VR Therapy for Menstrual Relief: An LLM Approach

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***Abstract*—The paper explores the use of Virtual Reality (VR) as a non-pharmacological method for managing menstrual pain. It highlights the high prevalence of dysmenorrhea (menstrual pain) and the limitations of current pharmacological treatments. The study integrates VR with large language models (LLMs) and generative AI to create personalized VR experiences to alleviate individual pain experiences according to participants' preferences. The research involves analyzing survey data, utilizing GPT-4 for prompt generation, and crafting VR environments that incorporate elements like music and immersive scenes. The experiment's results, though based on a small sample size, suggest that VR therapy can be an effective and engaging method for managing menstrual discomfort, indicating the potential of VR as a complementary method to traditional pain relief practices.**

***Index Terms*—Menstrual pain, VR, LLM, Generative AI**

I. Background

Menstrual pain, or dysmenorrhea, encompasses a range of symptoms including cramps, lower back pain, nausea, and headaches. The prevalence of dysmenorrhea is high, with around 80% of women experiencing period pain at some stage in their lifetime [1]. Furthermore, studies indicate that a significant percentage of women experience pain severe enough to affect their daily activities [2]. The impact on quality of life is notable, often leading to absenteeism from work or school and a marked decrease in overall life satisfaction.

A. Limitations and Side Effects of Pharmacological Treatments

The most common pharmacological treatments for menstrual pain include Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) and hormonal contraceptives. While these methods are effective for some, they present limitations and side effects that can be problematic. NSAIDs can cause gastrointestinal issues, and hormonal contraceptives are not suitable for all women due to their contraindications and side effects such as weight gain, mood changes, chest pains, irregular heartbeat, dizziness, and increased risk of blood clots [3, 4]. These challenges underscore the need for alternative pain management strategies.

As a result, there is a growing demand for non-pharmacological approaches to pain management, driven by the limitations of traditional treatments. Non-intrusive methods, in particular, are sought after for their minimal side effects and potential to be more inclusive and accessible. Non-pharmacological interventions can range from physical therapies to psychological approaches, offering a broad spectrum of options for individuals who cannot or choose not to use pharmacological treatments [5].

B. Emergence of VR as a Therapeutic Tool

Virtual Reality (VR) has emerged as a promising tool in the realm of pain management. Its application in chronic pain, postoperative pain, and even in palliative care has shown encouraging results. VR's ability to provide immersive, distraction-based therapy offers a novel approach to pain management, and its potential to address menstrual pain is an area of growing interest. The interactive and engaging nature of VR could offer a unique method for mitigating the discomfort associated with menstrual pain [6]

The effectiveness of VR in modulating pain perception is justified through several biological mechanisms:

- **Distraction Therapy:** VR distracts the brain, reducing the user's focus on pain. This distraction can decrease pain signals sent to the brain, lessening perceived pain intensity [7].
- **Altered Pain Processing:** VR can alter how the brain processes pain signals. By engaging multiple senses in a virtual environment, VR can modify the neural pathways involved in pain perception, potentially reducing the pain experience [8].
- **Stress Reduction:** VR experiences can induce relaxation and reduce stress, which is often a contributing factor to pain. Lower stress levels can lead to decreased pain perception [9].
- **Endorphin Release:** Engaging VR experiences may stimulate the release of endorphins, the body's natural pain relievers. This can provide a natural and drug-free method of pain relief [10].

C. Need for Personalized VR Experiences in Menstrual Pain Management

Virtual Reality (VR) therapy's effectiveness in pain management, including menstrual pain, can be significantly enhanced through personalization, aligning with the principles of precision medicine. Customization allows VR experiences to be tailored to individual pain experiences, preferences, and biometric feedback, thereby improving engagement and effectiveness [11, 12]. In a research project conducted by Pardini et al., 90% of the individuals in the study preferred a personalized environment because it advocated the realism of the stimuli and reminded them of the places they experienced in their childhood thereby enabling them to experience a greater degree of comfort [13]. Furthermore, the concept of personalization in treatment, as seen in areas such as addiction recovery, stresses the importance of addressing individual needs and circumstances. This approach can be mirrored in VR therapy for menstrual pain, where individual differences in

pain perception and coping mechanisms are considered which can in turn address age-specific needs and reduce stress [14].

The high prevalence and significant impact of menstrual pain call for diverse and effective management strategies. While pharmacological treatments have been the mainstay, their limitations, and side effects necessitate the exploration of alternative methods. Non-pharmacological, non-intrusive approaches, especially the innovative use of VR, present a promising avenue for pain management. This paper aims to explore the effectiveness and feasibility of VR therapy as a tool for reducing menstrual pain perception, providing a potential pathway to enhance the quality of life for many women.

II. CURRENT WORK

A. Current Work on VR for Cognitive Behavioral Therapy (CBT)

Recent advancements in Virtual Reality (VR) have introduced innovative approaches to Cognitive Behavioral Therapy (CBT), demonstrating significant potential in treating various mental health disorders and chronic pain conditions. For instance, the FDA's authorization of the EaseVRx system for chronic pain reduction marks a significant milestone in VR applications in healthcare. EaseVRx employs principles of CBT for pain reduction, using a VR headset and a breathing amplifier. It consists of 56 sessions, each 2-16 minutes long, intended for an eight-week treatment program. In their study, EaseVRx showed a significant reduction in pain compared to a control group. The system was granted Breakthrough Device designation by the FDA [15]. In addition, XRHealth offers VR-based treatments for chronic pain, providing personalized therapeutic experiences. Their approach, similar to EaseVRx, harnesses VR's immersive capabilities to engage patients in interactive environments, applying CBT principles and other therapeutic methods. This integration of VR in healthcare exemplifies the potential for personalized and effective treatment strategies in chronic pain management and mental health disorders [16].

B. Integration of LLMs and Generative AI in VR Development

This project aims to render personalized VR experiences to help reduce menstrual pain perception through a combination of LLMs, generative AI, and VR. The experiences and preferences of each participant will be analyzed using a trained LLM to generate an optimized prompt for a virtual environment. This prompt will be fed into a generative AI tool to create immersive virtual skybox spaces. This methodology is further explained in the Analysis Section of the report.

