



A Case Study: Chronic Pain Patients' Preferences for Virtual Reality Games for Pain Distraction

Xin Tong¹(✉), Weina Jin¹, Kathryn Cruz¹, Diane Gromala¹,
Bernie Garret², and Tarnia Taverner²

¹ Pain Studies Lab, Simon Fraser University, Surrey, Canada

{tongxint, weinaj, kathryn_cruz, gromala}@sfu.ca

² School of Nursing, University of British Columbia, Vancouver, Canada

{bernie.garret, tarnia.taverner}@nursing.ubc.ca

Abstract. We plan to conduct a longitudinal mixed-methods study to evaluate the impact of home-use Virtual Reality (VR) for chronic pain (CP) management with cancer survivors over a six-week period. The participants will play VR games for a minimum of 30 min per day for at least three days per week. Each week, the participants are required to use randomly assigned VR content from a group of VR titles that ranged from commercially-available VR games to VR meditation designed specifically for people with CP. Well before launching the longitudinal study, we compiled, tested, categorized and eliminated commercial VR titles, and developed a short list that varied by genre and methods of interaction. Therefore, to better understand which are the best VR games to use, how to offer good VR gaming experiences, and validate our choices, we compared CP patients' experiences of some selected games in VR and non-VR conditions in this research. Seven pain patients took part in the focus group study; initial results suggest participants preferred VR conditions compared to PC games according to both of the quantitative ratings and the qualitative interviews. They also liked puzzle-solving game mechanism comparing to exploration games. Participants also mentioned that the platform (VR vs. PC monitor) is more important than the actual content. This result will be helpful for the researchers to select proper VR games to test in the longitudinal study for pain distraction and management purposes since it has been done with patients.

Keywords: Virtual reality games · Pain distraction · Chronic pain
Gaming preferences · Case study

1 Introduction

Video games—especially immersive Virtual Reality (VR) games—are considered to be an effective method of pain distraction in short-term, acute conditions [1]. Among these relatively small but numerous studies [2], however, the efficacy of VR typically ends when the Head-Mounted Display (HMD) is removed or persists for a few minutes after that [3]. For Chronic Pain (CP) conditions, however, only a few studies of the

effectiveness of VR have been conducted [4]; among these, the long-term impact of VR on CP management and pain perceptions is unknown. Therefore, we proposed and received funding to conduct a longitudinal mixed-methods study to evaluate the impact of home-use VR for chronic pain management. The plan is to recruit 100 participants with CP; each will be randomly assigned to either a VR or control group (50 subjects in each). Each participant is scheduled to undertake either a series of VR interventions or no-VR control sessions using a computer in their own homes over a period of six weeks. The same content is available in both VR and non-VR conditions (i.e., on a non-stereographic computer monitor), and are randomly assigned.

Before the launch of the longitudinal study, it is necessary and important to decide what VR titles (VR “content” such as a game, exploration or training) to use in the study’s VR and non-VR conditions.

First, we identified a list of approximately 40 commercially available VR games, each of which is also available as a non-VR option, i.e., as a videogame on a standard PC. We also identified a VR “title” that was designed specifically for chronic pain patients and that also has a non-VR option. Next, the list of titles was categorized regarding game genre, required PC or VR devices, controller schemes, and methods of interactions. Finally, we developed a shortlist of titles that varied by category to assign to our participants. To validate that our choices were usable by and appropriate for CP patients, we conducted a case study described in this paper with CP patients trying out representative games from various game genres. Therefore, the result of this case study could be generalized for choosing games for other patients, and to understand game preferences of CP patients so the conclusions could be used in other VR research for pain management purpose.

Out of the four representative games, which are *Obduction* and *The Witness* for PC games, and *Call for the Starseed* and *Carpe Lucem* (as shown in Fig. 1), we have selected with VR or non-VR versions, and we hypothesize that participants will prefer VR version because its sense of immersion consistently tests greater. Furthermore, comparing all games, we assume that participants would prefer games with less intense gameplay and easier game mechanics and dynamics, rather than complicated or intense game. In this case study, we were trying to assess: (1) Whether these games are suitable for CP patients to play; (2) Whether each game fulfills the intended experience.

2 Related Work

Video games, especially VR games, have been considered to be a good source of distraction for pain management in acute conditions [4–7]. Games can be used in the medical realm as a valuable resource. Games are defined as such by having a goal, rules, feedback, and voluntary participation; all measurable features that can help patients engage in their treatment [8]. Recently, VR games and video games have also been used in chronic pain management [6, 9–11]. In addition to pain management, active video games have been previously examined to improve balance confidence and is additive to normal rehabilitation as a method pain management [5]. *The Virtual*

Meditative Walk (VMW) was one of the VR environments that the Pain Studies Lab has developed. A prior pilot study and publication about VMW validated that this VR environment was able to help patients reduce their pain levels in short-term timeframe [9]. Systems such as the VMW incorporate biofeedback inputs, a rising trend in medical VR, that can provide data integrated and used for feedback to patients and medical personnel [9, 12].

