fortier, 2003) because it was a proofreading exercise to spot spelling errors, similar to a classic administrative task. The attention task lasted 3 min. The participants then completed the pre-questionnaire with sociodemographic questions and perceived restoration, affect and stress measures. After the pre-questionnaire, participants were randomly provided with the VR headset in the VR condition or with a digital tablet in the 2D condition. The relaxation session took place in a dedicated room outside the work unit with an experimenter. The simulated natural environment in VR or in 2D was a valley by night with clear weather (Figure 2). For 2D condition, the simulation consisted in displaying a video of the same material on the digital tablet. The breathing session comprised a 4 s box breathing technique. Participants were guided by a virtual coach named Aya (Figure 3) through a cardiac coherence exercise and a body-scan exercise. Aya's voice explained how to concentrate on different areas of the body, and these areas were highlighted on the avatar representing the participant, as the protocol progressed (Figure 4).

The same natural environment and relaxation exercises were used in both the VR and 2D conditions. The relaxation activity lasted 17 min for both conditions. Finally, participants completed the post-questionnaire with the same measures as in the pre-questionnaire and additional measures concerning their user experience. The experiment lasted ~60 min per participant. Participants were then debriefed on their participation.

2.3 Measures

2.3.1 Demographic information

A number of items gathered information about the participants' age, gender and type of job. They were also asked how often they practice relaxation activities, what relaxing activities they performed in everyday life, and how familiar they were with virtual reality.

2.3.2 Perceived restoration

The Restoration Outcome Scale (ROS, Korpela et al., 2008) was used in the pre- and post-questionnaire to measure the perceived restoration outcome in the natural environment setting simulated using VR or 2D using a digital tablet. Three items reflected relaxation and calmness and were extracted from the ROS: "I feel restored and relaxed," "I have enthusiasm and energy for my everyday routines," and "I feel focused and alert." The participants responded on a 10-point Likert scale ranging from 1 (*not at all*) to 10 (*completely*). For the pre-questionnaire restoration subscale, the internal reliability was satisfactory, Cronbach's $\alpha = 0.89$. For the post-questionnaire restoration subscale, Cronbach's $\alpha = 0.86$. High scores indicated a high restoration state.

2.3.3 Emotions

The short version of the Positive and Negative Affects Schedule (PANAS, Watson et al., 1988) with 10 items was used (Thompson, 2007; Kuesten et al., 2014). Five items measured positive emotions: "excited, animated, awake," "enthusiastic," "alert, lively, energetic," "inspired, stimulated," and "determined, decisive." Five items measured negative emotions: "anxious," "upset, disturbed," "frightened," "nervous," and "fearful, worried." The participants responded on a 5-point Likert scale ranging from 1 (*never*) to 5 (*always*). The internal reliability of the positive and negative subscales was satisfactory. The positive emotion subscale of the pre-questionnaire and the negative emotion subscale of the pre-questionnaire had a Cronbach's α of 0.82 and 0.80, respectively. The post-questionnaire positive emotion and negative emotion subscales had respectively a Cronbach's α of 0.92, and 0.70 with one item removed.

2.3.4 Stress

A single-item of stress symptoms was used (Watson et al., 1999): "Stress means a situation in which a person feels tense, restless, nervous or anxious or is unable to sleep at night because

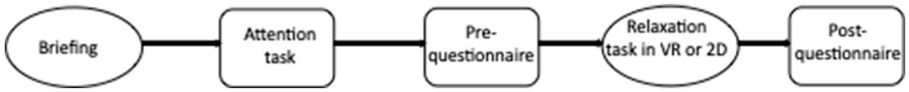

FIGURE 1
Flowchart of the procedure.

