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Dialing up the danger: Virtual reality for the simulation of risk

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There is a growing interest the use of virtual reality (VR) to simulate unsafe spaces, scenarios, and behaviours. Environments that might be difficult, costly, dangerous, or ethically contentious to achieve in real life can be created in virtual environments designed to give participants a convincing experience of "being there." There is little consensus in the academic community about the impact of simulating risky content in virtual reality, and a scarcity of evidence to support the various hypotheses which range from VR being a safe place to rehearse challenging scenarios to calls for such content creation to be halted for fear of irreversible harm to users. Perspectives split along disciplinary lines, with competing ideas emerging from cultural studies and games studies, from psychology and neuroscience, and with industry reports championing the efficacy of these tools for information retention, time efficiency and cost, with little equivalence in information available regarding impact on the wellbeing of participants. In this study we use thematic analysis and close reading language analysis to investigate the way in which participants in a VR training scenario respond to, encode and relay their own experiences. We find that participants overall demonstrate high levels of "perceptual proximity" to the experience, recounting it as something that happened to them directly and personally. We discuss the impact of particular affordances of VR, as well as a participant's prior experience on the impact of high-stress simulations. Finally, we consider the ethical mandate for training providers to mitigate the risk of traumatizing or re-traumatizing participants when creating high-risk virtual scenarios.

KEYWORDS

virtual reality, risk, simulation, training, journalism, presence, ethics

Introduction

Industry partnership

Our industry partners in this study, Head Set are an immersive learning company, founded by journalists Aela Callan and Kate Parkinson who have a combined experience of over 30 years covering war, natural disasters and high risk assignments around the world. They founded Head Set to address a perceived gap in existing training provision for journalists. In recent years, high risk environment training for media professionals has centred around Hostile Environment and First Aid Training or HEFAT, however as

FIGURE 1
Screen capture of characters interacting as shown in trailer video of "Stress Management and Civil Unrest" VR experience by Head Set. Video available from https://vimeo.com/465319599.

identified in a study by the Dart Centre for Journalism and Trauma, this training has not kept pace with changes in the industry:

"Training content remains military-and-battlefield centered, despite journalists describing a far broader range of crisis reporting/hostile environment assignments. Lack of training on gender-based violence as well as other gender- and culture-related topics are major gaps, as is gender equity among trainers. Trauma-awareness and digital security trainings also remain significantly limited." (Slaughter et al., 2017).

In response, Head Set have developed a half-day learning module entitled "Stress Management and Civil Unrest" These sessions are designed to support journalists who might be expected to report from high risk scenarios such as protest, riot and revolution. Each session includes a 20-min virtual reality experience and a range of wraparound workshop activities, group discussion and one-to-one support sessions.

Our researchers conducted a series of interviews with participants immediately after they had completed Head Set's "Stress Management and Civil Unrest" sessions.

The virtual reality experience is of a scenario in which the participant and a virtual colleague are deployed to report on a protest. Protesters have gathered in a Central London park in the United Kingdom to signal their opposition to coronavirus restrictions. The reporters are singled out and accused of being proponents of "fake news" and the crowd becomes hostile. The experience unfolds to include a series of high risk and violent encounters involving the participant, police and protesters. It has been designed to "dial up the danger," evoking a visceral "fight, flight or freeze" impulse which is later discussed and examined within the wider training session.

The visual style is semi-abstract, using high-contrast colours and with figures and environmental features rendered as mesh-like structures against a black background (see Figures 1, 2). Use of scale, movement, and sound are hyper-realistic, using high quality motion capture and spatial audio techniques to enhance the perceived authenticity of the scene.

The experience is intended to heighten participant's sense of presence, danger and powerlessness, and provides a common point of reference that is used to teach strategies to protect physical and emotional safety in future deployments.

As this use case is still novel, we chose to take an inductive approach to the research, allowing the process of enquiry to inform the outcomes. However, our overarching research questions, developed with our industry partners were as following:

RQ1: How do participants experience and communicate their own sense of presence, safety and agency in relation to this particular virtual reality experience?

FIGURE 2
Screen capture of riot sequence as shown in trailer video of "Stress Management and Civil Unrest" VR experience by Head Set. Video available from https://vimeo.com/465319599.

RQ2: What are the ethical dimensions and questions that should be considered when producing virtual reality simulations of unsafe environments?

Training in virtual reality

Virtual reality has long been considered an attractive proposition for the purposes of simulation and training. In 2005, before the latest wave of head mounted displays emerged, Sanchez-Vives and Slater theorised about the potential of Virtual Environments (VEs):

"It allows the creation of sensory environments that can be replicated almost identically and that are under the full control of the experimenter, including the creation of scenarios and conditions that are too expensive or dangerous, or even impossible to create in physical reality" (Sanchez-Vives and Slater, 2005).

Since then, virtual reality simulation for training has become big business, moving out of research labs and firmly into the private sector with PwC estimating the value to the UK economy alone at $294.2 billion by 2030 (PwC, 2019) The same report suggests that:

"The use of VR and AR in training boosts engagement and knowledge retention and enables organisations to enforce consistent, measurable standards at scale. The technology also provides a way to train employees where it is not always practical—or safe—to do so in the real world. For example, to simulate emergency situations or asset maintenance in dangerous environments." (PwC, 2019).

Current use cases for virtual reality as a site of training cover a broad spectrum. These include procedural training using specific instruments or techniques e.g., decontamination procedures for healthcare workers (Make Real, 2021), or flight simulations allowing pilot to rehearse risky manoeuvres (EASA, 2021). VR can also be used to simulate disaster scenarios, enabling emergency response training such in areas such as fire safety (Rossler, Sankaranarayanan and Duvall, 2019).

Virtual reality simulation is also increasingly being used for more "soft skills" training such as leadership (Mursion, 2020), customer service (Bellos, 2021) as well as in anti-bias and EDI training (Bodyswaps, 2022).

In "Reality Check: How Immersive Technologies can Transform your Business" Dalton (also the author of the PwC report) suggests that *"VR gives us the best of all worlds: the ability to create a believable, engaging and repeatable emergency but without the associated danger of the real thing"* (Dalton, 2021).

In the past 20 + years there has been extensive research into virtual reality as a site of learning that can be utilised in both educational and professional contexts. Some suggest that the more immersive something is, the more information trainees retain (Alhalabi, 2016; Krokos, Plaisant and Varshney, 2019) although others suggest the reverse (Ochs and Sonderegger, 2022). Another study suggested that the emotion elicited by

the experience had the greatest impact on memory, whereas the impact of presence on memory was weak (Cadet and Chainay, 2020). Dalton cautions against ascribing umbrella value judgements to a medium when there is so much potential for variation in content design:

"Like all tools, VR is only as effective as the person that wields it. Poorly designed experiences or ineffective applications of the technology can be damaging to a learning objective. Knowing when to adopt immersive learning is as valuable as knowing when not to." (Dalton, 2021).

