



Women's experiences of using virtual reality antenatally

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Abstract

Pregnant women use a range of non-pharmacological pain relief methods to help manage and reduce pain intensity and to induce relaxation. We conducted a study with 18 pregnant women to explore whether virtual reality (VR) would be an acceptable and feasible intervention for use in labour as a non-pharmacological method of pain relief and to aid relaxation. Virtual reality has been shown to be an effective distraction technique in other acute pain settings and also reduces anxiety. This in-depth usability study antenatally introduced four VR experiences to the women. They assessed the content and design features of the VR experiences and how they envisaged using VR in their labour via semi-structured interviews. The results of the antenatal study identified several themes: *evoking emotion* with sub-themes, *memory*, and *imagination*. The theme *presence*, includes sub-themes such as *relatability*, *realism*, *immersion*, *interactivity*, and *narration*. The theme *envisaging using VR in labour* with subthemes of *escape* and *anchoring* were descriptions of how women envisaged using VR in their labour. Finally, the theme: *the ideal virtual environment* describes the environments and features participants would like to see in the development of future VR for use antenatally and in labour. This study provides a unique and novel contribution to the field of VR and antenatal and labour care which can help inform the design of labour specific VR experiences for women as a non-pharmacological method of pain relief.

Keywords Labour · Pain · Pain relief · Anxiety · Relaxation · VR experience

1 Introduction

Many women use non-pharmacological methods of pain relief during labour, seeking a non-medicalised, 'natural' labour and birth. The use of non-pharmacological methods of pain relief in labour has a variety of benefits than purely the attenuation of pain. Non-pharmacological pain relief can help labouring women relax and manage the pain, increasing self-confidence and satisfaction with the birth experience (Leap et al., 2010; Thomson et al. 2019). Non-pharmacological methods women use in labour range from position changes, heat packs, water immersion, massage, and acupressure to the use of distraction techniques that include music therapy, visualisation and hypnobirthing. Hypnobirthing is a deep state of relaxation (like meditation) and includes techniques for visualisation, breathing and affirmation, and is used to help women in labour to manage pain (Wright and Geraghty 2017).

A novel non-pharmacological technique effective for managing acute pain and anxiety in various clinical settings is VR distraction therapy (Bermo et al. 2020; Eijlers et al. 2019; Gerceker et al. 2021; Piskorz et al. 2020; Smith et al.

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2020; Spiegel et al. 2019). VR has elements of many natural therapies, such as distraction and visualisation with meditation and hypnotic features. Unlike traditional distractions such as music and television, VR has emerged as an effective tool that provides multi-sensory input (visual, auditory and tactile). It is this convergence of sensory input and interactivity that gives the user the illusion of entering a virtual world ((Hoffman, et al. 2004a, b). This illusion of presence and immersion are considered central to the therapeutic value and efficacy of VR as analgesia (Triberti et al. 2014). Despite evidence of VR's efficacy in other clinical settings, it's acceptability and usability during labour remains under-explored. This paper reports on a study exploring pregnant women's (n=18 and >35 weeks pregnant) experiences of trialling four distinct virtual environments (VEs) for potential use in their labour.

2 Background

VR has historically been recognised for its entertainment value, for example, in the area of console games. VR is now used in a range of settings due to the availability of affordable headsets and software (Colloca et al. 2020; Garrett et al. 2018; Gold et al. 2007). VR has been used in a variety of healthcare settings focusing on breastfeeding, pain attenuation, anxiety and distress while undergoing painful medical procedures for paediatric and adult patients such as burn wound care, physical therapy, chemotherapy, dental procedures, and invasive procedures such as venepuncture and intravenous placement (Bermo et al., 2020; Gerceker et al. 2021; Gromala et al., 2015; Matsangidou et al. 2022; Ng et al., 2018; Piskorz and Czub 2017; Tang et al. 2022.; Tashjian et al. 2017; Ziabiari et al. 2022). Recently, VR has explored labour and birth (Cowles et al. 2019; Frey et al. 2018; Massov et al. 2022; Pratiw et al. 2017; Wong et al. 2021), because of its combination of visualisation, hypnotic and mediative features regarded as having optimum benefits in pain attenuation, relaxation and reduction of anxiety.

Numerous quantitative studies have explored the impact of VR on labour pain in women. Pratiw et al., (2017) conducted a randomised controlled trial of 60 women experiencing labour for the first time, in five Indonesian public health centres. The women were randomly allocated to two groups (30 in each group) with the intervention group using VR and the control group not using VR. The study used a VR 360 environment of rivers, beaches, waterfalls, and lakes where users glided through the environment. The intervention of VR was given for 10 min at each stage of labour determined by cervical dilatation (latent phase of 1-3 cm dilatation, and the three active phases at 4-5 cm, 7-8 cm, and 10 cm dilatation). During each stage pain scores were measured using

the Faces Pain Scale (FPS) (0–10) by the women and the nonverbal pain scale (NVPS) (0–5) was filled in by observers (midwife/researchers). Results from this study found statistically significant lower pain scores in the intervention group compared to the control group using both the FPS and the NVPS. These results are clinically significant in that the women in the intervention group reported decreased pain intensity compared to the women in the control group throughout the progress of their labour at all four stages of dilatation which are generally associated with progressively increasing levels of pain intensity.