However, very few studies have compared CP patients' preferences of game selections, and to our knowledge, none of the research has compared CP patients' experiences of the same game in VR and non-VR conditions. This study aims to account for a comparison group unlike previously done studies when VR was included [7]. Furthermore, patient preferences have been minimally explored in other respects, such as game controllers used that may enhance or diminish their experience [13]. Therefore, in this study, we invited a few CP patients to experience each game sequentially and then had a focus group discussion to better understand whether the game experiences would help us to investigate further research questions.

3 Research Methodology

3.1 Study Goals

The aim of our study is to find out CP patients' preferences of playing video games in PC and immersive VR conditions. The experiences of CP patients differ regarding game genres, game devices, controller schemes, and whether the experience is on a VR or PC platform.

This study can help the researchers better understand CP patients' gaming choices, knowing what are the potential appropriate games for them to play, and what are the media forms they would prefer to play with. Our hypothesis is that the game content, and the game platform does matter for patients, which will generate effects on their consistency and willingness of using a game for pain management in a long-term run. Further, we hypothesize that participants will prefer games genres which are not mentally demanding since elder CP patients usually could not cope with too complicated game tasks nor can they use the controllers to navigate with physical movement limitations.

For instance, we expect *Carpe Lucem* and *The Witness* to provide a puzzle-solving challenge whereas *Obduction* and *Call for the Starseed* offer exploration. Exploration games are usually less overwhelming and provide more relaxation than a puzzle-solving game. So we hypothesize that our participants would like *Obduction* and *Call for the Starseed* better than *Carpe Lucem* or *The Witness*.

3.2 Participants

Seven chronic pain patients were originally recruited through direct recruitment method (researchers sent emails to potential participants from a list). The participants were all female (Mean = 35.86, SD = 12.64). The average length that they have chronic pain is 7.64 years (SD = 7.16). Five of the participants have experience playing mobile games,

and four played it several times per week (P04, P05, P06, P07), one several times per day (P01), while the other two have none experience playing any game (P02, P03). However, P03, P04, and P06 had experienced a VR environment once before (Table 1).

Table 1. Participants' age distribution.

	Amount of people
19–24	2
25–29	1
30–40	2
>40	2

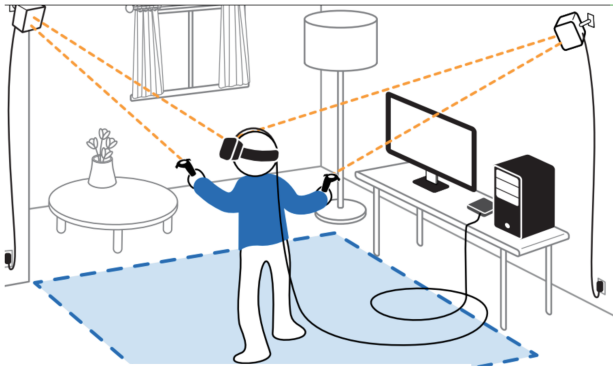


Fig. 1. (Left image) HTC Vive VR device setting. Copyright @ HTC Vive.

3.3 Apparatus

In the VR condition, *HTC Vive* HMD and *Alienware* desktop were used, and in the PC condition participants used another *Alienware* computer and a monitor to play. The VR condition setup was illustrated in Fig. 1, while the player uses a desktop and sit in front of the monitor in the PC condition. Figure 2 shows one of our participants play the game. As for the four games that were chosen, *Call of the Starseed* is a calm and slow First-Person VR adventure game in which players need to a few solve puzzles to progress in the narrative. *The Witness* is a PC title, which is a similar title to *Call of the Starseed* regarding the intended experience: players solve puzzles in an island. The puzzles in *Call of the Starseed* requires bodily movements such as bending, which might not be easy for CP patients. Therefore, we also included the game *Carpe Lucem*, which involves solving physics puzzles in a sitting or standing position. *Obduction* is an exploration game which has both VR and PC versions. The virtual environment in *Obduction* has many sci-fi elements. Figure 3 shows the screenshots of all four games.

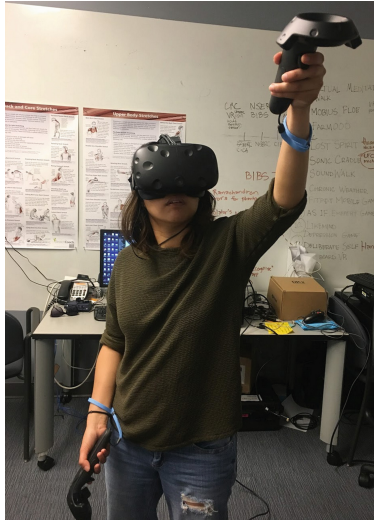


Fig. 2. (Right image) A participant interacting with the game in HTC Vive HMD device.