Suffice to say, perspectives and results regarding the efficacy of VR training vary significantly, however a recent meta-analysis concluded that training delivered using a virtual reality headset *"can improve both knowledge and skill development, and maintain the learning effect over time."* (Wu et al., 2020). Makransky and Peterson (2021) also attempt to synthesise a large corpus of study in order to identify the contributing factors that can combine to maximise the apparent benefits of using virtual reality for training and education. They propose that *"(h)eightened levels of situational interest, intrinsic motivation, self-efficacy, embodiment, and self-regulation and lower levels of cognitive load can have positive effects on learning outcomes"* (Makransky and Petersen, 2021).

As is so often the case in fast-moving industrial practices, some of the most influential data regarding the efficacy of immersive training practices has not come from peer reviewed study, but from influential corporate players who have published results of their own studies. A 2020 report by management consultancy firm, PwC entitled "The Effectiveness of Virtual Reality Soft Skills Training in the Enterprise" (PwC, 2020) is routinely quoted by training providers as "evidence" of the effectiveness of immersive training provision at a corporate level. The PwC report suggests that relative to in-person or online counterparts, those training in virtual reality (v-learners) are:

- "Up to 275%" more confident in what they have learned;
- 4x more focused during learning;
- Able to complete training 4x faster;
- 3.75x more emotionally connected to learning;
- And that "v-learning" is more cost effective at scale than other forms of training. (PwC, 2020).

PwC do not publish their source data or methods therefore it is difficult to comment on the accuracy of their findings, however the influence of such firms on global investment and public policy is well established (Kipping, 2003; Morgan et al., 2019). Such strong advocacy is likely to have an impact on market confidence and the subsequent growth of the sector.

Whilst there has been a significant amount of research into virtual reality training, the emphasis thus far has been on the most commercially salient factors such as information retention, cost and scalability. Less is currently known about the experience of individual participants. In this paper we aim to offer a more participant-centred lens through which to consider ethics and impact of this medium.

Presence

Headset based virtual reality gives participants a unique vantage point from which to experience story worlds and media content. Rather than observing at a distance from a rectangular screen as with film, tv, games and mobile experiences, the user now finds themselves at the centre of an unfolding circumstance, a circumstance that occurs all around them, and that they are now a part of. This sensation is often referred to as "presence" "that peculiar sense of "being there" unique to virtual reality" (Bailenson, 2018).

Unlike it is more quantifiable cousin, "immersion" (Sanchez-Vives and Slater, 2005), a participant's subjective experience of presence can be difficult to pin down. In recent years, psychologists and neuroscientists have offered various approaches to support better understanding of this elusive notion of "presence." Some recommend segmenting according to:

- Environmental presence, the feeling of being present in a space
- Social presence, feeling present with other people
- Self-presence, the sensation of being a physically present entity. (Lee, 2004; Ratan, 2012; Won et al., 2015).

Maintaining a persistent sense of presence in VR may have similarities to the perennial notion of "flow" in games design (Csikszentmihalyi, 1990; Chen, 2007). Chen describes designing for "flow" as a way to "maintain and extend an interactive experience before it is interrupted." Breaks to flow such as extra-diegetic menu screens, ludo-narrative dissonance, or anything that might call attention to the non-game circumstances of the player might be considered to work against seemingly desirable state of "flow." The same philosophy is frequently encountered in VR design, where "total immersion" is presumed to be the optimum state.

Increasingly powerful chipsets and publicly available immersive toolsets such as Metahuman Creator for Unreal Engine (Epic Games, 2021) and D-ID (D-ID, 2022) demonstrate the capacity of converging artificial intelligence (AI) and generative adversarial network (GAN) technologies to rapidly create "high fidelity digital humans." There appears to be a corresponding trend in HCI research focussed on the delivery of "virtual information that is indistinguishable from reality" (Cuervo et al., 2018; Itoh et al., 2021).

Whilst increased "realism" in VR has not always been shown to correlate with heightened user presence (Nunez, 2004), this sectoral tendency is likely to further narrow the "perceptual gap" between virtual and physical experience (Thomas and Glowacki,

2018) in the years ahead. Slater et al. (2020) refer to this as "superrealism" a near-future condition in which "(v)ery high quality visual and behavioral realism of virtual humans is becoming increasingly likely and available".

Slater offers the following model for understanding presence:

- Place Illusion (PI)—the sensation of being in a real place
- Plausibility Illusion (Psi)—the illusion that a scenario being depicted is actually occurring (Slater, 2009).

The latter provides useful nuance, allowing for the possibility of an immersed participant reporting a strong sense of presence, even eliciting "response as if real" behaviours known as RAIR (Slater, 2009), whilst retaining firm grasp of the artifice of their experience. Slater offers the above model with the qualifier that "In the case of both PI and Psi the participant knows for sure that they are not "there" and that the events are not occurring".

For the simulation of risk, this dual consciousness, giving cognitive priority to the virtual environment whilst retaining awareness of the physical circumstances, might be a welcome dynamic, enabling participants to feel present in a simulated scenario whilst retaining a sense of personal safety as suggested by PwC. The extent to which this dual understanding is consistent, or insulating against potential harm, however, is hotly contested.

Madary and Metzinger (2016) call attention the way that those who use VR tend to recall their experiences by giving "autophenomenological reports of the type "I am this!."" This is a response that seems quite different to other media experiences such as film, television and games, where users might refer to something they have "watched" or "played," rather than something they themselves have done. Madary and Metzinger suggest that VR dissolves boundaries between a user's standard phenomenal self-model (PSM) and that of the virtual persona they are embodying. They express concern that "not only that there may be unexpected psychological risks if illusions of embodiment are misused, or used recklessly, but that, if we are interested in minimizing potential damage and future psychosocial costs, these risks are themselves ethically relevant." (Madary and Metzinger, 2016).

A recent study indicates that, whilst participants generally do understand that the virtual environment is not the same as the real environment in the moment, the spatial and relational qualities of virtual reality can make it difficult to reliably distinguish between memories of "real" and virtual experiences over time. They refer to this as a blurring of "perceptual proximity" (Rubo et al., 2021) between virtual reality and lived experience. It has been suggested that this blurring may be even more pronounced in younger participants (Liao et al., 2019) who are still forming their phenomenological self-models and sense of objective reality.