The study by Frey et al., (2019) was a pilot randomised controlled crossover trial that used a within-subjects design. These authors investigated the effect of VR on 27 women in labour who were observed during unmedicated contractions in the first stage of labour with and without VR for equivalent time periods. Results from this study demonstrated statistically significant decreases in affective pain, cognitive pain and anxiety while using VR in labour. 82% of women reported enjoying using VR during labour and 70% were interested to learn of future VR developments specifically for childbirth. These authors suggest further VR applications should focus on ease of use, custom-tailored virtual environments, and emotionally engaging content for extended periods (labour can last for hours) that appeal to labouring women, and the use of VEs that are proven effective in reducing acute pain and anxiety. However, Frey et al., (2019) was unable to determine the features of VEs that may appeal to labouring women, or that may be effective in reducing pain and anxiety, as the quantitative study only examined pain dimensions. The study was not designed to allow insight into features and content of future VEs. A qualitative study by Musters et al., (2022) compared meditative virtual reality environments and an active gaming application. Results from this study found that women in labour used the meditation application first during early labour (up to 3 cm dilatation) and the gaming application thereafter for 30 min. Most women indicated that guided meditation VR environments are most suitable during labour and that labour pain became too intense to focus on games. A recent qualitative study conducted focus groups to identify virtual reality environment preferences for use by labouring women. Results from this study found that preferred virtual experiences are very personal and diverse. There is a diversity in preferred images also. Some participants indicated a preference for interactive applications that would make them feel excited or evoke curiosity. Other participants were more drawn to calming and relaxing virtual experiences. Images of nature such as a forest, the beach or mountains were suggested by some of the participants as options, others suggested computer-generated colourful images or an intergalactic space. Narrative from

the participants suggested that interactive applications may be more suitable for the beginning of labour. As a distraction during active labour women felt they needed assistance to help focus on relaxation. Meditative applications or virtual breathing exercises were considered to be more helpful in active labour (Van Leugenhage et al. 2024). Future research is needed to identify possible preferences for virtual environments for use by women in labour. This qualitative study aims to address this gap.

A systematic review by Triberti et al., (2014) identified three psychological variables effective in increasing the therapeutic efficacy of VR in the area of analgesia. These were: presence, fun and anxiety. Presence was being identified as being capable of improving the efficacy of VR as analgesia and is probably the most important psychological factor that is directly linked to the experience of VR. There was a strong positive association between a high sense of presence and desirable analgesia effects. Fun is the second psychological variable identified in the systematic review as having a positive effect on the effectiveness of VR as analgesia. In three studies by Hoffman et al., (2008, 2004a, b, 2024) fun ratings were positively correlated with presence ratings and pain reduction. Several studies found that participants in the VR condition obtained significantly higher fun ratings compared with participants who participated in the non-VR condition (Maani et al. 2011; Schmitt et al. 2010; Sharar et al. 2008; Wender et al. 2009). Triberti et al., (2014) suggest that the advancement of knowledge into the efficacy of VR analgesia requires the comparison and analysis of different VREs. The aim of this study was to conduct a feasibility study with participants to determine whether VR was acceptable for use in labour and to conduct a usability study which aimed to compare and analyse different VEs. This is in line with Triberti and colleagues (2025) who advocate for future research that gives greater attention to “content” features, such as narrative and emotion, and to identify the factors that prompt meaningful change in their users. It is argued that the study of the sense of presence needs to move beyond technical components to psychological and social factors. A more sophisticated understanding of presence will have practical implications for the growing development and adaptation of virtual reality in healthcare (Triberti et al. 2025). In a recent paper on virtual reality approaches to pain, the authors identified user experiential factors of presence, interactivity, immersion and embodiment. These experiential factors interact with one another, shaping the virtual reality experience itself, while also influencing the cognitive, emotional, social, behavioural and physiological outcomes of pain-related therapy targets. Such outcomes include reduced pain intensity and disability, increased engagement in daily activities and an overall improvement in quality of life (Trost et al. 2021). The literature review

identified several ideal characteristics or criteria to increase the level of presence experienced in VR. These were, realism, interactivity, narrative, fun and emotionally arousing (Hendrix and Barfield 1996; Ijsselsteijn, 2002; Klimmt and Vorderer 2003; Riva et al. 2007; Sherman and Craig 2003; Welch et al. 1996; Wender et al. 2009). In a qualitative study, a strong sense of presence arose when the virtual reality environment elicited authentic cognitive, emotional and behavioural reactions and when participants wove their own interpretations or narratives about what was happening (Riches et al., 2021). These criteria were used as much as possible to choose some VEs for the participants in this study to trial in the antenatal period and to evaluate their use in labour. There has been limited research on the evaluation of content and criteria of VR for *pregnant women in the antenatal period* for potential use in labour and birth which is the focus of this paper.

3 Methodology

3.1 Study design

This study used a sequential exploratory mixed methods study design to structure the research. The exploratory sequential mixed methods design comprised three phases: antenatal qualitative, intrapartum¹ quantitative, and postnatal qualitative. Results from the first phase, antenatal qualitative are reported here. The second phase results, quantitative results were published in the Australian and New Zealand Journal of Obstetrics and Gynaecology and the third phase, the postnatal qualitative results were published in PLOS One. It was felt that joint analysis would decrease success of being published in the chosen journals. To fully explore and understand the phenomenon of women’s experiences using VR antenatally and as a non-pharmacological method of pain relief in their labour and birth and to determine a possible effect on labour pain, a mixed methods approach was chosen as the most appropriate method. Labour pain, like other types of pain, in studies undertaken by pain researchers is commonly quantified using numeric or semantic scales which aims to capture the intensity of pain experienced at a timepoint. Labour and labour pain, are, however, complex, and multi-dimensional phenomena. The first phase (antenatal – reported in this paper) was to determine feasibility and acceptability of VR as an intervention in labour. This qualitative phase sought to explore women’s initial experience using VR in the antenatal period of their pregnancy and how they envisaged using VR in their labour. The mixing of methods can strengthen a study, allowing us to understand

¹ The time period spanning childbirth, from the onset of labour through delivery of the placenta.