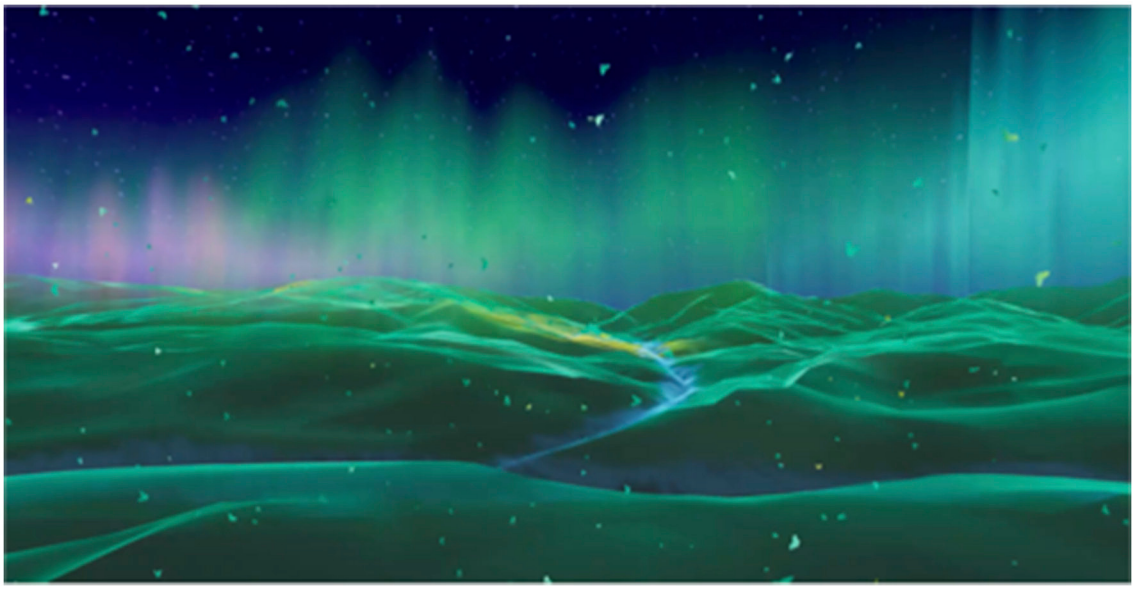

FIGURE 2
Screenshot of the simulated virtual environment.

his/her mind is troubled all the time. Do you feel this kind of stress these days?" The response was recorded on a five-point Likert scale ranging from 1 (*not at all*) to 5 (*very much*). This measure has been used in online surveys for a variety of occupations, corresponding to other measures of mental exhaustion (Elo et al., 2003) and has proven to be a valid measure of occupational stress by the National Institute for Health Research in France (Langevin et al., 2012). In the pre-questionnaire, participants indicated the extent to which they had felt this stress in the days preceding the experiment, and in the post-questionnaire they were asked to what extent they were feeling stress after the experiment. High scores indicated high stress.

2.3.5 Sense of presence

The sense of presence was measured with three items of Slater-Usoh-Steed questionnaire (SUS) (Slater et al., 1998; Usoh et al., 2000). The items were: (1) "Rate your sense of being in the virtual environment (1 = "*not at all*", 7 = "*very much*"); (2) "To what extent were there times during the experience when the virtual environment was reality for you?" (1 = "*at no time*", 7 = "*almost all of the time*"); (3) "When you think back to the experience, do you think of the virtual environment more as images that you saw or more as some place that you visited? (1 = "*something I saw*" 7 = "*some place that I visited*"). The internal reliability was satisfactory, Cronbach's $\alpha = 0.79$. High scores indicated high sense of presence.

2.3.6 Acceptability

To evaluate the acceptability, participants assessed their perception of the relaxing activity with five items from the Unified Theory of Acceptance and Use of Technology (UTAUT, Venkatesh et al., 2012). The items evaluated ease of use, usefulness, efficiency, overall satisfaction and behavioral intention. The participants responded on a 10-point Likert scale ranging from 1 (*strongly disagree*) to 10 (*strongly agree*). The internal reliability was satisfactory, Cronbach's $\alpha = 0.79$. High scores indicated high acceptability of the system.