Embodiment

In virtual reality, the illusion of presence, particularly self-presence is intrinsically linked to the concept of "embodiment." This partly relates to the presence or absence of an avatar, giving the user a sense of their physicality in the virtual world. Embodiment is also intrinsically connected to the participant's ability to take action within the virtual scene. At a basic level, the embodied participant can choose where to look and for how long in a virtual reality experience. If available, the participant in VR may also choose to move around within a scene, to touch and interact with objects in the environment, to make choices that impact of the progression of the experience, to use their voice to interact with non-playable characters, AI informed characters or other participants in multi-person environments who have their own agency and embodied reality to explore within the virtual space.

Sanchez-Vives and Slater suggest that "Presence is tantamount to successfully supported action in the environment...reality is formed through actions, rather than through mental filters." They go on to suggest that "The key to this approach is that the sense of "being there" in a VE is grounded on the ability to "do" there" (Sanchez-Vives and Slater, 2005). This is an approach that has caused some within the immersive sector to suggest replacing the term "storytelling" with more experiential, user-centric language such as "story doing" (Allen, 2017), "story living" (Connect4Climate, 2017; Robinson, 2016) or "story finding" (Uricchio, 2020) as terms that are more indicative of the active role played by a participant within a virtual reality story world.

Theories of embodied cognition suggest that we explore and make sense of the world (VR or otherwise) through our bodies, using senses like touch, taste, proprioception and kinaesthesia in order to map and reinforce the experiential reality of our experiences (Merleau-Ponty, 1962). Users have been shown to demonstrate high levels of "homuncular flexibility" adapting to unfamiliar bodies in virtual reality, rapidly accepting their own re-embodiment, for example as a frog or a dragonfly or in "The Eyes of the Animals" by Marshmallow Laser Feast, a ghost-like entity without fixed corporal form "Bodyless" by Hsin-Chien Huang. In a research context, participants have shown remarkable aptitude for accommodating additional limbs in VR simulations, rapidly remapping their standard body control systems to accommodate new kinaesthetic capabilities (Won et al., 2015).

The sensorial nature of presence and embodiment in VR has profound consequences for users experiencing simulations of hazardous or unsafe environments. In the infamous "Rubber Hand Illusion" (Botvinick and Cohen, 1998) test subjects consistently experience a rubber hand as their own and seek to protect it when threatened. This illusion appears transferable into virtual reality experiences, in which "VR technology directly targets the mechanism by which human beings

phenomenologically identify with the content of their self-model." (Madary and Metzinger, 2016) Even without the tactile stimuli of the rubber hand illusion, some users report sensations of physical touch, colloquially termed "phantom touch," in response to collisions with virtual elements or avatar-to-avatar contact in social VR spaces.

In a virtual reality recreation of Milgram's infamous obedience tests, Slater suggests that the perception of threat and harm in virtual reality extends beyond consequences for the subject's own body. Participants in Slater's study express concern for the safety of a virtual character, frequently refusing to deliver electrical shocks as instructed when the virtual character exhibits signs of distress. Slater et al. (2006) conclude that "humans tend to respond realistically at subjective, physiological, and behavioural levels in interaction with virtual characters notwithstanding their cognitive certainty that they are not real" (Slater et al., 2006). More recently the Stanford "empty chair experiment" has demonstrated that people will avoid sitting in a physical chair if they have previously seen it occupied by an augmented reality character, even after removing the headset that would allow them to regard it as such. These experiments suggesting a tendency for immersed participants to incorporate a virtual character's corporeality into their perceptual models (Miller et al., 2019).

Emotive response

Virtual reality has been shown to have effective mood inductive qualities "with the most common emotions elicited being anxiety, relaxation, fear and joy" (Bernardo et al., 2020) Studies have shown VR to be an effective tool for eliciting positive emotions such as a sense of "awe" in participants (Chirico et al., 2018) in support of mindfulness exercises (Chandrasiri et al., 2020).

A study comparing gaming using a laptop and using virtual reality headsets, Lavoie et al. (2021) observed that "those in the VR condition reported higher levels of absorption, which in turn increased the intensity of their negative emotional response to the scenario." They expressed concerned about the levels of negative rumination observed in participants in follow up questionnaires later in the day, connecting it to the symptoms of PTSD and positing that "depending on the nature of the gameplay, VR use can cause some users to experience emotional harm" (Lavoie et al., 2021).

Virtual reality is often discussed in terms of its capacity to elicit an empathic response in users. Claims about the potential of virtual reality non-fiction experiences to encourage "pro-social" behaviours (Milk, 2015; Slater and Sanchez-Vives, 2016) have been influential in the development of the sector, with significant support from Oculus (now Meta Quest) through their "VR for Good" program, providing investment for content designed to "expand our understanding of people and cultures around the world—all through the power of virtual reality." (Oculus, 2021).

In response to such claims, several scholars have called into question the "pro-social" impact by challenging the replicability of the findings (Farmer, 2019), questioning validity and appropriateness of the claims (Nash, 2018; Rose, 2018) and the cultural assumptions and colonial lens through which notions of empathy and pro-sociality are being considered (Nakamura, 2020).

Potential for harm

As alluded to above, many of the seemingly positive affordances of virtual reality simulation contain within them the potential for negative impact. In their proposed "code of ethical conduct," Madary and Metzinger (2016) offer a comprehensive appraisal of potentially problematic issues and offer some practicable guidance for the mitigation of risk. In several cases, the risks identified are the inverse of elsewhere identified positive affordances, such as eliciting empathetic responses and inducing participants to make pro-social choices. They reason "(j)ust as VR can be used to increase empathy, it can conceivably be used to decrease empathy. Doing so would have obvious military applications in training soldiers to have less empathy for enemy combatants, to feel no remorse about doing violence." They also signal the risks associated with mood induction "the power of VR to induce particular kinds of emotions could be used deliberately to cause suffering." They go so far as to suggest that "Torture in a virtual environment is still torture. The fact that one's suffering occurs while one is immersed in a virtual environment does not mitigate the suffering itself."

Perhaps anticipating a "but it is not real" response from their readership, Madary and Metzinger assert:

"Because of the transparency of the emotional layers in the human self-model, it will be experienced as real, even if it is accompanied by cognitive-level insight into the nature of the overall situation. Powerful emotional responses occur even when subjects are aware of the fact that they are in a virtual environment" (Madary and Metzinger, 2016).