Table 1 Demographic characteristics of participants

Characteristic	n (%) of total sample N=25
<i>Age (years)</i>	
25–34 years	16 (64)
Over 34	9 (36)
<i>Ethnicity</i>	
New Zealand European	15 (60)
Other European	4 (16)
Asian	6 (24)
<i>Educational Qualifications</i>	
Secondary School 3–4 years	1 (4)
Tertiary	24 (96)
Primiparous	17 (68)
Multiparous	8 (32)

phenomena more fully, to gain in-depth and broader insights due to the wider range of views and perspectives presented (Greene and Caracelli 1997).

3.2 Participants and recruitment

Twenty-five participants were recruited for the antenatal period study (Table 1). Ages ranged from 28–42 years. Most participants identified as New Zealand (NZ) European, four as Other European, and two as Asian. Two had previous VR experience. Participants were recruited via their midwife, when attending antenatal appointments, education classes, and via email. Inclusion criteria were either nulliparous or multiparous, 35 weeks and greater pregnant and 18 years of age or over. 12 participants were nulliparous (has not given birth previously) and six were multiparous (having borne more than one child). Participants were excluded if they had any contraindications to VR use.

3.3 Virtual reality intervention

A user study was carried out with the participants who trialled different VEs in the antenatal period in their own homes. The participants all used wireless Oculus Go headsets which provides a 3 DOF. The Oculus Go portable headset was selected as it was the cheapest and easily accessible portable headset on the market at the time. There were no portable 6 DOF headsets on the market at the time of the study and the women had mobility issues being pregnant so there was no need for a high-end hardware setup. The four VEs were consumer ready products available on the Oculus Go website. The four VEs were selected based on the criteria identified in the literature to increase levels of presence, be fun, be a distraction for women in labour, and represent natural environments (Kaplan 1995). In terms of realism, more realistic scenes would have been preferred for the underwater environment and in the beach environment, however the natural scenes of this type had groups of

people doing activities or talking in the environment which was not considered conducive to relaxation. In terms of interactivity, VEs that were chosen, had interactive features, for example, dolphins swimming right up to the participant, so that it felt like they could be played with. It was not an interactive game. In terms of fun, in the studies that identified this variable, the users were playing a game. We did not consult with participants prior to selection of the VE's for viewing.

3.4 Data collection

Participants were shown all four VEs and a semi-structured interview was conducted. Participants were asked questions after each VE, and further questions were asked after all four VEs had been viewed. The VEs were Ocean Rift²—an underwater environment with dolphins, Nature Treks VR³—an animated beach environment, Shape-Space VR—an abstract-like art environment of coloured moving ‘blobs’, accompanied by a type of Zen chanting music, and Birth of a Star—a documentary type environment of real shots of space accompanied by music and a voiceover. The first author who is a qualified midwife with 25+ experience conducted the study in the participant's homes and brought the VR headsets. Each interview was digitally recorded and checked by the participants and checked and analysed by all the authors.

3.5 Ethical considerations

Prior to commencement of the study, participants were given an information sheet and gave written consent to participate in the research. Participants were given pseudonyms to protect their identify. This study was approved by our University's Human Ethics Committee.

4 Results

The analysis was conducted using thematic analysis following the six-step method outlined by Braun and Clarke (2012). Given the exploratory nature of the research question an inductive approach was adopted, allowing codes to emerge from the content of the data based on participant's experiences. Both the first and second author initially reviewed a sample of transcripts individually before collaborating to develop preliminary coding schemes. The coding process was iterative, with related comments categorised into themes. Subsequent readings helped to define

² https://www.oculus.com/experience/rift/125378157981619/?locale=en_US

³ <https://naturetreksvr.com>

these themes, leading to their subdivision and merging until they reached stability. Each author independently examined the data within each theme and minor adjustments were made through consensus until stable themes were established. The identified themes underwent careful scrutiny and were reviewed in a recursive manner to ensure quality and accurately reflect the essence of the raw data. The first theme was *evoking emotion*. Two sub-themes which described the features in the VE that enhanced the ability of a VE to evoke an emotion were using *memory* and using *imagination*. The second theme described the sense of *presence* the participants experienced in relation to each VE and is divided into five sub-themes identifying features which enhanced this sense of presence: *relatability*, *immersion*, *realism*, *interaction* and *movement*, and *narration* and *storytelling*. The third theme *envisaging using VR in labour* describes how the participants envisaged using VR in their labour. Two sub-themes were constructed from the data, firstly as *escape*, VR as an effective distraction technique and as *anchoring* describing using the VR in labour as a way of grounding oneself, to avoid feeling out of control and avoid negative thoughts. Finally, the fourth theme, the *ideal virtual reality environment* describes the environments and features participants would like to see in the development of future VR for use antenatally and in labour.

4.1 Evoking emotion

This theme describes the participant's impression of the VEs in terms of an emotional experience. These experiences varied greatly amongst participants with some reacting positively and other negatively to each VRE. There were a range of emotional responses after each of the VEs were viewed and these were described in the participant's narratives. The participants described how watching and listening to each VE evoked emotional responses. All the participants were able to recall a particular emotional state and participants used a variety of emotion words to describe their experience. All four VEs induced at least one emotion for each of the participants.