2.3.7 User experience

To complete and enrich the quantitative data, an open-ended question was included concerning the participants comments about their user experience during the session ("Your comments on the session"). Responses were analyzed as a combination framework approach of inductive coding and content analysis. Content analysis of the open-ended question consisted in quantifying the frequency of keywords used by participants

FIGURE 3
Screenshot of the virtual coach Aya.

in their answers, and identifying illustrative verbatims. A first screening of the corpus was conducted separately by two researchers (HA and EM). Codes were generated independently by one of the authors (HA) and arbitrated by a second author (EM). They discussed agreements and disagreements when they occur. The analysis grid finally retained included five categories: (1) restoration, relaxation, calm, (2) enjoy experience, (3) immersion, disconnection, isolation, (4) problems with breathing rhythms, and (5) discomfort associated with VR HMD.

2.4 Statistical analysis

Statistical analyses were conducted with Jamovi version 2.3 (The Jamovi Project, 2022). Descriptive statistics (frequencies, means, standard deviations, maximum and minimum values, skewness and kurtosis) were calculated to explore demographic characteristics, relaxing activities, familiarity with VR, perceived restoration, emotions, stress, sense of presence and acceptability of devices. Contingency analyses (Chi-square tests) were used to examine any differences between participants under the two conditions. Repeated measures ANOVA with time (pre-intervention vs. post-intervention) as a within-subjects factor and condition (VR vs. 2D) as between-subjects factor was used to assess the effects of VR or 2D relaxing intervention on the different measures. An independent Welch *t*-Test was used to assess the effects of condition (VR vs. 2D) on the sense of presence and acceptability. Effect sizes with Cohen's *d* were reported.

3 Results

3.1 Baseline sociodemographic and familiarity with relaxation activities

A manipulation check was conducted to assess for significant group differences prior to the start of the intervention. The results showed no effect of demographic variables between the two conditions (Table 1): age, $t_{(45)}$ 1.93, $p = 0.06$; gender, $\chi^2_{(1)} = 0.003$, $p = 0.96$; past use of relaxation activities, $\chi^2_{(1)} = 0.13$, $p = 0.72$; current use of relaxation activities, $\chi^2_{(1)} = 0.45$, $p = 0.50$; VR familiarity, $\chi^2_{(1)} = 0.00$, $p = 0.98$.

3.2 The effects on affective measures

As expected, the results of the mixed repeated measures ANOVAs revealed an effect of the moment of intervention (pre vs. post) on the different subjective affective measures, showing an increase in perceived restoration, $F_{(1,45)} = 35.83$, $p = 0.001$, 8, $\eta^2 = 0.44$, a decrease in negative emotions, $F_{(1,45)} = 106.24$, $p = 0.001$, 8, $\eta^2 = 0.70$, and a decrease in stress between pre- and post-test, $F_{(1,45)} = 90.94$, $p = 0.001$, 8, $\eta^2 = 0.67$. However, the results did not show any effect of the intervention (VR vs. 2D), or a two-way interaction between time and intervention on the subjective affective measures. The detailed results can be found in the Supplementary material.