In "Making a New Reality," Sinclair suggests that "virtual reality pieces that hack the user's brain into feeling present in a virtual space and embodied in a virtual body require a higher level of ethical interrogation" (Sinclair and Clark, 2020) calling for new standards and accountability protocols to be established for this new medium.

Madary and Metzinger (2016) suggest that there are certain "red lines not to be crossed in reality" offering "(o)bvious candidates for such content would be sex (virtual paedophilia, virtual rape) and violence." These red lines cover broad terrain and, if enacted, would shut down many of the most popular VR titles of the moment which, at the time of writing include Gun

Raiders, a "VR shooter for all ages" (Gun Raiders Entertainment Inc., 2021) and Blade and Sorcery (Warpfrog, 2021), a medieval melee fighting game in which "the combat is limited only by your own creativity" The red lines of sex and violence would also presumably apply to the VR porn industry, valued at $716 million in 2021 and projected to grow to $19 billion by 2026 (Woodford, 2021), although it may be reasonably inferred that Madary and Metzinger were referring to specific categories of sexual content in their recommendations.

For immersive journalism pioneer, Nonny de la Peña, the visceral, emotional and potentially upsetting nature of VR as a storytelling device is entirely the point. She acknowledges the risk of creating traumatic experiences and looks for approaches in her work that prioritize "telling the truth without traumatizing people" (Bye, 2022). De la Peña recommends the existing journalistic practice of foreshadowing graphic content and offering specific content warnings in advance to give people the opportunity not to engage if they so choose. She also speaks about the responsibility of makers to consider the ethics of audience experience in what they choose to show and not show, particularly in nonfiction VR.

For Bailenson too, the potential to heighten emotions and simulate specific, high-stress scenarios is a strength of the medium. Referencing research working with US veterans he suggests "(i)n people with PTSD, we can use VR to bring them closer to reality, to heighten their emotions by programming real-seeming environments and put them in touch with their memories" (Bailenson, 2018).

The question of what constitutes "harm" and "safety" is complex and highly subjective, with contrasting viewpoints in evidence across disciplines. We do not try to resolve this complexity in this paper, but aim to contribute to an evidence base that will support informed and responsible practice within the sector. In recent interviews with VR industry professionals, Lavoie et al. (2021) "highlighted a desire for and lack of knowledge about the psychological consequences of VR." They shared that makers frequently expressed "concern for the well-being of VR users" but found a vacuum of information "limiting their ability to take steps to mitigate any negative outcomes." With this case study we hope to offer some first steps towards better information in this regard and would welcome further evidence-based study of this topic.

Influence of demographic context

One study that offers a route into these questions is a VR audience study conducted by William Uricchio (MIT Open Documentary Lab) at the 2019 International Documentary Festival of Amsterdam (IDFA) DocLab. IDFA DocLab is a festival of non-fiction immersive and interactive experiences and a key feature of the immersive industry calendar. The study was designed by Uricchio who was himself inspired by the writings of psychologist Jerome Bruner (1986). In contemporary studies, Bruner invited subjects to give "re-tellings" of recent experiences, encouraging them to "tell us back the story in their own words" and (something of a linguistic red herring for our purposes), to create "a virtual text." Researchers would then apply close reading techniques to explore the effect and subjectivity of each individual's experience.

In 2019, Uricchio and team similarly invited participants to "re-tell" their experiences of works in the public exhibition programme, either in verbal interviews or by completing a written questionnaire immediately following their experience. Uricchio explains; "Factors such as person ("I" or "you" or "he/she"), agency, and voice were as important to Bruner's analysis as the world depicted and the manner of its depiction. Did the subject "witness" a scene, or were they involved as an element of or an actant in the scene? We adopted this close-reading approach in order to understand how users experienced particular immersive projects." (Uricchio, 2020).

Following close analysis, Uricchio's preliminary findings suggest that a participants' demography can influence their use of first/second/third person. The study found that novice users of VR were "most effusive" and frequently "referred to themselves in action mode" using the first person "I/we" forms, whereas those more familiar with the form "tended to describe the projects' effect in the second and third person but rarely first" (Uricchio, 2020). He also notes gender-based variations, reporting that male interviewees "tended to be evaluative rather than experiential," and that female respondents were more likely to report dizziness and nausea.

Refined research questions

Based on the literature we created a series of research sub-questions (SQ) or exploratory statements that could be further investigated in relation to our study:

SQ1 Participants will retell their experience of the VR module as though it were something that had happened to them directly, engaging the PSM as predicted by Madary and Metzinger, and evidenced by primary use of the first person (I/we).

SQ2 Participants with prior experience of VR will be more likely to use second or third person personal pronouns (you/he/she/they) as predicted by Uricchio, indicating higher levels of detachment from the subject matter.

SQ3 Participants will experience a persistent sense of presence and embodiment, reporting RAIR (Response as if real) as described by Slater in relation to the VR training materials.

SQ4 The simulation of risk will be reported as emotionally impactful as predicted by Bernando, Chirico etc.

FIGURE 3
Pico Neo two Eye headset used by participants to experience virtual reality module. Image shared with permission from Tobii Ltd.

SQ5 The simulation of risk may be reported as traumatic, as hypothesized by Madary and Metzinger.

Materials and methods

Stress management and civil unrest training with head set

Participants experienced the virtual reality component of their training sessions using a Pico Neo two Eye headset (see Figure 3), which allowed them to look and move around within the virtual world with six degrees of freedom (6DOF) without being tethered to an external computer.

Participants used a hand controller for interactions in-app. Within the narrative the controller primarily appears as a mobile phone in the participant's hand. It allows them to communicate with the news desk when prompted, and to capture photographs of the unfolding scene.

Developing a methodology

The methodology used was developed in conversation with William Uricchio from MIT Open Documentary Lab and builds on the framework previously mentioned for the audience study at IDFA DocLab 2019.

Our research team conducted semi-structured interviews with 22 individuals over four sessions from April to September 2021, each of whom had just completed the half day training course "Stress Management and Civil Unrest" with Head Set. Questions available on request from corresponding author.

All of the Head Set training sessions were conducted remotely *via* Zoom video conferencing software. Sessions ran for 3 h and included a 20-min VR experience. To support remote participation during the global pandemic, Pico Neo virtual reality headsets were either shipped by Head Set to the participant's home setting or collected by participants from Bristol VR Lab at the University of the West of England.