The participants described a range of emotions that they experienced after viewing each VE. These varied from "relaxed", "calmness" or "happiness" when viewing the underwater dolphin and the beach VE. The third VRE, the blob environment evoked strong emotive words and diverse descriptions such as "confusion", "scary", "disconcerting", "soothing", "entrancing". Finally, the space environment evoked a range of emotive words and descriptions such as: "ethereal", "relaxing", "awesome" and "boring". When presenting the themes reference is made to the specific VR referred to by the participants, that is, the beach VE or the dolphin VE.

4.2 Virtual Environments Underwater Dolphin Environment: calm, relaxed and serene

Most commonly, when women described the dolphin VE they reported feeling "relaxed", an emotional state of low tension, "calmness" or "happiness." Other descriptions when referring to this VE were "immersive", "encompassing", "pleasant", "engaging", "serene", "safe", "excited", and "interesting." The dolphin VE has an animated environment which is underwater and consists of a group of dolphins swimming around. This movement is accompanied by bubbles, seeming to appear and disappear when the user breathes in and out. There is a discrete sound of bubbles and water. Several participants described their engagement with the dolphin VE as engaging, calming and serene.

"It was fantastic, very calming but not sleepy, engaging. I loved the dolphins, they were playful...calm, sweet, and curious." (P4)

4.3 Beach environment: bit boring, not a lot happening

The beach VE was described very similarly to the dolphin VE. Common descriptions were that it was "relaxing", "calming", and "soothing." Some participants however considered it as "boring." The beach VE is set in a tropical looking island with a sandy beach, turquoise water with waves gently rolling. There is a palm tree gently swaying, clouds slowly moving overhead. Within the scene there are various objects, a rowing boat and some animals, birds in the sky and turtles moving across the beach. As well as the sounds of the waves it has some soft music playing in the background. P3 found the discrete sound of the bubbles relaxing. *"It was really peaceful and relaxing, everything was slow moving...so it just made you feel calm and relaxed."*

4.4 Blob environment: engaging, scary, disconcerting

The blob VE evoked strong emotive words and diverse descriptions by some such as "creepy", "disturbed", "confused", "scary", "weird", "strange", "uneasy", "unusual", "uncomfortable", and "disconcerting. Many others did not share these disconcerting experiences and had a positive response to the blob VE. These positive descriptions included that the VE was "beautiful", "creative", "intriguing", "captivating", "engaging", "interesting", "meditative", "entrancing", "absorbing", "hypnotic", "unique", "calming", and "soothing." This VE consisted of some animated shapes which looked like blobs of multi-coloured pain moving through the environment. The blobs move constantly

and come towards the viewer. Accompanying this scene is some music that sounds almost like chanting. This environment produced a divisive reaction amongst the participants. Some were positive, finding it engaging and distracting, for others, it produced a very negative response of confusion, anxiety, and fear.

“Like nothing I’ve ever experienced before, it was almost quite scary...very distracting, bordering on unpleasant because it was just a little bit scary.” (P1)

4.5 Space environment: engaging, creepy, cool

The space VE evoked emotive words and descriptions such as “curiosity”, “engaged”, “safe”, “interesting”, “nice”, “relaxing”, “calming”, “ethereal”, “awesome”, “intense”, “informative”, “boring”, and “lovely”, while also being “creepy”. This VE was the only one utilised that was not animated. It consists of real footage of space and the Hubble, resembled a documentary in that it provides an informative commentary of what is going on in the environment. A narrator provides the voice over and accompanying this is classical type music. Some of the participants described this VE in terms of engagement and curiosity. For other participants this VE produced negative reactions like being creepy and not relaxing at all.

“Curiosity...definitely fully engaged, I’m like, what, this is cool, what’s going on and then when you fly into this telescope, and it shows you all the colours and you look around.” (P2)

Each VE was viewed by the participants in the order above. Each VE was viewed only once by every participant. All participants viewed the VE’s sitting upright.

4.5.1 Using memory

The ability of a VE to induce an emotion or to be appealing was often due to the participants retrieving a pleasant memory that they associated with the scene. Many of the participants recalled memories that they had of a specific place. For example, when viewing the tropical island, some participants recalled overseas holidays to tropical destinations, such as Bali. While others were reminded of places closer to home. These memories appeared related to their positive experience of a place rather than how similar a place looks in relation to the VE.

“Is the XYZ⁴ Island or the time we were in the Philippines? It took me back to different memories, or definitely somewhere I’d like to go, you can imagine yourself on the beach with your towel and sunscreen... it took me to my own story to a time when we were on a beach...perhaps because I could imagine myself or it made me think about memories of my own...it just made me start daydreaming. I definitely found it a lot more relaxing the scenes that I could picture myself in, that took me to a memory or took me to another place.” (P3)

4.5.2 Using imagination

Many of the participants expressed an ability to create imaginative stories connected to the VEs. This creative ability enhanced their enjoyment of the VE and induced a strong emotional response. There was a noticeable difference amongst the participants and their imaginative responses after viewing the VEs. Some participants were literally buzzing with excitement after a VE and described in detail what they imagined happening or saw in the VE. Other participants described the VEs with little detail. They appeared to find it difficult to imagine or create a story within the VE. Narratives of the participants identified the importance of using their imagination or their ability to suspend disbelief to enhance their VR experience. Each participant had their own unique VR experience, and this could be different for each participant. This was reflected in what they shared about their ability or desire to suspend belief while being in the VE.