III. DATASET

A. Creation

A survey response-based dataset was created to develop personalized virtual reality (VR) experiences for managing period pain. This dataset, gathered from survey responses of 29 women, though small, is rich in personal insights, covering demographic information (age and ethnicity), detailed menstrual cycle data (average flow, period duration, discomfort levels, cycle lengths), methods used for pain relief, emotional states during menstruation, interest in VR-based pain relief, and preferences for VR content, including lifestyle choices like vacation spots, favorite animals, and music genres which people tend to gain comfort from. The majority of participants are Asian (87.5%), with smaller proportions of White (6.3%), Hispanic or Latino (3.1%), and Black or African American(3.1%) respondents, and the age range is 17 to 50 years, with a median age of 23.5 years, highlighting a younger demographic. The uniqueness of our dataset lies in its comprehensive compilation of survey responses that detail a spectrum of emotional responses related to period pain—a critical element that is frequently overlooked by traditional medical datasets, which often focus solely on the clinical aspects of menstruation-related disorders. The richness of our dataset extends beyond mere symptomatology, delving into the realm of personal experiences and emotional states that are pivotal in the perception and management of pain. This approach is crucial for creating empathetic and effective VR experiences.

B. Biases

The dataset's reliance on a technological medium for the survey introduces selection bias, as it may exclude those less comfortable with technology. The self-reported nature of the data can lead to self-reporting bias, and the small sample size raises concerns about sampling bias, limiting the dataset's representativeness of the broader population. Additionally, the ethnic composition of the dataset, predominantly Asian, could lead to cultural bias, as the experiences and attitudes towards period pain might not be universally applicable across different ethnic groups. Another critical consideration is the dynamic nature of pain and emotions. The experience of pain and emotional states can fluctuate due to hormonal impact significantly, which predefined survey questions might not fully capture. These static responses might not reflect the day-to-day or even intra-day variability in what individuals find comforting or effective for pain relief.

C. Cleaning

The data cleaning process involved removing irrelevant data, correcting errors and typos, and standardizing formats using text mining and NLTK. This was done to select useful features and ensure data consistency, particularly for generating prompts without using sensitive words that might trigger negative emotions while on period.

IV. ANALYSIS

A. LLM's

We used GPT-4 for the extraction of valuable insights from a set of survey questions to generate a prompt. Before selecting between GPT-4 and LLaMa-2, we tested with LLaMa -2 but found emotionless answers and hallucinated responses. Therefore we proceeded with GPT-4. During the feature selection phase, the survey questions delved into emotions, preferred VR experience elements for comfort, and coping mechanisms

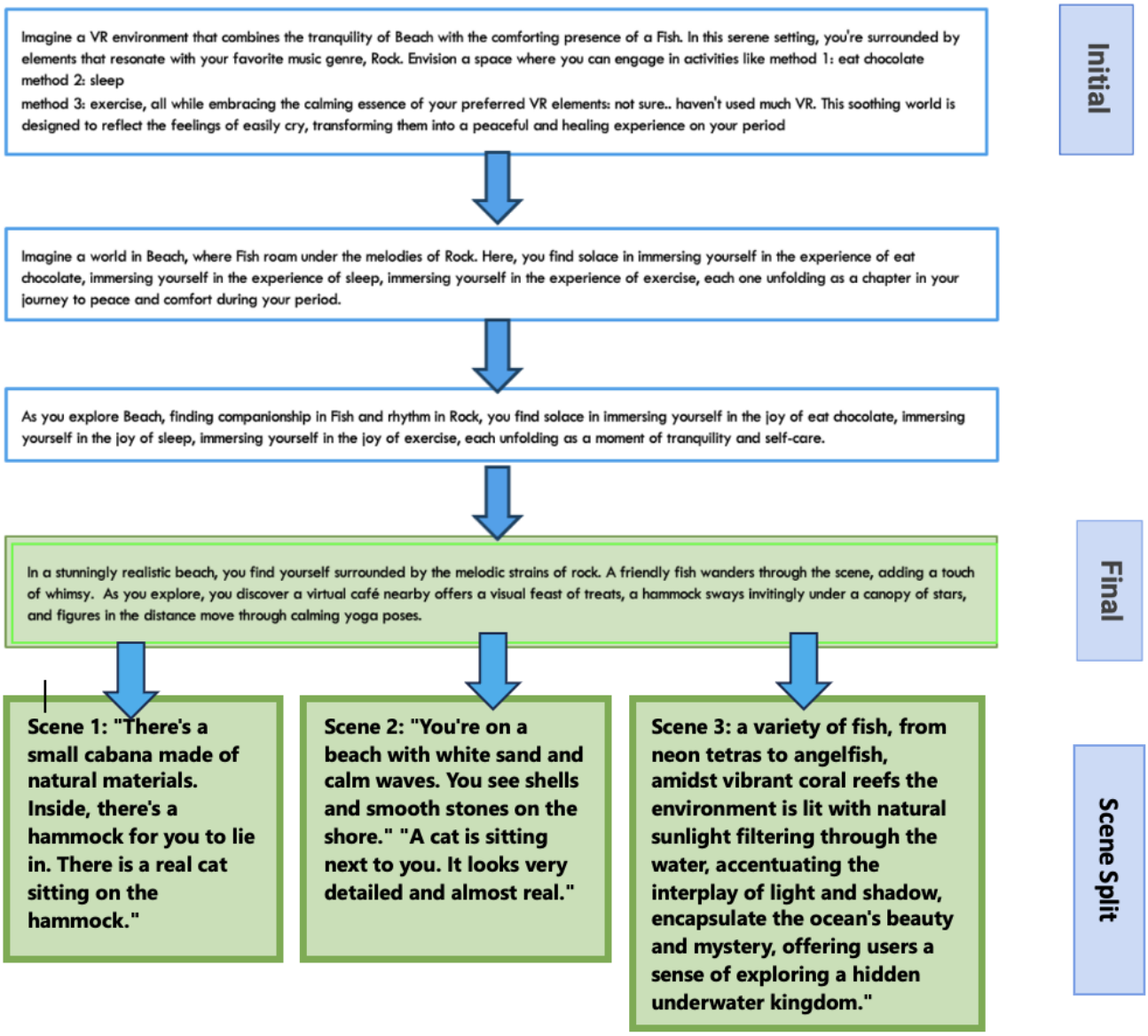

Fig. 1. Prompt Generation Process.

during menstruation. However, usage of sensitive words like ”period” and ”medicine,” was detrimental as that didn't add value to the visual aspect of the prompt. Additionally, the lengthier prompts were unsuitable and intangible for the VR environments since it. To address this, we employed feeling-based and olfactory-based conversion methods, simplifying the storyline and dividing it into multiple scenes. The feature engineering process involved transforming the original, intricate prompts into more concise and generalizable versions to enhance the overall effectiveness of the survey. **Fig. 1**

B. Music Generation

Recognized for its positive impact on emotional well-being and cognitive function, music therapy holds great value, especially during periods [17]. To enhance the auditory dimension of our VR scenes, we explored music integration using OpenAI Jukebox and Meta AudioCraft libraries. However, issues like poor audio quality and the inability to capture subtle musical emotions or lyrics led us to Google's MusicLM. Overcoming initial setbacks, MusicLM became the cornerstone of our music generation strategy, seamlessly integrated into our VR experience. This allowed users to enjoy a captivating musi-

cal atmosphere, enhancing overall immersion and engagement within our virtual realms.