In addition to the VR component, the "Stress Management and Civil Unrest" sessions included information, support and training related to contemporary journalism, shifting public attitudes, stress management and mental health, as well as space for participants to share experiences and ideas with one another. These elements were not captured. The training and research interviews were conducted on a one-to-one basis immediately following the training sessions and were conducted in "breakout rooms" in the same Zoom call as was used for the training.

In the IDFA study Uricchio observed that "*spoken interviews yielded much richer information about the users' experience than did the written questionnaires*" (Uricchio, 2020) In response, all of our interviews were conducted verbally.

In our choice of interview questions, we retained much of the language used by Uricchio (2020) encouraging our respondents to give Bruner-esque long-form retelling e.g., "describe what happened as though you were telling a friend." We additionally gathered basic demographic information about the participants to allow us to examine data in relation to potential differentiators

identified in the literature such as age, gender, connection to the subject matter and prior experience with virtual reality.

Sample

Training sessions were available only to industry professionals, and all participants identified as journalist or media professionals.

We understood from our industry partners, Head Set, that in modern journalism, freelancers make up a significant proportion of those currently working in the sector, as confirmed by Massey and Elmore (2018). As they are rarely directly employed by large media agencies, freelancers are consequently less likely to be funded to receive the specialist training offered by Head Set in this instance. As such, we were concerned that a key perspective would be absent from our study.

To improve industry representation in the sample we leveraged additional funding from Bristol and Bath Creative R and D program to run specific sessions at no cost for freelance journalists, ensuring that their voices were included in our study. We partnered with three news agencies in Bristol, United Kingdom, Bristol 24/7, Rife Magazine and The Bristol Cable. All of these agencies work mainly or entirely with freelancers and in partnering with them we were able to offer two designated sessions at zero cost to their network of freelancers.

Analysis

All interviews have been transcribed and anonymised. We used NVivo and LIWC2015 software to support close reading on a per-transcript basis, and trend analysis across the full sample.

Using NVivo, we conducted thematic analysis, initially coding for the key terms; "presence," "safety" and "agency" derived from our first research question. On reviewed the full transcripts we additionally coded for "efficacy" i.e., the effectiveness of the VR in a training context and "association" to capture instances where participants made associative links to memories or situations beyond the immediate context of the training. Both additional codes were added in response to their prevalence within the transcripts.

We closely reviewed the coded passages, looking for recurrent or contradictory themes, and for recurrent overlap or lack thereof between codes.

Using LIWC2015 we ran a full spectrum of linguistic analysis and reviewed the results for points of conspicuous significance. We gave particular focus to the use of personal pronouns as a means to test the first two of our research sub-questions (SQ1 and SQ2). We additionally consulted research published by LIWC (Pennebaker et al., 2015) offering further insight into the common use of personal pronouns in different forms of literature.

As a means of appraising our third, forth and fifth research sub-questions (SQ3, SQ4, and SQ5) exploring behavioural and emotional response, we ran a word frequency query using NVivo, noting commonly occurring descriptive terms, and reviewing these in tandem this with the linguistic analysis provided but LIWC 2015, particularly the specific measures of positive and negative emotion (posemo and negemo) as well as cognitive processing load (cogproc).

In the results below, key data points and exemplar quotes have been chosen to illustrate general trends.

Results

Participants

All of our participants described themselves as journalists or media professionals, with a broad range of journalistic experience. In our sample 50% preferred "she/her" pronouns, 45% preferred "he/him" and 5% preferred "they/them." Participant's ages varied with most in the 20–29 or 30–39 categories (36% of sample from each) followed by the 40–49 and 50–59 categories (14% of the sample from each). None of our respondents were <20 or >60.

The levels of journalistic experience ranged from relative newcomer (6 months) to veteran reporter (25 years). Only 27% had previously received hostile environment training and 14% had received public disorder training. We asked participants to estimate the number of "high risk instances" they had personally experienced during their careers to date, and responses ranged from zero to 50+, with the most common response being 10–30 instances.

We asked about participant's prior experience of virtual reality to allow us to interpret the impact of headset familiarity and novelty into our analysis. From this we learned that 34% of participants had experienced headset-based VR prior to their session with Head Set, the rest had no prior experience of this medium.

Of the 22 participants, 14 attended *via* sessions offered specifically to freelance journalists. It is possible the other sessions also included freelancers but this information was not captured by the research team.

Use of language

The majority of participants (68%) mostly or entirely used the first person "I/we" forms when retelling their experiences. This supports the premise of our first research sub-question (SQ1) and that of Madary and Metzinger 2016) and Rubo et al. (2021) suggesting that VR experiences directly engage the

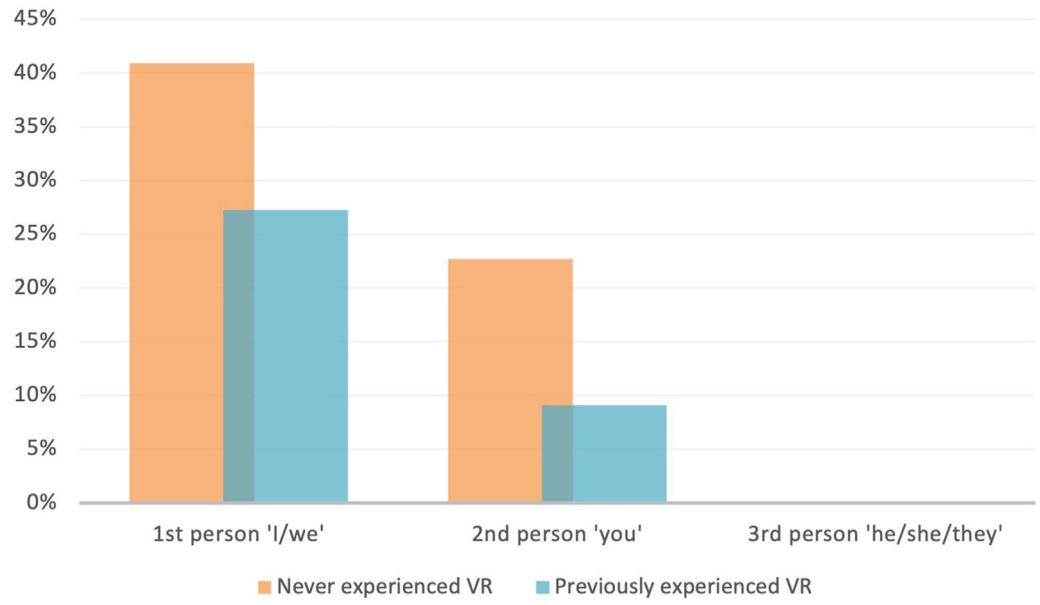

FIGURE 4
Chart illustrating study participant's primary use of personal pronouns.