“I was trying to make a new idea of where I could be right now, so this is a new beach and maybe I’ve kayaked there right now but you find yourself quite lost in the scene, which is good...I could be sitting there by myself; I could be shipwrecked...you could go into lots of different thoughts. It didn’t remind me of anywhere that I could have been but it made me think about where I could be.” (P1)

4.6 Presence

Presence is often described as the feeling of ‘being there’ in the VE more than in the physical environment. This concept was introduced to the participants in the interviews. It was a concept that was unfamiliar to them. However, when they described their experiences in VR, they used terms that indicated that they were experiencing the concept of presence. They used phrases such as: “I was really in it” (P5), “it was

⁴ masqueraded for anonymity.

like I was instantly there...it didn't feel fake, it felt quite real which added to it." (P2), and "bubbles that came from me, that was sort of me, and it felt quite real." (P6). The expression of such phrases demonstrated a feeling of disorientation and of disconnect at times, of being between the virtual and the physical world. Presence is a subjective feeling and was experienced individually and to different degrees by the participants who used the VR. Participants spoke of scenes in the VEs that evoked a sense of presence.

"The dolphins...seemed to be attacking my goggles and the space thing...I didn't expect that, it was really cool, it felt like I was there." (P7)

Participants who viewed the dolphin VE were observed reaching out their hands as if to touch the dolphins. P8 described their experience of the dolphin VE: *"it was good, sometimes you felt like you wanted to go and touch them...it was as if you were there. Do you get people kind of [makes swimming gestures with hands], swimming around?"* The blob VE also evoked a feeling of presence for some participants.

"Maybe the weird one [blob VE]...I felt like I was more in it than looking...with the dolphins it was probably having the air bubbles coming out continuously and just the very natural sounds...the way things were interacting in a close way with me." (P5)

The ability of the VE to enable the participants to feel a sense of presence or being there and to be distracted was influenced by the extent that participants could relate to the VR story, images, and sound, immerse themselves in the VE, and by the movement and narration features of the VEs.

4.6.1 Relatability

The concept of relatability was described by the participants in many of the narratives. For the VE to feel real, to be believable and to be effective as distraction it needed to be an environment that they could relate to or imagine that they could be part of. The quality of the VR also had an impact. As demonstrated in the quotes, viewing a scene that was indicative of their own world experience was enjoyable, reassuring and relaxing.

"Probably the beach one, because that's where I felt most relaxed. I could just be there, whereas with the others I was aware that this is such a weird and wacky scene that I would never be in....I've never been to outer space, I've never been in a world with random

pain blobs, and I've never swum with dolphins...it's just my ability to put myself in the scene." (P9)

Some participants shared that they did not relate to the blob and space VEs as these environments were too outside of their everyday experience.

For some participants, these scenes created a sense of discomfort and unease. One participant (P11) found the blob VE different as it was appealing and helpful as a distraction due to the constant change and peculiarity of it.

4.6.2 Realism

For a VE to be relatable the realism of what was being watched and heard was a crucial feature identified by the participants. The technical quality of the images, the digital fidelity, such as pixelation, use of colour and depth images (e.g., perspective and shadows), or natural movements enhanced the experience of VR. Poor technical quality in the beach VE was found to be distracting in an uncomfortable way and caused several participants to complain of eye strain. The realism of the VE in terms of the content and storyline was also a feature. For this study only the space VE had both a narrator and a storyline so there was no ability to compare. In the three animated VEs the level of realism surprised the participants.

"It [beach VE] seemed a bit more pixelated than the [dolphin VE]...It was a bit harder on your eyes and a distraction from the good parts of the scene...and I think some of the quality issues meant that I was quite aware that it was a video...I don't know if it needs to be real...the actual quality of the images is important, the music and the sound is important." (P12)

4.6.3 Immersion

Wearing a VR headset gives the user an all-encompassing view of the environment they are watching. There is a sense of dimension that is experienced requiring the head to be turned, raised, or lowered and this creates realism through a fidelity that draws attention and results in the immersion of the experience. The images can be seen by the person moving their head 360 degrees. A person can see the VE in their peripheral vision also. The intent of this immersive experience is to block out the physical world as much as possible. Immersion in VR is also experienced by sound that appears to be all around them. This combination of visual and auditory sensory stimulation enhances the VR experience. The dolphin VE was considered very immersive. For some participants being immersed was about being involved.

“It was very immersive, it felt like being in the water ... seeing the dolphins moving around...so one might be over there moving around...and you can look up at the surface of the water and that seemed quite real...and you immerse yourself in the scenes and that’s quite a positive.” (P11)

For other participants, it was being in the audience; *“I found it quite immersive and quite relaxing and quite fun as well, being able to follow the dolphins around” (P15)*. Most participants spoke of immersion being a positive experience, but for a few participants it was not positive as the nature of the headset meant they could not get away from it.

“I suppose claustrophobic might be a word even though it’s the big open ocean, you feel quite immersed in it, which is possibly not a positive...I guess it feels quite all encompassing...the fact that you can look in any direction and it’s still there, unlike when you look at television...that does feel that it’s quite immersive.” (P13)

4.6.4 Interaction and movement

The VEs which had more action or movement occurring in them or more objects to observe or try to locate (e.g. dolphin VE) were more distracting for the participants interviewed. These VEs were often described as “busy”, with a lot going on and were considered as ideal to distract and engage with while viewing. There was a sense with the busier environments that you could be more of an active participant, be involved in the VE rather than watching it as a passive participant.

“There are nice, simple scenes so there’s not too much to distract. I did get a fright with one of the dolphins coming at my peripheral [vision]...[The blob scene] was quite beautiful, so different, and changeable and there was always something to look at.” (P1)

The VEs described by the participants as “slow” or “boring” (e.g., beach VE) had little movement in them, they were quite static. Although static, these environments were sometimes described as peaceful and relaxing but once again there was an indication of passivity, so it seems impossible to lose oneself in these environments.