C. VR

We seamlessly incorporated Blockade Labs' open-source text-to-VR Skybox generator into our workflow. Initially leveraging prompts from our GPT-4 model, we encountered limitations in handling lengthy prompts and potential information loss. To address this, we adopted a more effective strategy by creating shorter scene prompts stitched together for the intended effect. Additionally, Blockade Labs provided 2D images initially, limiting user interaction. To enhance immersion, we skillfully crafted equirectangular images using the open-source project Gensis (refer to **Fig. 3**). These images enriched the scenes with depth, a critical for creating dynamic environments. Ultimately, our approach empowered users to traverse and explore virtual realms, offering an elevated interactive experience.

V. EXPERIMENT

The Experiment started with participant recruitment where 4 participants met our criteria and we collected survey responses, participants wanted experiences that had scenes related to beaches, mountains, and camping, where they chose cats and fish as their favourite animal and music of pop, country, and classical genre. These responses are then analyzed through text mining using NLP techniques to extract key information. The insights gained are used by a language model, GPT-4, to generate tailored prompts, including a 'comfort prompt' aimed at fostering a sense of well-being. This prompt is used to create a soothing song via a music generation model, MusicLM, which presumably complements the VR environment. The prompts are optimized for the intended experience, which is then crafted into an immersive VR session. During the session, participants are continuously monitored with a pulse oximeter to track their physiological responses, ensuring safety and gauging the experience's impact. The VR experience is tested on users, and their feedback is collected through a post-experience survey, likely to refine the process and enhance the personalized experience. A comparison is done with how these participants would feel in VR therapy vs when they use a YouTube video of a similar genre. **Fig. 2**

VI. RESULTS

A. Summary

In this VR experiment for menstrual pain relief, tailored experiences using GPT-4 generated prompts were preferred over LLaMa-2, enhancing personalization for participants. While participant experiences and physiological data—marked by heart rate variations—indicated positive responses towards VR therapy, these results are inconclusive due to the small sample size. Participants generally reported engagement and distraction from pain during VR sessions, contrasting with the more relaxed yet less engaging experience of YouTube videos making the user impatient in the static position. Despite survey feedback supporting VR therapy's perceived effectiveness, the limited number of participants constrains the generalizability of these findings, making broader conclusions about VR therapy's efficacy in menstrual pain management tentative.

B. Interpretation

Incorporating detailed participant experiences with specific pulse rate statistics, the VR experiment for menstrual pain relief provides insightful revelations about the effectiveness of VR therapy in pain management.

Participant 1's average pulse rate during normal conditions was 83 bpm (min 78, max 86) **Fig. 4.** During VR therapy, their pulse rate exhibited more variability, averaging at 81 bpm with a range from 69 to 93 bpm **Fig. 5**. This fluctuation parallels their mixed emotional response to the VR environment, ranging from feeling impressed by certain visuals like the beach scene to feeling confined in the closed setting. They expressed that they would like to experience a place in the VR setting where they can travel, which is something that is restricted to do during periods. Interestingly, while watching the YouTube video, their average pulse rate decreased to 77 bpm (min 66, max 93) **Fig. 7**, indicating a more relaxed state despite less interactivity potentially because of less excitement and static position.

Participant 2 maintained an average pulse rate of 83 bpm (min 75, max 94) **Fig. 4** under normal conditions, which remained consistent during VR therapy (average 83 bpm, range 72 to 97 bpm) **Fig. 5**. This response aligns with their positive VR experience of feeling trippy and distracted from menstrual discomfort despite the feeling of dizziness and heaviness from the headset. their preference leaned towards the scene with fishes and liked the music incorporation but would prefer more familiar music. During the YouTube video, their pulse rate averaged lower at 76 bpm (min 65, max 95) **Fig. 7**, pointing to a calmer yet potentially less engaging experience.

Participant 3 had a normal average pulse rate of 84 bpm (min 76, max 92) **Fig. 4**. In contrast, during VR therapy, their pulse rate notably decreased to an average of 75 bpm (min 66, max 85) **Fig. 6**, indicating a relaxed and engaged response to realistic VR scenes like the camping setup, however, faced challenges navigating. The YouTube video further lowered their pulse rate to an average of 67 bpm (min 60, max 80) **Fig. 7**, suggesting higher comfort but less engagement, potentially due to lack of excitement and static position.

Participant 4 showed a higher normal pulse rate of 100 bpm (min 92, max 115) **Fig. 4**. During VR therapy, their pulse rate decreased to an average of 92 bpm (min 83, max 103) **Fig. 6**, reflecting relaxation and enjoyment specifically during the waterfall and ocean scene. despite some frustration with VR boundaries. While watching the YouTube video, their pulse rate was slightly higher on average at 93 bpm (min 86, max 105) **Fig. 7**, but still indicated a relaxed state potentially because they felt impatient and anxious in the static position.

The survey responses, alongside the experimental feedback, reveal a nuanced picture of VR therapy's impact on menstrual pain. Participants generally rated their period pain as mild to moderate **Fig. 8**. The effectiveness of the YouTube video in