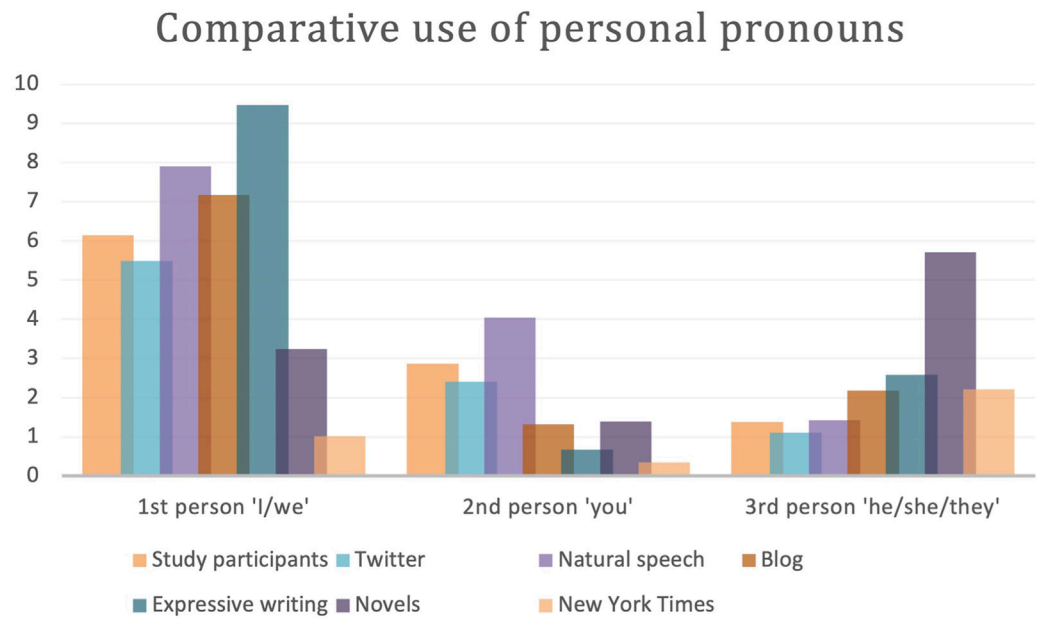

FIGURE 5
Chart illustrating comparative use of personal pronouns in different literary contexts.

phenomenal self-model (PSM), leading participants to report experiences as something actively experienced. The second person "you" was mostly or entirely used by just 32% of participants, and whilst there were sporadic uses of the third person "she/he/they" across the transcripts, there were no instances where it was mostly or entirely used in a single retelling. One notable instance of third person usage occurred when a participant adjusted their usage from third to first person mid-sentence to emphasize their own sense of presence within the scene *"he found himself in a dead- We found ourselves in a dead end."*

Our second research sub-question (SQ2), based on the Uricchio IDFA study (Uricchio, 2020) predicted that participants with prior experience with virtual reality would be more likely to use the second and third person in their retelling, signalling higher levels of detachment than those new to VR. As above (Figure 4) this predicted behaviour was not borne out in our findings. In this study the first person "I/we" was dominant across the spectrum of novice and familiar users, with a proportionally higher instances of second rather than first person usage in those with no prior experience of VR, inverting our expectations.

One interesting discovery in the data was derived from a LIWC2015 paper offering comparative baselines for how personal pronouns are commonly used in different literary contexts (Pennebaker et al., 2015). In our study, the frequency and weighting of participant's use of personal pronouns most closely resembled language used on social media platform, twitter (see Figure 5).

To take an even more granular view, zooming in on use of the first person, our participant's use of "I" (4.58) is almost equivalent to instances found on twitter (4.75), but approximately half that of natural speech (7.03). Instances of "we" in our participant's re-tellings (1.56) were higher than any other baseline, more than twice that of twitter (0.74), and most closely resembling blog entries (0.91).

Although not a defined research sub-question, we did test our data against indications from the Uricchio study that gender would contribute to the use of effusive, evaluative and experiential language. We did not find any significant correlations related to gender although it may be helpful to conduct more detailed analysis in future investigations.

Response as if real

Research sub-question 3 (SQ3) predicted that participants would experience a persistent sense of presence and embodiment, responding to the virtual reality scenario as though it were real. We explore a range of emotive responses below, however in a very physical sense, the interviews were peppered with examples of participants bodily responding to the unfolding scenario as though it were real, or stopping just short of doing so. One participant reported ducking down and trying to become inconspicuous in order to *"keep my profile low."* Another described trying to engage the charaters in conversation, and another reported *"when everything started erupting or happening, they say "run" and for a second I almost ran. It just stopped me feeling the sofa, in my house."* As we were not observing the VR experiences there is a limit to how much we can infer about the level physical response demonstrated by participants, however participant retellings do contain frequent references to RAIR suggesting that they felt present, embodied and physically implicated in the scenes.

Presence and safety

To investigate research questions 4 and 5 (SQ4 and SQ5), examining emotive response and trauma respectively, we looked more closely at the discursive tone and language used by participants, particularly as they relate to our research questions.

Across the sample, participants' sense of presence and safety seem richly intertwined. Multiple people spoke about the sensation of being there and the curiousness of how quickly they were convinced of being in another place. One participant commented *"I was really aware of everything happening and I was reacting it like it was a real scenario."* Another described the experience as something that *"didn't go through my rational filter".*

As predicted by Slater (Slater, 2009), participants retained an awareness that the events were not actually occurring, but that they still felt present, exhibiting "response-as-if-real," cognitively prioritising the virtual reality experience over their physical surroundings.

"It felt real, or something. I mean it is unreal but you feel emotionally connected to the experience even though you know that it is not real".

"I thought I had that very clear in my head but there were moments where I obviously reacted it like it was real life because I jumped at something."

Some spoke about their sense of themselves in relation to the scenario, and the implications of "being there" for them personally.

"even though I was not in the VR experience as (anon), I was aware of the fact that I was (anon), a female journalist, but also a Muslim journalist, but also a Black journalist . . . So, I was also aware of these things that I was thinking about in the back of my head, as to how people are going to respond to that."

Many spoke about how visceral the experience was for them. One participant shared *"it really gives you that very physical sense of going through something, which you can't get from just going, "Well, yes, there was this time when I went and did this and it was stressful and this is why." But you can't really remember how it physically felt."* Several suggested that this more embodied mode of experience was a positive feature of the training, giving them a

strong sense of how they might now act were they to find themselves in a similar situation in real life.