“I found the [beach VE] quite boring, there wasn’t much to see, so I didn’t feel that distracted...as opposed to the other one, where I was, like, oh there’s another dolphin, whereas there’s just one lonely little turtle making its way up the beach...not a lot happening,

you’re thinking, wow that’s lovely but it’s almost as if there’s not enough happening for me to lose myself in.” (P14)

In the blob VE, the movement of the shapes coming towards the participants was described as, disconcerting, frantic. Several of the participants reported that this VE made them feel anxious and overwhelmed. P14 found the movement of the shapes towards her creepy and the feeling of being suspended in the sky added to this feeling of anxiety.

“First of, when I put it on, I was thinking, what the hell am I looking at, yeah, it made me feel quite anxious, because I couldn’t tell what anything was that I was looking at and then they were getting closer to me, whatever they were and I didn’t want them to touch me, it felt a bit creepy. I felt that I was suspended in the sky as well which was quite weird...and maybe, them coming not quite so close to you, so you could see them further away, but some of them were coming very close and for me personally, I was like, no I don’t like that.” (P14)

For P10, it was that the blob VE was, *“very busy...it felt a...little overwhelming...I didn’t like the fact that there was a lot coming at me at once...there was a lot going on.”* Interactivity, connected to movement, contributed to participants in this study experiencing the VE as more realistic and enhanced the enjoyment of the experience. It also contributed to feeling a higher level of presence, the feeling of being part of the VE. They found a VE more distracting when they felt they could be interactive within it. The combination of the movement of the dolphins up close and the use of bubbles was enjoyable and appeared to be synchronised to align with and or guide the breathing of the participants.

“I found it quite immersive and quite relaxing and quite fun as well, being able to follow the dolphins around with the breathing and bubbles. The beach scene I found that quite calming, maybe a little less interactive than the dolphin one. I felt I wanted something to happen, but I’m not sure when I’m in labour, whether that’s what I’d want or not (laughing).” (P15)

4.6.5 Narration and storytelling

In the space VE, there was a narrator telling the story of the birth of a star. This VE was made with real footage. Participants’ descriptions of this VE emphasised the importance of both the narrator and the storyline for both distraction and enjoyment. This VE was compared to a documentary or a

movie experience. It was engaging because it was telling a story that was compelling and needed to be watched until the end. Participants reported that they felt that they had to keep listening to find out what happened, like a movie. This VE was more likely to be described as distracting and engaging rather than relaxing, possibly due to the inclusion of a narrator and an educational component. The narrator, the music and the storyline all contributed to providing a distracting and engaging experience for many of the participants.

“Yes, I liked this one the best...it was definitely more engaging because it moved around, it talked to you this one was instant distraction and I like documentaries...it definitely made time pass and I felt that this one totally felt safe, instant curiosity, engaged, very colourful and the narrator is talking to you in a very soothing voice.” (P2)

It required participants to concentrate on what was happening as the facts were narrated.

“You’re completely transported away from what’s going on in the room...He was talking about some star formations, you wanted to know where he was going to next, which would make me, engage me more and probably spend longer in VR because there’s more coming.” (P1)

4.7 Envisaging using VR in labour

4.7.1 As escape

The participants actively engaged in all four VEs and all the participants wanted to use the VR device in their labour. They found using VR to be an effective distraction, describing it in terms of escape, and helping to remove them from the present reality. Many participants articulated they envisaged that they would use the VR in labour to distract them from the pain of contractions, as a tool to help them relax, and to encourage positive thoughts while labouring. The use of the word escape by the participants was a powerful description of how VR resulted in some participants feeling as if they had removed themselves from the physical environment and yet were present. Participants used words such as “remove”, “drift off”, “being taken away”, “lose yourself”, to convey this sense of escape from the physical world into the virtual world.

“I can see how it would take you away, you’re almost not even looking at it, it’s just something, and even the music, the music’s not very nice to listen to, [in blob VE] but it’s enchanting...I can absolutely see how it

would take you away from the immediate pain that you were feeling.” (P9)

4.7.2 As an anchor

In discussing VR and managing their labour pain, participants considered that VR could act as an ‘anchor’ and help them ground themselves, enabling them to feel calm and in control of their pain. They shared that they would use it as a visualisation tool to help bring them back to a serene, focussed state. As such a tool, one participant said that it would work similarly to meditation. Participants were concerned that when they were in labour, they would lose control. They wanted to avoid negative thoughts and the feeling that they were not coping with labour and the pain. They acknowledged that feeling out of control or catastrophising would affect their ability to cope with the pain of labour.

“I think because it’s so novel, it’s quite a distraction and staying in a curious and positive mindset, I think it would be really helpful for that and that’s what I’m looking forward to, yeah. I think that I’d really like to use it in early labour to enjoy the contractions, to not just suffer them but to get through them and to work with them and I think that the visuals and the visual cues will be reminders to stay calm and be relaxed.” (P4)

P4 found the space VE quite inspirational and moving. The imagined using the beautiful environment throughout labour to remind herself, that labour, like life itself, is transient and fleeting. She said this VE was empowering, and the images, the sound of the countdown and the operatic music in the scene would help release tension and aid relaxation while in labour. She would use the scene to pace herself between contractions.

“It’s fleeting [the space VE] like life is fleeting and that’s O.K...it’s really positive...the pacing [of the VE] because it was a narrative it felt like it had a beginning and an end and I think that’s going to be important, you will get through it [labour]. You have to go through it [labour] and the imagery of going through a star, of going through a cluster, that was wonderful, you have to go through it [labour], there’s no way of getting around it (laughing), it doesn’t have to be painful or scary, you just go through it...yeah, it was empowering.” (P4)

Participants perceived the VR as a ‘tool’ to include in their toolkit of complementary therapies for use in labour. They would not use the VR on its own but would use it alongside

and interchangeably with other techniques such as water immersion, music, hypnobirthing, other visualisation, and meditative techniques. They also envisaged that they would use VR to help relax them, to calm them and help them focus on their breathing techniques.