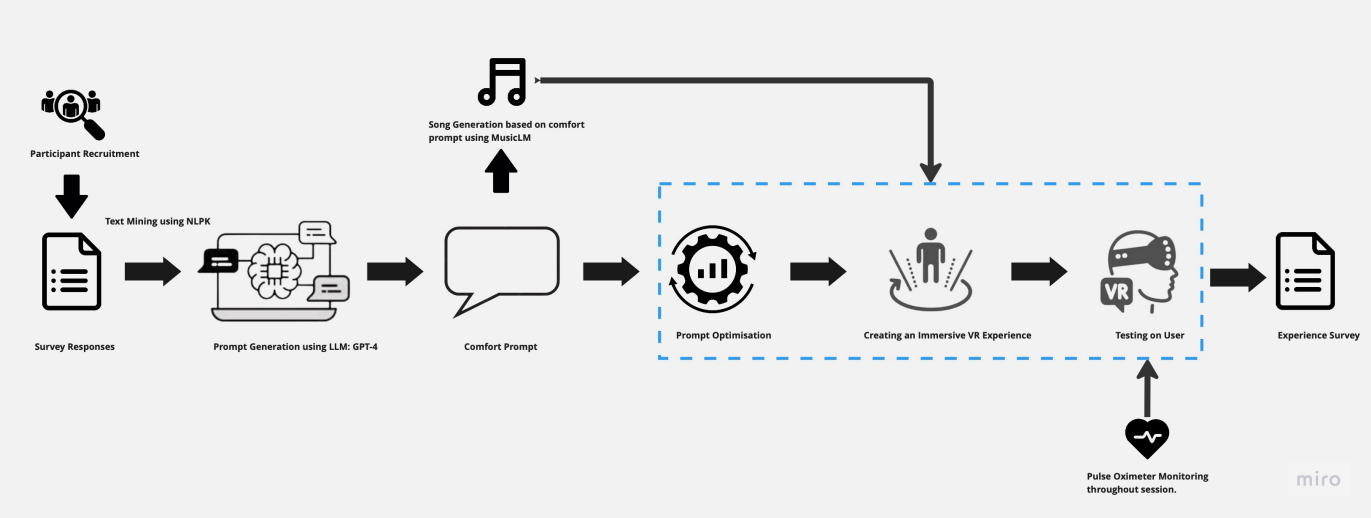

Fig. 2. Experiment Flow

alleviating period pain received mixed responses, with some participants finding it somewhat helpful, while others did not see much benefit **Fig. 9**. In contrast, the VR therapy experience was more favorably received. Most participants found the VR therapy effective in alleviating period pain **Fig. 10**, with several rating its effectiveness moderately high **Fig. 11**. The satisfaction levels with VR therapy were also positive, indicating an overall good experience with the VR environment and its potential for pain relief. Some participants favored traditional remedies over VR therapy for future pain relief, highlighting the need for a personalized approach in pain management **Fig. 12**. However, the interest in VR therapy as a future option was notable, suggesting its potential as a complementary method to traditional pain relief practices. Link to participant experiences

VII. CONCLUSION

The results of this study indicate that VR therapy can be used as a potential alternative for menstrual pain relief. The integration of immersive VR environments with user-specific preferences, supported by physiological data (pulse rate variations), suggests that VR therapy can be an effective, engaging, and personalized approach to managing menstrual discomfort. The varying physiological responses, combined with subjective experiences, emphasize the importance of customizing VR experiences for optimal pain management.

A. Limitations and Future Work

While this study resulted in positive outcomes for the participants, more iteration is necessary for improved results. Firstly, due to the lack of access to the premium version of Blockade Labs, we faced token limitations as well as restrictions to use several generation styles. In addition, the study requires the participants to be on their period and experiencing pain. However, 50% of the participants were on the fourth day of their period and were not experiencing the same level of pain as on the first or second day. This requirement, added to time constraints and limited access to VR headsets, posed several challenges in conducting the experiments. Lastly, each scene was developed directly on the headset which disrupted the smooth transition between scenes and the tranquil and immersed state of the participant.

In the future, we would like to refine the VR scene generation by exploring different tools as well as training and utilizing a GAN. We would also like to automate the pipeline for runtime scene and prompt generation using the user's voice commands. Currently, we have a script that can generate the prompts from user information and save the generated scenes. Since the integration of music received positive feedback from the participants, we plan to train an ensemble LSTM and LLM model to select the most appropriate song based on the scene prompt and the user's vitals. Furthermore, the personalization aspect of the project can be enhanced by replacing the capsule in the scenes with a personalized avatar that is chosen and designed by the user. In hindsight, we believe that it is worth exploring the effect of existing Meta apps, as per the participant's preference, for the objective of the project.

VIII. CONTRIBUTIONS

Harshini and Mahira worked on prompt optimization, explored different LLMs for analyzing the users' responses, and generated the Skybox images. They also coordinated the experiments by designing the surveys, recruiting participants, and arranging for the required devices. Khushi developed the VR environment, created the scene for each participant in Unity, and added interaction to the Skybox images. During the experiments, Khushi handled the deployment of the scenes, Harshini took notes, and Mahira monitored vitals and guided the participant. They also worked on writing the report. Lisa worked on the ideation of the project, researching existing tools for the project, exploring automation of the pipeline and music generation, and review of the report.

GPT - 4 Generated Prompt for scene: "Envision a stunning waterfall cascading into a pool by a vast ocean. Lush shores, tropical flowers, and swaying palm trees frame the scene. The sky is a brilliant blue, with the soothing sounds of waterfalls and ocean waves blending in a tranquil natural paradise."

Blockade Lab's generated scene

GPT - 4 Generated Prompt for scene:A tranquil campsite under a star-filled sky, surrounded by the quiet beauty of the countryside. The scene includes a cozy tent, a crackling campfire, and comfortable camping chairs.

Blockade Lab's generated scene

GPT - 4 Generated Prompt for scene:"Envision a stunning waterfall cascading into a pool by a vast ocean. Lush shores, tropical flowers, and swaying palm trees frame the scene. The sky is a brilliant blue, with the soothing sounds of waterfalls and ocean waves blending in a tranquil natural paradise."