As strong sense of presence was in evidence in the way that many of the participants spoke about their own safety e.g., *"the dog could bite me," "my colleague was being assaulted very violently, and it felt like I might be next"* and *"I felt very unsafe"*.

Although many reported feeling personally threatened or at risk, it is important to note that this was frequently referred to as a strength of the virtual reality training module, as inferred by de la Peña (Bye, 2022) and Bailenson (2018). One participant commented on the sense of scale she experienced. *"It was really good to feel like that person behind me was someone who could intimidate me, a lot taller, a lot bigger. That was really good."* This in her view, enhanced the believability and thus the efficacy of the training. Another referenced the utility of VR identified by Dalton (2021) and others to simulate danger without physical consequences *"It was really useful to go beyond that and into an actual violent experience without being in any danger, that was a really helpful thing to experience."*

One participant spoke of the compounding effect of the intensity of the content and the experience of being in a headset, a new experience for him *"that feeling of being surrounded is very- Like the claustrophobia of that. Especially because you are inside this funny headset thing, which you're not used to being, so you are a bit unsure of yourself anyway."*

Some also spoke of an awareness of their safety outside of the headset. *"I was so worried I was going to run into the fridge or something."* One spoke of a break in presence when they inadvertently stepped outside of the boundaries of the experience and gained a view of their home environment *via* the headset's pass-through cameras, prompting temporary confusion and disorientation.

Beyond concerns for their own safety, in or out of the virtual world, multiple participants described a strong connection to other virtual characters, particularly "Ravi" who is introduced as the participant's colleague, and is the victim of physical violence at the conclusion of the narrative. One participant related "*these big men set upon the colleague and they beat him up, and that is very mean. And you can't do anything about that."*

Safety and agency

The participants' perceived sense of safety also seemed connected to their agency, or ability to influence the unfolding circumstances.

In the virtual reality experience, participants had six degrees of freedom and therefore the agency to look all around and to move within the scene. They had a virtual mobile phone which was used to connect with the newsroom and to take photographs at salient moments. Beyond that, the piece has been designed with limited agency and does not contain "decision points" or complex interactivity.

Several of the participants spoke about the frustration of not being able to take more action. One recounted that *"in this experience we didn't have much choices* (sic) *I feel very unprotected.* (. . .) *Maybe in real life you have a few more options because you can still run away but in this case we couldn't run."* Words like "*powerless,*" "*helpless,*" "*control*" and "*vulnerable*" occurred frequently across the transcripts. Some found it particularly disconcerting that circumstances ran contrary to decisions they might have taken, *"that really stressed me out, actually, because I would not have done that in real life"*.

Some participants expressed a desire for more agency to enable more role playing within the scene, for example "*I would have liked to have the opportunity to test in a safe environment what my decision-making ability would have been.*" Others, however, noted the congruence to the subject matter, suggesting "*(i)t created that feeling of powerlessness that you might have actually while working or even some of it, even in daydreaming, it was quite effective and quite emotional.*" This maps to Head Set's approach in the design of the experience, choosing to simulate the "freeze response" journalists might experience when faced with high stress environments. They go on to discuss the "fight, flight and freeze" responses and in the wider training session.

The impact of prior experience

Based on the IDFA study by Uricchio (2020) we explored the potential of demographic factors such as gender, age and prior experience to influence participant's emotive responses. The most significant modifier seems to have been the journalist's level experience "in the field" prior to participating in the session. Interestingly, those responding in the most emotive terms seem to be those with either the least or the most directly related experience.

Journalists with little experience of high-risk deployments discussed being confronted by the potential of future risks e.g., *"The reality has really been forced on me that situations really can turn nasty"* with several confirming that they not considered the risks shown, or what their responses to them might be prior to the training.

We found that those with several years' experience as a journalist, but with low or no experience of high-risk situations tended to describe their experience in less emotive terms. One person reflected *"I saw a simulation of a public disorder covering gone wrong and it didn't really make me feel anything, to be honest."* Some in this category also suggested that even stronger content might be desirable. *"If it was somewhere else, where maybe gun fire was used, I would want more sessions basically. To deal with more escalated situations."*

Many of those with significant experience in high-risk deployments described their experience in VR in highly emotive, visceral terms e.g., *"this feeling of stress and this feeling of helplessness. It was a very physical thing. My heartbeat went up and I was hiding away and I felt like I froze and I felt frustrated and all these are very real feelings that you will not have over a Zoom session"*.

For one experienced interviewee, the VR module gave them an opportunity to reflect on their previous experience, and how their attitudes may be changing in relation to their career trajectory:

"And today in the protest, because it has been a long since I've been in a situation like that I felt like, more scared that I would feel before. We were talking about adrenalin. Before I would run towards the fire, I would run towards the protest and if someone was fighting, I would go closer to see what is going on. And maybe, lately, which is something that I don't really like to recognise, because it means that I am becoming weaker in a way, for myself. I am maybe feeling a bit, erm, trying to keep more distance from bad situations."

In this instance the virtual reality experience, coupled with the workshop activities that followed appears to have given them an opportunity to rehearse challenging scenarios and consider their own personal and professional response.

Whilst the overall curve seems to suggest that those with low or high experience will retell their experiences in more emotive terms than those with moderate levels of experience, it is notable that the outlier in this was the most experienced journalist we spoke to who was comparatively dispassionate in his response to the VR content. This individual had 25 years as a journalist and had been involved in 50 + high risk deployments. He shared, *"I sort of saw it as a representation that was not within my actual space"* and *"I didn't feel a real connection with the kicking on the floor. I was still watching it as a game."*

As an additional caveat, although prior experience appears to have played a crucial role, several people spoke about the value of the virtual reality module as providing a common point of reference across the cohort *"the VR experience all put us on a level field, so we had all gone through something even if we hadn't experienced it in real life for years and years like other people had"*.

Given the range of responses, research sub-question 4 (SQ4) which predicted that "the simulation of risk will be reported as emotionally impactful" has proved too general of a statement to adequately interrogate here. It would be useful for future studies to explore the hypothesis that close perceptual proximity experienced in VR can result in the same simulated scenario eliciting a range of subjective emotive responses among participants. These responses we identified appear strongly linked to the participant's prior experience and personal context. A larger sample size in future studies might offer greater insight into the influence of direct subject-matter contact and autobiographical experience in responses to VR and the simulation of risk.

Risk of traumatizing/re-traumatizing.