“From what I’ve learnt about labour in a very theoretical way, if you can be more relaxed, it helps, so I think I would probably use it for actual distraction from pain but also try and get myself kind of calm and relaxed.” (P12)

4.8 Ideal virtual environment

Envisaging how they would use VR in labour and after trying out the four VEs, the participants described features and environments that they thought they would enjoy in their labour and that they would find distracting and relaxing. There were a variety of environments mentioned, demonstrating how subjective a VR experience is. Features participants wanted, included the natural world, people, particular sounds and colour. For some participants, environments that interested them and were personal to them were important.

“It needs to be an environment that the person wearing the goggles finds relaxing, so if someone’s afraid of water, they’re not going to like the underwater dolphin scene...I’m quite an active person so I like to see scenes where there’s things happening to keep my interest.” (P14)

The idea of a natural environment was popular:

“I quite like rainwater, like walking through bush, and being in that setting, like a rainforest...and the bird-life...that would be something I’d be interested in...I quite like the calming music that goes with some of the VR environments.” (P10)

For some, their love of animals was incorporated into their idea VE, combining nature and animals.

“I can imagine something like being in Africa with elephants and lions, just being able to watch and to see animals moving in their environment.” (P17)

The idea of incorporating people and family members into the VEs was mentioned several times in terms of enjoying the environment. While several participants mentioned that would want to know the people, others considered just having people present who were being natural was sufficient. Participants considered the presence of people would either

act as a distractor watching people on a beach or at a café or would be a motivator to help with labour.

“I would like a natural scene, not very many people, a few kids in there, just to remind you that it’s all worth it....you’re doing this for your children. Yes, absolutely, my hubby and my daughter, if I could replay the whole Fiji experience in that I was just hoping I’d get with the beach scene...” (P18)

Only one participant (P14) did not want any people in the VE, she wanted privacy and isolation, imaging herself as the only one present [beach VE] in the kayak. The ideal VE for labour had to be relaxing, as opposed to being a distraction. These participants talked about preferring environments that had “not much going on”. Movement in the VE would be slow and repetitive.

“Something that’s just a little repetitive is probably quite good, so the waves coming in and out, the tree waving gently, that’s something that can lull you, something you can relax your breathing too, something that’s nice and slow, nothing moving too fast.” (P1)

The movement would also help with contractions and should be designed to be specific to labour. One participant related the opening of a cervix to a flower.

“The opening visuals, your muscles and the different muscles in the uterus contracting up and opening of the cervix. I think that the opening visuals could be helpful, you know flowers opening.” (P4).

In contrast, other participants described their ideal VE as one that would be the most distracting in labour. They wanted busy VEs with a lot happening in them and VEs that were interactive, that they could move with, rather than just passively watching.

“This book that I was reading about, they were using VR. It described a scene which sounded quite cool, where you were on a...device, floating down a river and kind of going past various things that, when you looked over one way you would veer slightly that way. And quite interactive, yeah you can control it a little bit.” (P15)

One participant who had previously used VR wanted something extremely fast like a rollercoaster, interactive game, and distracting.

“The only other times I’ve used VR was the shark encounter and you were going down in a cage and it was purposefully designed to try and scare you, there were sharks swimming, and you don’t know what’s coming and there are things coming up from the deep, it’s so real and it’s almost like, I would go that way, or a rollercoaster or extreme things...” (P9)

Narrative was identified as an important component for the VE to be distracting, a combination of a narrator voicing the story and a storyline within the VE. Topics suggested included a travelling narrative, a museum tour, and works of art. Participants identified how different features could be used for different purposes, for example, the dolphin VE was described as mainly for relaxation while the space VE that was narrated was more for distraction.

“When the narrator talked, that really helped as well....but if he’s talking to you, it’s like that’s really calming and you get to turn around and look at all the scenery.” (P2)

5 Discussion

The results identified that all four VEs shown to the participants in the antenatal period were able to induce a range of emotional responses. These emotional responses were subjective and varied between the participants, although commonly the underwater dolphin VE and the beach VE were described as “relaxing”, inducing feelings of “calm” and “happiness.” The ability of VEs to evoke a specific emotion has been identified as relating to cognitive psychology (Baños et al. 2004, 2008; Felnhofer et al. 2015; Riva et al. 2007). Scenarios of VEs are set up to induce most commonly specific emotional states such as relaxation, joy, sadness, and anxiety.

Participants in this study identified two main features that assisted them in evoking an emotional response from the VE. These were the use of memory, recalling a past pleasant experience that was associated with a positive mood and their use of creative imagination. Participants were reminded to tropical holidays, beach days with their family and for one participant, a connection with a memory of a loved one through a specific VE. These results could lead to the creation of a VE that is a personal memory to use antenatally and in labour to help induce an emotional response.

Similarly, in a study on the experience of women who laboured in a delivery room, the use of visual and auditory stimuli elicited positive emotions because they were associated with important aspects of the couple’s daily lives. The projection of natural landscape scenes on walls of the room

were positive distractions and women described recalling childhood memories from the beach (Nielson and Overgaard 2020).

The ability to suspend belief is a strong precursor to having an enhanced VR experience and to perceive the media as realistic. Many participants gave a detailed description of their time on the tropical island. They imagined how they got to the island, who might be with them and what they did on the island. These rich imaginative narratives indicated that they had found the VE both engaging and enjoyable. Creative imagination and engagement together with a willingness to experience presence in VR are also reliable predictors to experience presence (Sas and O’Hare 2005). Presence is defined as the extent to which something (environment, person, object, or any other stimulus) appears to exist in the same physical world as the observer (Felton., 2021).