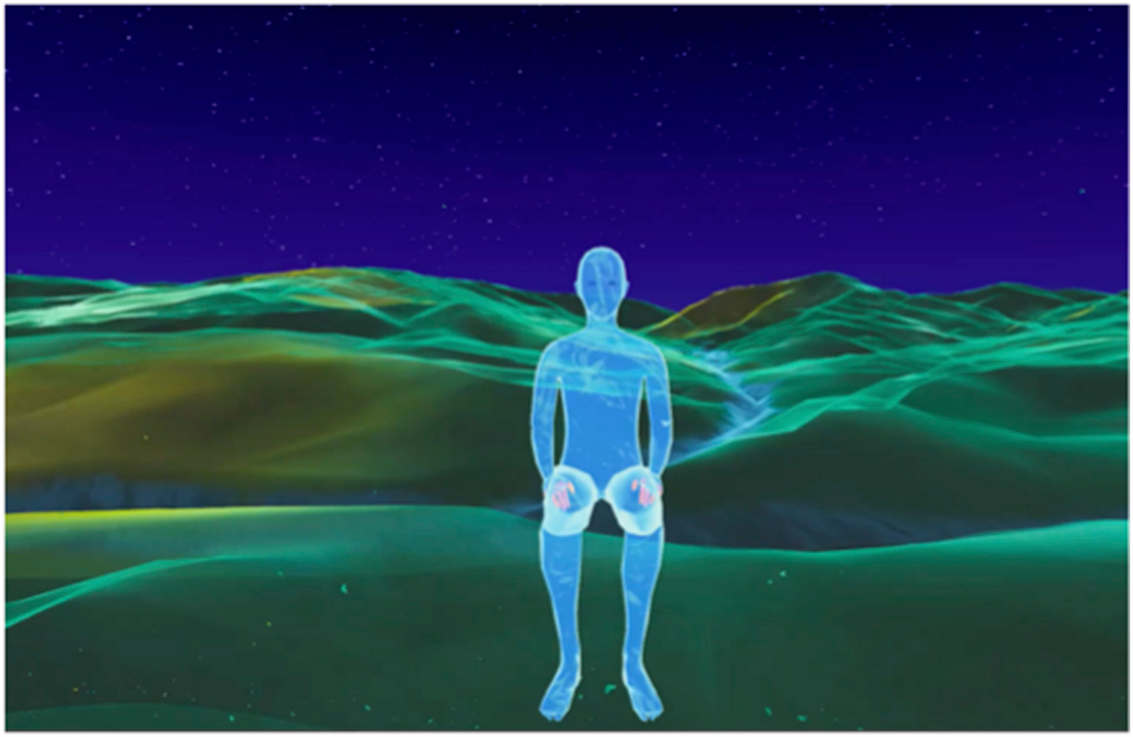

FIGURE 4
Screenshot of the body-scan exercise.

3.3 The effects on the sense of presence and acceptability

As expected, the results of the independent sample Welch *t*-test revealed an effect of the intervention (VR vs. 2D) on the sense of presence, $t_{(45)} = -3.63$, $p = 0.001$, *d Cohen* $= -1.06$, by showing a higher sense of presence and immersion in the VR condition ($M = 4.63$, $SD = 1.53$) than in the 2D condition ($M = 2.98$, $SD = 1.57$). Moreover, the results revealed an effect of the intervention on the acceptability measure, $t_{(45)} = -1.89$, $p = 0.034$, *d Cohen* $= -0.56$, revealing a better acceptability of VR ($M = 8.59$, $SD = 1.22$) than 2D using a tablet ($M = 7.73$, $SD = 1.82$). Specifically, participants found the "environment more relaxing" in the VR ($M = 8.60$, $SD = 1.77$) than 2D condition ($M = 7.18$, $SD = 2.67$), $t_{(45)} = -2.22$, $p = 0.034$, *d Cohen* $= -0.66$, and would "recommend it more to someone else" in the VR ($M = 8.59$, $SD = 1.22$) than 2D condition ($M = 7.55$, $SD = 1.82$), $t_{(45)} = -2.62$, $p = 0.014$, *d Cohen* $= -0.78$.

3.4 Qualitative outcome: user experience

To complement and enrich quantitative analyses, the comments of participants after the session were analyzed. Overall, themes related to a positive experience of the relaxing session were more frequently mentioned ($n = 44$) than those related to a negative experience ($n = 17$). These data are consistent with the measures obtained with the affective scales, and confirm Hypothesis 1 concerning the positive effects of deep breathing exercises during work break. Moreover, consistent with hypothesis 2, positive experiences were mentioned 29 times in the VR condition, compared to only 15 times in the 2D condition. The VR device provided twice as many positive experiences for the users. As expected, the positive aspects most frequently mentioned were linked to relaxation and restoration, pleasant experience, and a feeling of disconnection and immersion. Negative experiences were mostly related to the rapid rhythm of the breathing session and for a few participants discomfort associated with VR HMD. Examples of verbatim phrases and frequencies in each condition can be seen in Table 2.