Blockade Lab's generated scene

Fig. 3. Prompt to Scene Examples

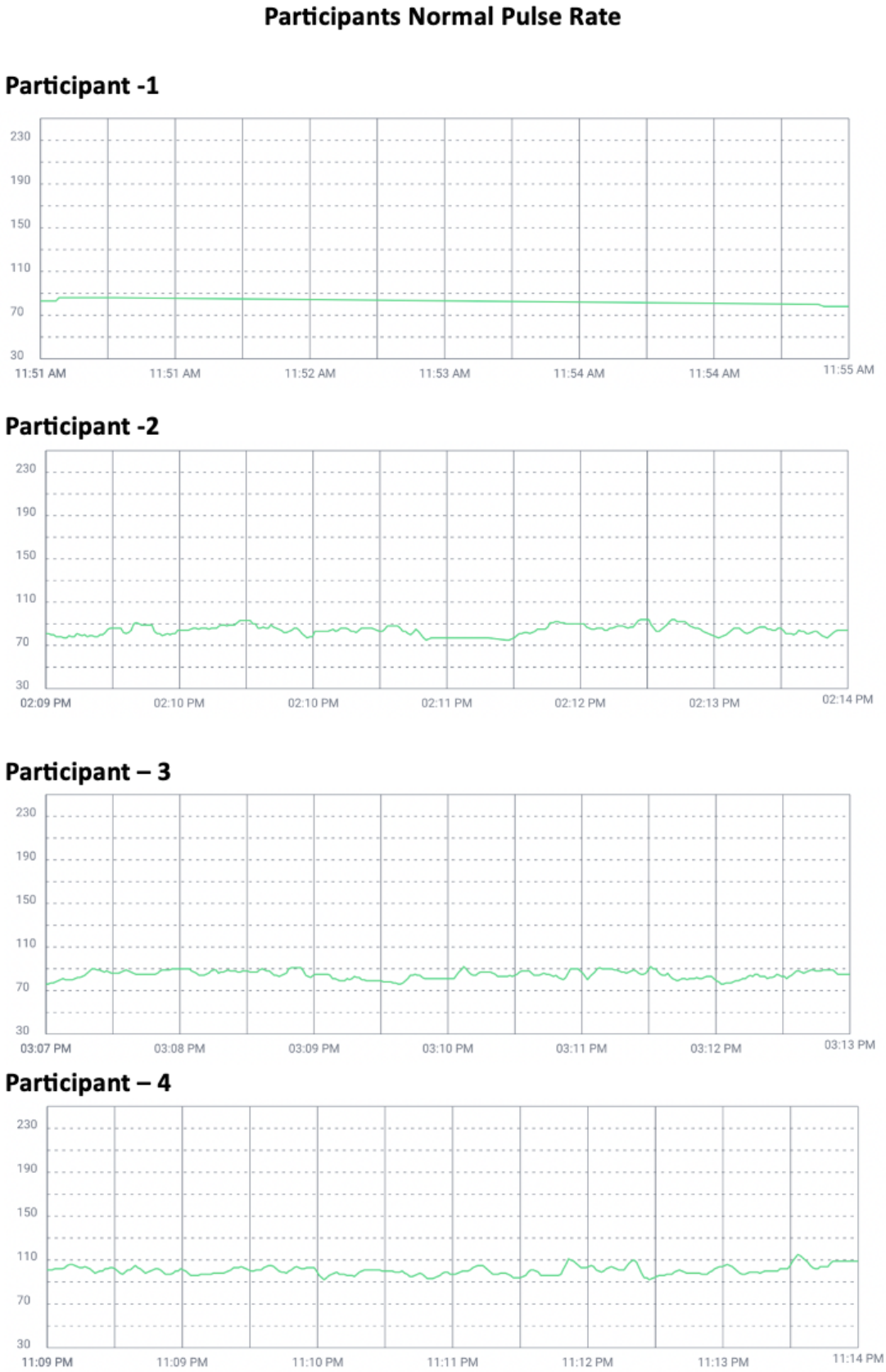

Fig. 4. Pulse Heart Rate of Participants Prior to Experiment.

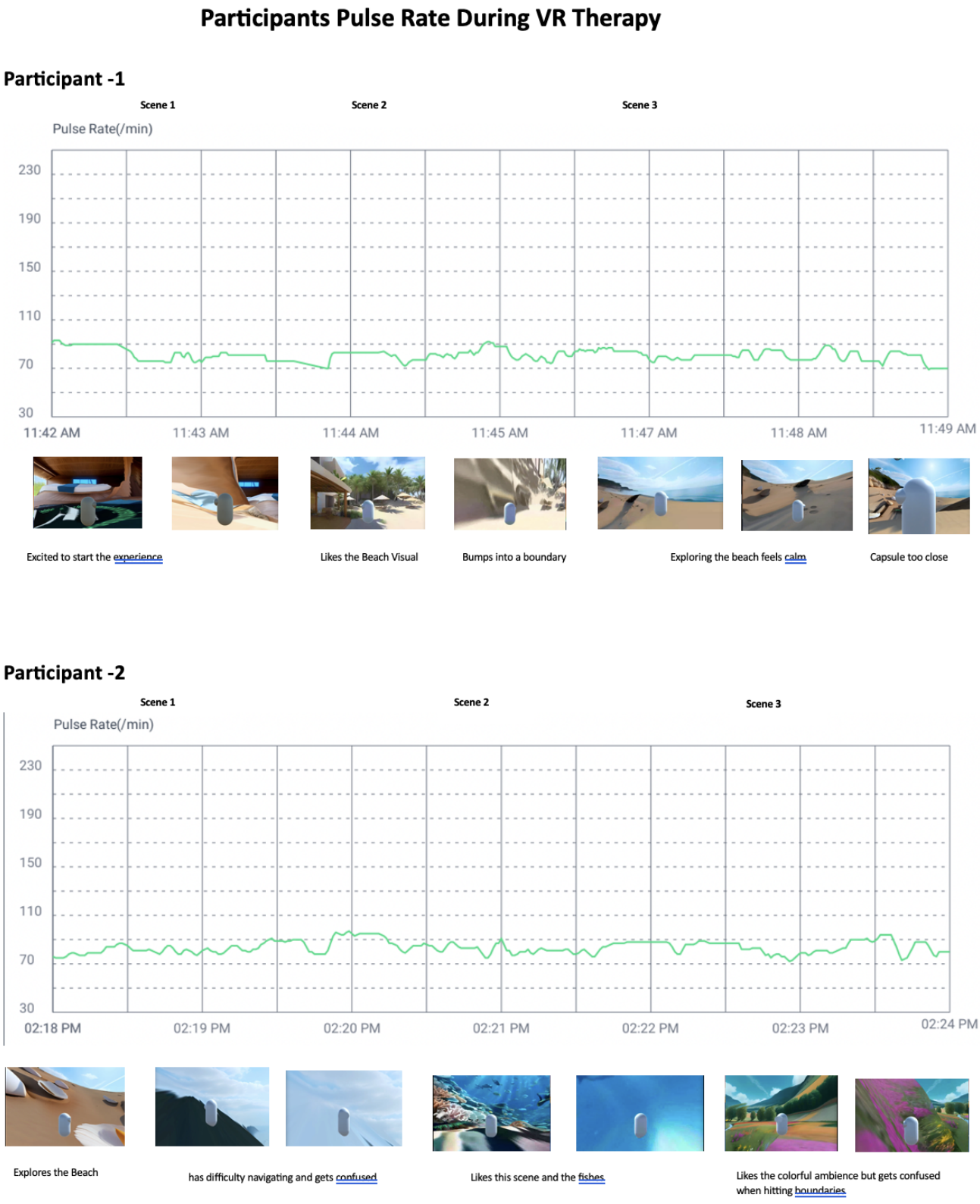

Fig. 5. Pulse Rate of Participant 1 and 2 During VR Therapy, showing variations according to scene.