For the participants, the ability of the VE to feel more real than the physical world or to be distracting was the relatability of the scene. Relatability originates from the verb “relate”, since 1965 in the Oxford English Dictionary “relatable” has gained the meaning of something “which one can identify with or empathise with”. The ability to connect their experience in VR to prior experiences allows the participants to bring their own knowledge and expectations into play. This creates a more compelling and memorable illusion (Thornson et al. 2009). In their discussion about the VR experience, Sherman and Craig, (2003) identify a specific confluence of factors which work to persuade the user of the existence of the VE. The very first of these factors is that the environment needs to be personally meaningful to the participant.

Several features of the VE were identified by the participants in this study as contributing to an increased feeling of presence or more effectiveness as a distraction technique. The theory of distraction determines that attention is required for pain and exists in a limited supply, therefore, diverting attention by the use of VR, can reduce the resources available for processing pain (Li et al. 2011). Participants identified immersion in VR. They described being able to look all around them and experience the sense that the physical world was shut out. There are several indicators that are used to qualitatively measure how immersed a participant feels within a VE. As demonstrated in this study, an obvious method is to ask a participant how deeply they felt they were immersed in the VE. Another method is to observe the participant and their reaction to the VE.

Findings from this study indicated that all participants would use VR in their labour and that they considered it an acceptable and feasible intervention. The participants described the VR as enjoyable and novel and they were looking forward to using it either in early and active labour

or both. They identified that the VR could be used in a variety of ways, as distraction or ‘escape’ and as an ‘anchor’ or a way of grounding themselves and to avoid negative thoughts or catastrophising. This is the one of only a few qualitative studies that explored women’s experience of using VR in the antenatal period with a view to using it in labour. Other research studies have identified a range of pain-coping strategies that women describe they would want to use when they are in labour. Lowe (2002) found that strategies for managing pain include relaxation, distraction, imagery, breathing techniques, control and focusing.

Findings from this study identified the use of breathing as a relaxation technique. In the dolphin VE participants could synchronise their breathing with the bubbles coming out of the virtual diver’s mask. The potential impact of VR on breathing has obvious benefits for women in labour. Women in labour are very focused on their breathing and are coached by support people and midwives on how to breathe through contractions and in between. The use of controlled breathing is a coping strategy to reduce stress and anxiety and is favoured in all stages of labour (Simkin and Bolding 2004; Thomas and Dhiwar 2011; Thomson et al. 2019).

Other research has also identified the role that catastrophising has and how it leads to women thinking increasingly more negative thoughts in pregnancy (Escott et al. 2009; Felnhofer et al. 2015). Participants in this study wanted to avoid catastrophising in labour, however the alleviation of anxiety and pain-related fear antenatally can impact both the intrapartum and puerperium period. Flink et al., (2010) found that women who did not catastrophise before labour had a better postnatal recovery. In contrast, women who catastrophise prior to labour reported higher levels of discomfort postnatally (Escott et al. 2004; McNeil and Jomeen 2010).

To help inform the design of VR-based interventions for pregnant women, participants described the type of VEs and features that they would like to view such as a pleasant memory of a place, holiday or with people they cared for. The playing of a pleasant memory may help induce an emotional response and enhance the emotional experience of the VE. Views of nature (e.g. mountain or tropical island) were also identified by many participants as their preference as they were calming and relaxing).

5.1 Limitations

The sample of participants was purposively selected, and the participants who consented were highly motivated to experience VR while they were pregnant and in labour. The study was exploratory in nature, thus of necessity it was conducted with a relatively small sample size, however this does not negate the worthiness of these findings, rather it

provides an opportunity to present unique perspectives from the participants. It is not known how applicable the findings are to pregnant women generally. The author acknowledges that the four VE’s were shown to both nulliparous and multiparous participants and the potential differences between these two groups is not addressed. There is the potential for multiparous participants who have had experience with using nonpharmacological techniques in their previous labour to identify more clearly how they would use the VR in their labour and possible preferences for VE’s for use in labour. The lack of participant input before selection of the VE’s to be trialled could be considered a methodological limitation and in future studies the selection of VE’s should be discussed with the participants. Only four VEs were trialled (due to limited time), however the findings may have application in the design of VEs as it evaluated user preferences and expectations in the use of VR in the antenatal setting. The space VE was unique in relation to the other 3 VE’s. The space VR was a documentary type environment, therefore included real footage, no animation and had a strong narrative presence. No control device was compared against the VEs and headsets.

6 Conclusions

Participants in this study trialled four VEs to familiarise themselves with VR antenatally and to determine whether VR would be acceptable and feasible to them to use in their labour. All 18 participants wanted to use VR in their labour. Based on the findings from the research, participants enjoyed their experience of using VR while pregnant, they found it emotionally arousing, effective as distraction as well as relaxing. Participants wanted to use the VR in their labour as a complementary alternative therapy and as a coping strategy to help manage pain, aid relaxation and to feel in control. Findings from this study point to directions for future research in the use of VR both in the antenatal period in preparation for relaxation and stress reduction in labour. This research provided new knowledge in VR and design of VEs for use by pregnant women. This research identified features of VEs that induced emotional responses, contributed to enjoyable experiences, increased the sense of presence and levels of distraction. These features have the potential to help influence the design of the effectiveness of VR in pregnancy and labour. Findings from this research supports the use of VR as a medical technology with benefits for pregnant women antenatally, and in labour.

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Declarations

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