4 Discussion

The current study aimed at investigating in employees at work the effects of relaxation exercises with VR or 2D systems on perceived restoration, emotions and stress level. It also aimed to explore the effects on user experience in order to understand the conditions of use of VR or 2D systems in the workplace.

As expected, the findings confirm that a short break during the workday with deep breathing exercises in fully-immersive VR or in 2D video leads to perceived restoration and feelings of energy after the intervention. The sense of restoration and positive energy were higher after our intervention, and the negative emotions expressed by employees decrease. Today, little research exists on the effects of relaxation exercises with immersive systems during work break, and this study provides an additional empirical contribution with

TABLE 1 Contingency table of the condition variable with the demographic variables.

Variable	VR	2D	Total
Mean age	40	46.3	43
Gender			
Female	18	16	34
Male	7	6	13
Total	25	22	47
Past use of relaxation			
Yes	17	16	33
No	8	6	14
Total	25	22	47
Present use of relaxation			
Yes	8	5	13
No	12	12	24
Total	20	17	37
VR familiarity			
Yes	9	8	17
No	16	14	30
Total	25	22	47

2D, control condition; VR, virtual reality.

employees in the workplace (Naylor et al., 2019; Nijland et al., 2021; Bodet-Contentin et al., 2023; Riches et al., 2023).

The second hypothesis concerning the higher positive effects of fully-immersive VR compared to 2D video system was partially confirmed. As expected, the quantitative results on the sense of presence and acceptability measures demonstrated the higher value of the VR headset compared to the 2D condition. Moreover, the qualitative data about user experience confirmed this finding by showing a better user experience with the VR device. Indeed, positive aspects and pleasant feelings emerged twice as often in the VR condition compared to the 2D condition. The positive experience and sense of relaxation, as well as disconnection were mentioned more by employees when the relaxing exercise was guided by the virtual coach with HMD. The 2D condition provided a lower sense of immersion and positive experiences linked to a feeling of lightness, isolation, and relaxation. Thus, ability to immerse into the relaxing activity in a virtual environment allowed people to have an enhanced feeling of the present moment and disconnect more from their job (Riches et al., 2021; Frost et al., 2022; Pardini et al., 2022; Gentile et al., 2023; Malighetti et al., 2023). It should also be noted that only five out of the 25 participants reported discomfort associated with wearing a VR helmet.

However, the results did not reveal a significant effect of VR system compared to 2D video on the subjective affective measures of emotions and stress. The absence of difference between the 2D video and VR conditions on affective measure outcomes has been observed in other recent studies (Soh et al., 2021; Reece et al., 2022; Suseno and Hastjarjo, 2023). Several explanations can be proposed to explain this lack of difference. First, there was no avatar in the virtual environment, while the presence of a virtual body can increase the effectiveness of psychotherapy applications (Gall et al., 2021; Suseno and Hastjarjo, 2023). Moreover, participants did not personalize VR environment while participants generally preferred to experience a greater immersivity, pleasure, engagement, and relaxation in a personalized virtual settings (Pardini et al., 2022). Second, the level of interactivity in the VR condition was low and the participants only explored the virtual environment by passively observing the landscape, which was similar to the 2D video condition. Some studies conducted with children have demonstrated that interactive virtual reality produced more anxiety reduction and lower pain levels than passive experiences (Ferraz-Torres et al., 2022). Third, the immersive environment used in the VR condition could be adapted in future studies by adjusting luminance or brightness levels to improve the realism of the natural environment. Indeed, the simulated environment was not a realistic environment, and this could explain why no difference was found between the two conditions. Participants could have been more centered on breathing exercises rather than being immersed in a natural environment.