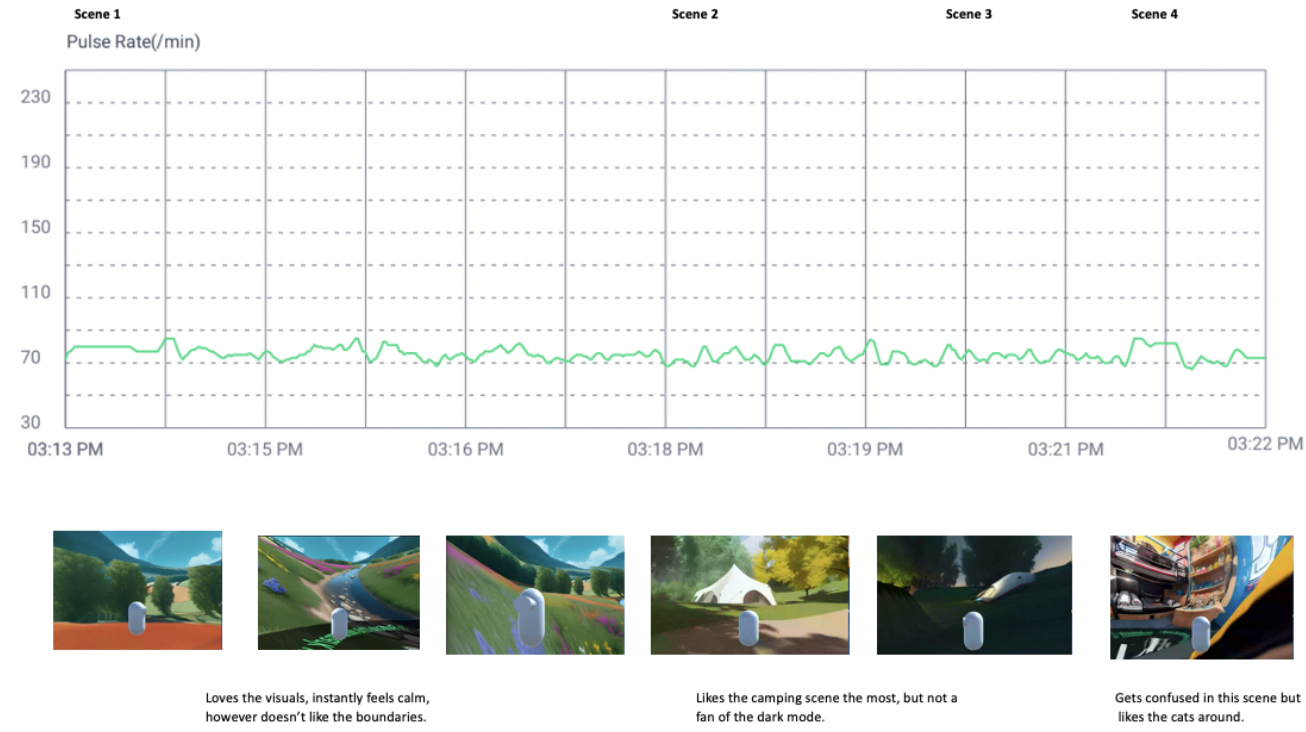

Fig. 6. Pulse Rate of Participant 3 and 4 during VR Therapy, showing variations according to scene.