Finally, we looked to explore our fifth research sub-question (SQ5), based on the risk of so called "risky content" traumatizing or re-traumatized users as raised by Madary and Metzinger (2016). Some participants spoke about their own concerns in this regard. One participant suggested that it was a safe space for them to explore their own responses, but that if *"you've got real trauma issues, and then that's not a very safe space in itself"*.

Several participants reported that the experience was a trigger to past memories, prompting some to revisit personal experiences during their retellings of the VR experience. One participant reported *"For one moment, I just felt like I was in the crowd with real people. So, I'm not sure, because I have similar memories to this situation, so it came to me."* Another shared *"it took me back to a certain situation where I had something similar. Not beaten, but something similar. Taken, or- Not kidnapped, in a way, but taken, in a way."*

These reflections seem to imply an increase in the *"perceptual proximity"* as discussed by Rubo et al. (2021) and a step towards the negative rumination signposted by Lavoie et al. (2021), testing the boundary between simulated content and memory.

Beyond the virtual

Despite our questions inviting participants to focus on the virtual reality section in their retellings, many of them spoke at length about the wider program of training and support provided.

Participants were given a lot of detail about what would unfold before putting on their headsets, including specific content warnings about the violence that they would witness, in line with the ethical approach recommended by de la Peña (Bye, 2022).

In the group and individual discussions following the VR, participants were given the opportunity to discuss their experiences with one another and with the trainers, including what they would do differently, and relating any upsetting or triggering responses they had experienced. They were given practical strategies for planning for high-risk deployments, and managing their responses in the moment, developing what Head Set refer to as an "emotional flak jacket" to support emotional as well as physical safety.

When positioning this study in relation to the wider critical context around the simulation of risk, we think it is important to acknowledge the significant amount of "scaffolding" activity offered by the training providers in this case study, serving to contextualise the virtual reality experience for participants. The full Head Set curriculum gives participants an opportunity to explore their own responses in a professionally guided setting and encourages them to gradually re-establish boundaries between real and virtual threat.

This layer of expertise and support does not always connect well with the commercial models being recommended in industry, particularly those suggesting that VR is cost effective because it can remove the need for specialist training providers (PwC, 2019). Further study might attend to the question of the impact and ethics of simulating risk, threat and violence without such carefully scaffolded support.

Discussion

Returning to our initial research questions:

RQ1: How do participants experience and communicate their own sense of presence, safety and agency in relation to this particular virtual reality experience?
RQ2: What are the ethical dimensions and questions that should be considered when producing virtual reality simulations of unsafe environments?

Our findings seem to suggest that participants in this virtual reality simulation experienced the scenario in a direct and active form. Encounters are primarily recalled and framed as though the VR was something that the participants experienced for themselves, rather than witnessed at a mediated distance.

We noted the connected dynamics of presence, safety, agency and external association in this particular case study. Each factor impacting on the participant's personal relationship to the content and affecting the visceral and emotive nature of their reporting. We observed particularly strong connections between a participant's sense of personal safety and their experience of presence as well as their agency, or capacity to take action within the scenario.

In the retelling of their experiences, participants in this study exhibited strong emotional and visceral connections to their own, virtually present character, and to those of the wider cast of virtual beings. Reports of feeling physically intimidated by some and deeply concerned for the safety of others permeate the transcripts. This seems to support claims (Slater et al., 2006; Miller et al., 2019) that the sense of physicality, risk and threat in VR is not constrained to the user's own phenomenal self-model (PSM), and should be carefully considered in the design of high-risk scenario simulations.

We noted the positive linkage made by many participants between heightened emotional experience and the effectiveness of the training. This supports ideas that the enhanced sense of presence and embodiment available to designers of VR experiences can be leveraged for the production of impactful training materials.

We identified that prior experience, at least within this sample was a strong indicator of how an immersive work would be received. In this case participants with the most and the least direct experience of the subject matter using more emotive language in recalling of their own experience. Whilst these responses were generally regarded as positive and constructive by participants, a way to rehearse one's own response to risk in a controlled setting, a small grouping found that the experience triggered unwelcome or upsetting memories related to their own histories.

Our industry partner Head Set were aware of the potential impact of their work prior to engagement with this study. In addition to the VR simulation under scrutiny, it should be kept in mind that they have developed a range of "emotional scaffolding" tools that wrap around the VR experience e.g., pre-engagement survey, discussion forums, signposted mental health resources and expert guidance in order to hold in balance that which de la Peña might describe as "telling the truth without traumatizing people" (Bye, 2022).

One such example is the way that they capture information about each participant's prior experience before they begin the course. Part of their internal company language is to classify participants on a scale:

- green, having never covered high risk;
- orange, having covered high risk but never been in a "scrape";
- red; having covered a lot of high risk and potentially been in some life threatening "scrapes".

Such pre-classification and flexibility allows Head Set to plan and subtly adapt each session to the anticipated needs of the participants. Based on the literature around responsible approaches when deploying "risky content" in VR (Madary and Metzinger, 2016; Slater et al., 2020) such safeguarding seems entirely appropriate and may well be indicative of best practice at this stage in the evolution of the sector.

For the purposes of this study, the adaptation may also have partially limited our ability to gain insight into what would have happened, were such preparation and adaptability not factored in. It is difficult to assess whether instances of rumination or reminiscence around prior trauma, for example, would have been more or less pronounced were such accommodations not in place.

From an ethical perspective, our results seem to suggest that simulation of high-risk content should be developed, if at all, by those with an informed understanding of the interconnected affordances of presence and embodiment, social dynamics and agency, as well as the impact of each on a participant's perception of their own safety. How that might be implemented in an industrial context is challenging and may require some level of legislative intervention, the creation of a recognised qualification, kitemark or approved provider status to support user safety. Again, further research and collaboration with additional industry partners and policymakers would be highly valuable in this space.

Early findings from this study provide a challenge to the prevailing notion of VR training as a cost-effective business model, imagined to replace in-person training or e-learning modules, or to render expert supervision obsolete.

Overall, we have illustrated that the simulation of risk in virtual reality for training purposes can offer providers and participants a potent, impactful and distinctive platform for experiential learning. We would suggest that training providers simulating risk and danger have a duty of care to those who might experience their work. This may include a responsibility to give content warnings and to provide targeted emotional support. Although difficult to explore in this small study, it seems likely that the auxiliary resources provided by Head Set made a positive contribution to the experience of their participants, and we would welcome further study to better understand the implications of differing approaches.

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Faculty of Arts, Creative Industries and Education Research Ethics Committee, University of the West of England. The patients/participants provided their written informed consent to participate in this study.

Author contributions

VM—lead researcher and sole author.

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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.

Publisher's note

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