4.1 Practical implications

The findings of this study also have applicative implications for the tools available during work breaks. Although the present study did not reveal added value of the VR system relatively compared to the 2D video on self-report affective measures, this result is also interesting because it indicates that 2D would be an appropriate alternative for employees for whom fully-immersive VR with HMD would not be possible for medical or other reasons. Thus, taking a mental break from work and relaxing in another room with new technologies such as a digital tablet can be a minimal and sufficient strategy to relax employees. Interestingly, the low-cost 2D condition with the video on a digital tablet was equally useful, reducing negative emotions and stress, while increasing perceived restoration over time. The question is how to invest in these tools, and in particular how to make them inclusive for all employees.

4.2 Limitations and future studies

Although the interest of our study resides in its ecological validity with the participation of employees in their workplace, it nevertheless presents a number of limitations. Firstly, since the study involved employees who had agreed to take time off work or were given timeout by their superiors, it involved a self-selected sample, which limits the generalizability of the results. Furthermore, the sample was comprised of voluntary participants, the majority of whom were women. Future studies could involve recruiting a sample of male employees, randomly selected from a larger sample. Longer-term effects of several sessions of VR relaxation should also be considered in future studies. As regards measuring relaxation effects, many studies have used objective physiological measures (e.g., heart rate, sweating) rather than subjective measures via questionnaires or qualitative approaches such as user experience. However, studies show that physiological

TABLE 2 Examples of verbatim phrases relating to user experience.

Themes	VR	2D
Restoration, relaxation, calm ($n = 25$)	$n = 15$	$n = 10$
	"Very pleasant session which soothed my stress"	"The session left me calm and relaxed"
	"Very pleasant session, very relaxing and peaceful"	"Surprised by the relaxed feeling experienced at the end of the session"
Enjoy experience ($n = 14$)	$n = 9$	$n = 5$
	"Very beautiful environment"	"Positive experience!"
	"Pleasant session"	"Enjoyable"
Immersion, disconnection, isolation ($n = 5$)	$n = 5$	$n = 0$
	"A great tool for isolation"	
	"Very good immersion experience"	
	"I felt like I was floating / light headed with a strong desire to close my eyes"	
Problems with box breathing rhythm ($n = 12$)	$n = 6$	$n = 6$
	"Breathing rhythm very intense, a bit too fast at the end"	"The rhythm of the session seemed too fast. The breathing rhythm was too intense"
Discomfort associated with VR HMD ($n = 5$)	$n = 5$	$n = 0$
	"Headset was a bit heavy"	
	"Headset prevented the feeling of space"	

2D, control condition; VR, virtual reality.

indices are not the only reliable indicators to assess relaxation and stress levels, and their acceptance by employees might sometimes be difficult in a natural situation. In future studies, subjective and objective measures should be combined, but without complicating on-site testing. Simple non-invasive physiological data collection equipment is now available which would not disturb workers (e.g., Apple watch, Garmin Smartwatch, Fitbit).

5 Conclusion

In conclusion, this study has shown that VR-based relaxation is a satisfactory device to enable employees to relax and take breaks at work. It provides a real sense of disconnection and detachment from the workplace that allows employees to increase their wellbeing. The elaborate graphics produced with VR allow urban employees to immerse rapidly in a natural environment with the recognized benefits on mental state. The 2D solution, while less immersive and engaging, can also be a good alternative for employees for whom VR is not recommended. The question of inclusive digital tools is a key issue in quality of working life programs. We need to think about approaches and methods for reducing stress and improving wellbeing in the workplace that do not exclude certain populations (e.g., people with disabilities or minorities), or certain organizations for which the VR solution would be too costly. The deployment of inclusive VR tools that take into account the specificity of users and the needs of companies should be a preoccupation of future research and design offices.

Data availability statement

The original contributions presented in the study are publicly available. This data can be found here: https://osf.io/w29pn/?view_only=1059c62374354a58873a9f9342afd2a6.

Ethics statement

Ethical approval was granted by the Ethics Committee of the University (#2022-014). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

EM: Conceptualization, Formal Analysis, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft. VD: Conceptualization, Investigation, Methodology, Writing – review & editing. HA: Data curation, Methodology, Writing – review & editing. NM: Conceptualization, Investigation, Methodology, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/forgp.2024.1441816/full#supplementary-material

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