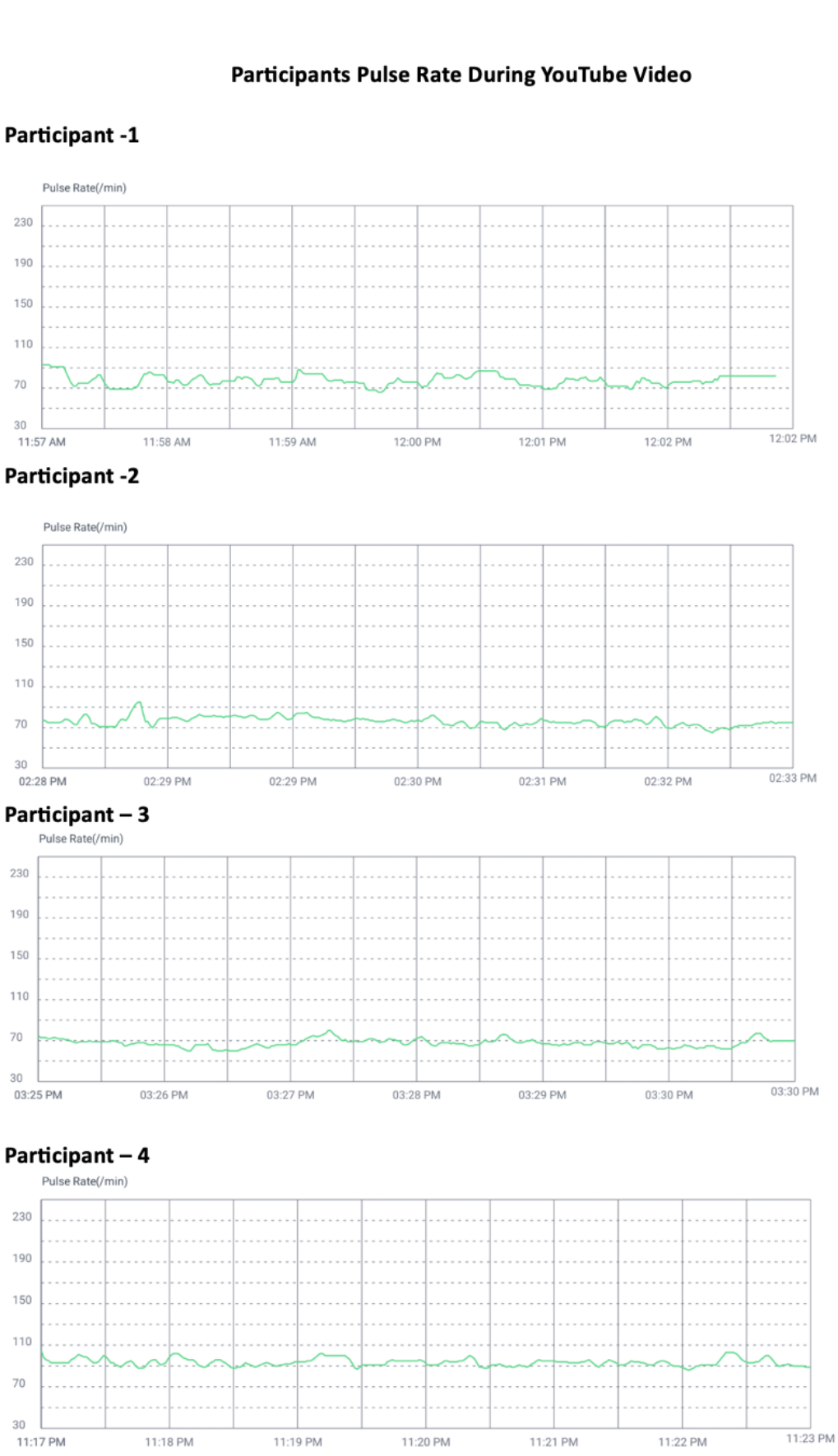

Fig. 7. Pulse Rate of Participants during Youtube Video

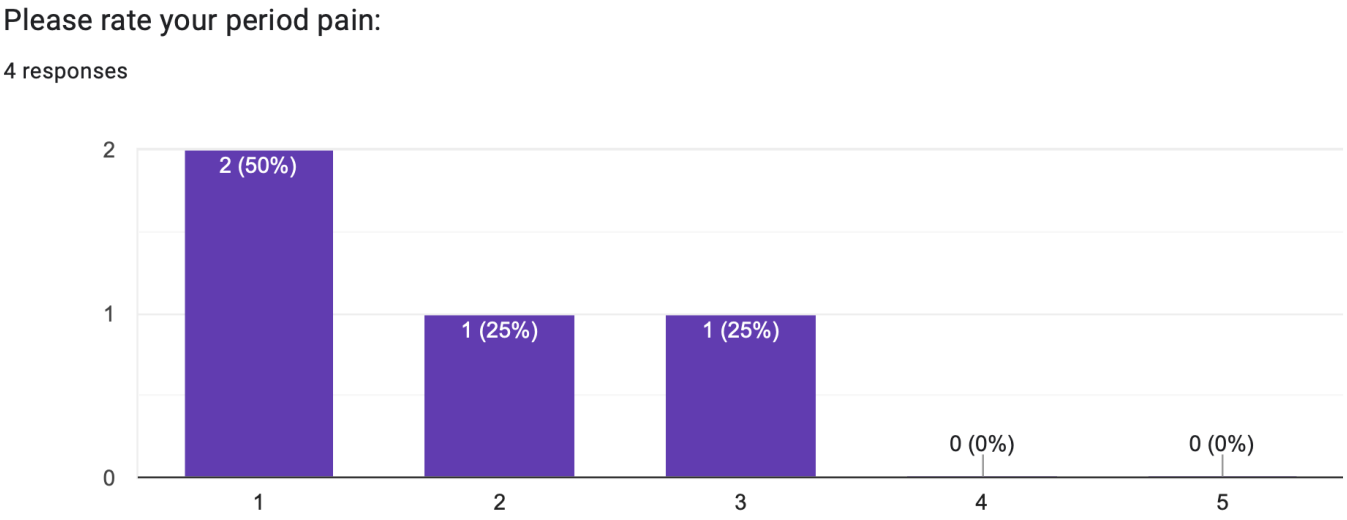

Fig. 8. Experiment Survey Response: Level of Pain Before VR Therapy

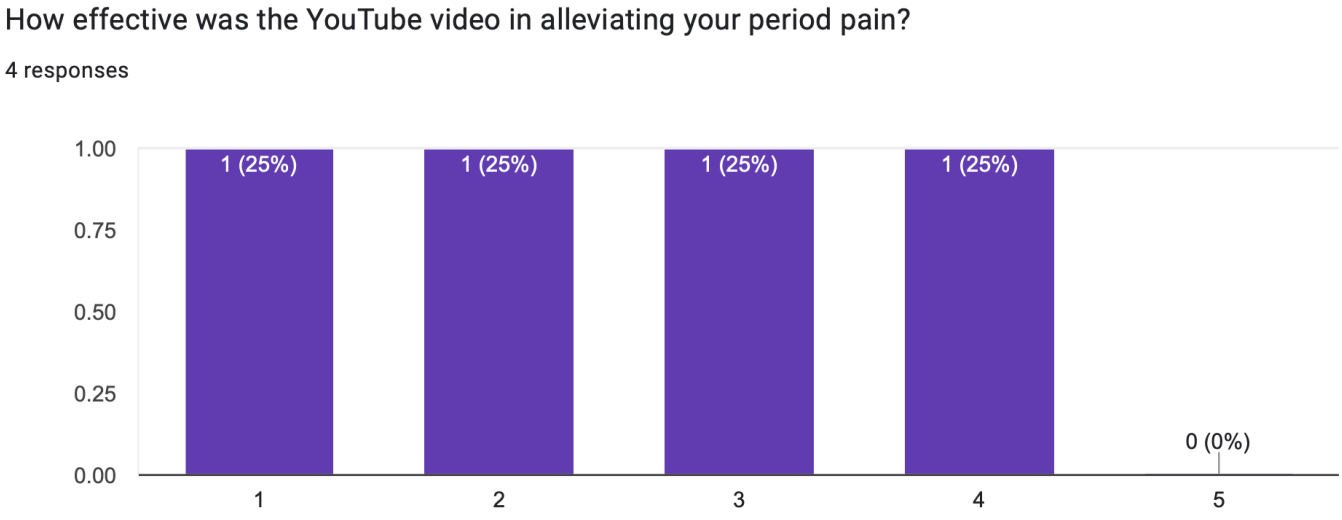

Fig. 9. Experiment Survey Response: Effectiveness of YouTube Video

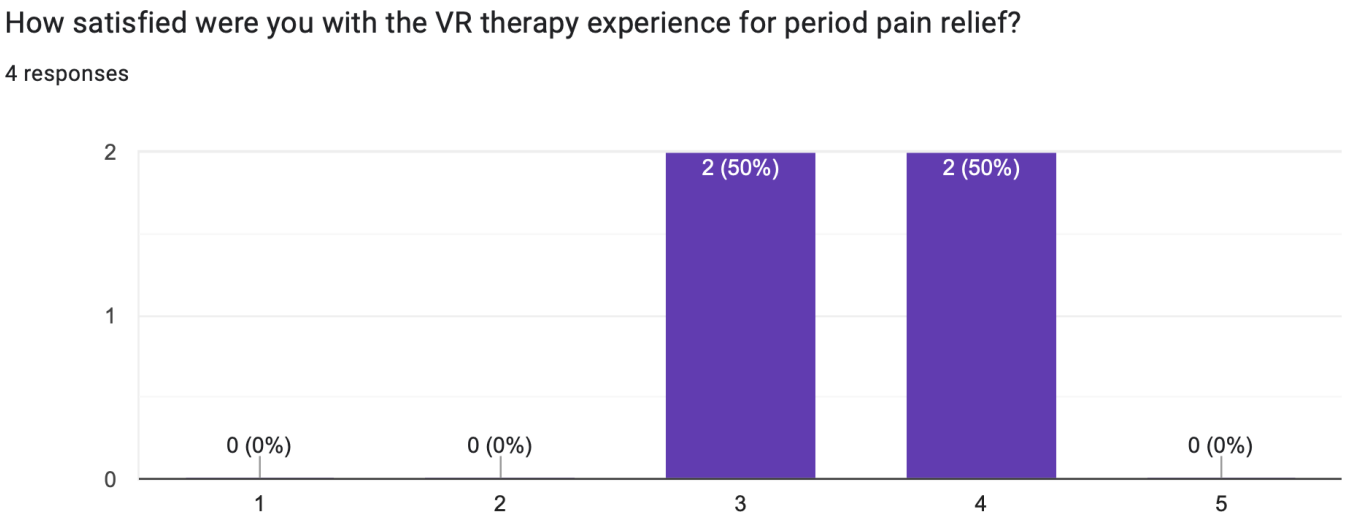

Fig. 10. Experiment Survey Response: Level of Satisfaction After VR Therapy

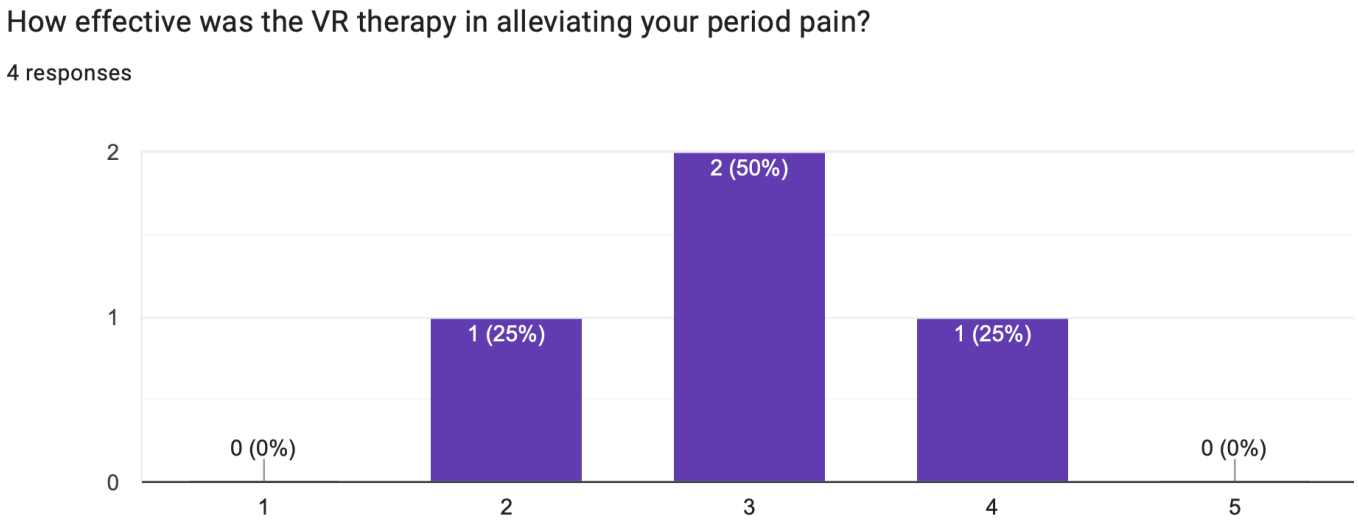

Fig. 11. Experiment Survey Response: Level of Pain After VR Therapy

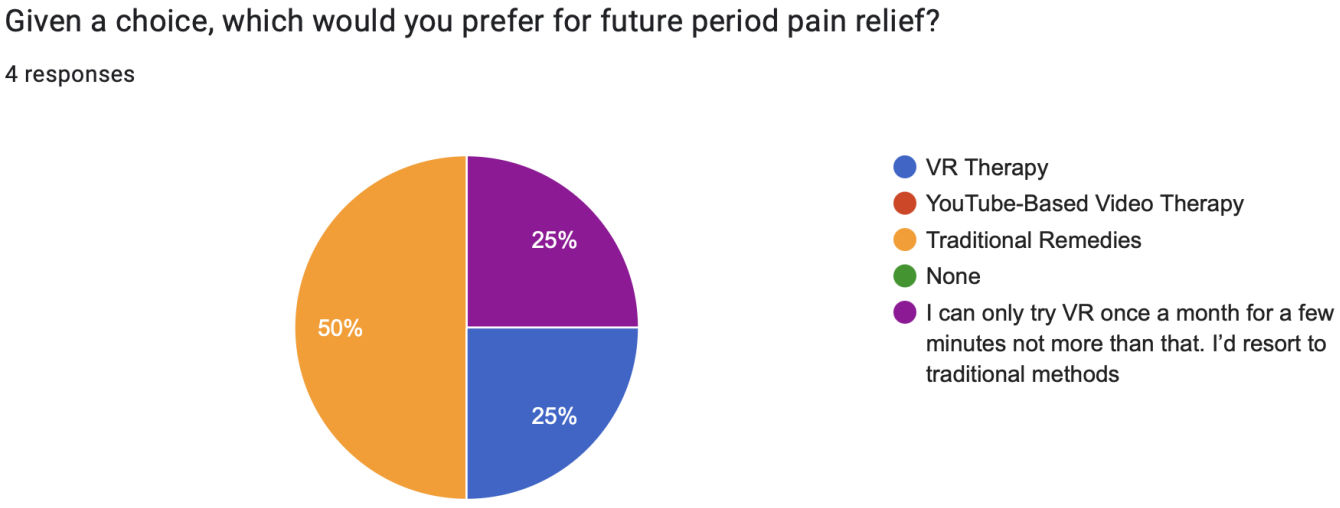

Fig. 12. Experiment Survey Response: Participants Preference of Therapy

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