Fig. 3. Screenshots of four games played in this study (from top to bottom) (a) *Call for the Starseed* (VR game); (b) *Obduction* (PC game); (c) *Carpe Lucem* (VR game); (d) *The Witness* (PC game)

3.4 Study Procedures

This is a mixed-method study design with both a quantitative measurement survey and a qualitative interview discussion. Firstly, we gathered their demographic information and assessed their gaming and VR experience in the pretest questionnaire after getting their ethics. Next, the participants were asked to play either two PC or VR games in a random order and then answer their evaluations for this platform. Then they will try out next platform and give ratings regarding the same questions.

We asked them to rate their interest and willingness to play each game in the posttest questionnaire after they play all games. The participants were asked to rate each game on an 11-point Likert scale (0 means dislike the game and 10 means like the game). The post-test interview was audiotaped after getting consent from the participants. One of the researchers led the discussion by asking the major guide questions. The interview guide contains questions like among all games, which VR or PC games do they like best, which platform they'd prefer to use, ease of use of both controllers in VR and in PC platform, as well as the physical effects on them during their play time (such as motion sickness, pain level changes if there is any, etc.). Furthermore, the participants were asked to talk about their own choices of the game for pain distraction purposes if they were the designer.

The study lasts for around 1 to 1.5 h in total with each participant. Two VR games (*Call for the Starseed*, *Carpe Lucem*) and two PC games (*The Witness*, *Obduction*) were tested.

4 Results and Discussions

From the demographic information we collected, we conclude that five of them were the casual type of gamers (P01, P04, P05, P06, P07) while the other two were non-gamer at all (P02, P03). They all had no prior experience playing VR games.

4.1 Quantitative Analysis

For the two PC games, participants did not enjoy *Obduction* very much ($M = 4.17$, $SD = 2.40$), while they showed moderate interest in playing *The Witness* ($M = 5.17$, $SD = 2.79$). For the two VR games, the participants both rated them higher than the PC games, showing a greater interest in *Carpe Lucem* ($M = 8.86$, $SD = 0.90$) than *Call for the Starseed* ($M = 7.50$, $SD = 1.38$). As for the probability that they will play the game at home, all expressed higher ratings of VR condition ($M = 8.43$, $SD = 1.72$) than PC condition ($M = 6.17$, $SD = 2.79$).

4.2 Qualitative Analysis

For the game genre, we include a puzzle game and an exploration game both on VR and PC platform. Although our participants gave a higher rating of puzzle games like *Carpe Lucem* overall, each game has its supporters, and participants' taste diverge. Participants' preference on game genre seemed to be dependent on the combination of

game design and the platform and did not transfer when game platform changed. For example, P03 enjoyed the puzzle game (*The Witness*) on PC while favored the exploration game (*Call for the Starseed*) on VR. However, the puzzle game is not in favor of all the participants, for example, P04 mentioned "I'm assuming the puzzles... was getting repetitive. That may be the only thing that I would dislike about it. If all the puzzles were kinda the same."

For the gaming platform, 6 out of 7 participants favored VR over PC platform and preferred VR games if they have the freedom to choose any games. "It was more fun to be in it, than staring at it." [P01] "It's virtual reality, it's almost, it feels more tactile." "I think it's more just the spatial awareness." [P03] One participant like the PC game, since she had neck pain and commented that "just because the VR was a little rough on the neck" [P04].

For the physical feelings, most participants felt comfortable and relaxed while playing the VR game. For instance, "Very relaxing playing the VR game... complete body relaxation" [P02]. One participant mentioned the pain level decreased from 6 before the study to 5 during the interview. This effect is after both PC and VR gameplay. "And now it's on 5. ... I found that feeling relieving in a way." [P03] "I feel like the VR, because it's so new to me, because it's so cool, like, it's almost more of a distraction. Afterward, the pain would come back, and it might get worse if I was to play for a long time. But while I'm playing it, I might not notice the pain as much. ... I wasn't really thinking about it (the pain condition)." [P05] "(In VR) I felt more distracted. I was more comfortable in a sense, like, yeah. I didn't feel nauseous. ... Cuz you're doing something, and you're focused and it's, it's very distracting" [P07].

However, due to some participants' pain conditions, playing games on various platforms could cause certain physical discomfort. For the PC platform, some participant report discomfort while sitting and using the mouse and keyboard to control simultaneously. "Like my pain is the worst in my hands and wrists. So it's hard for me to like, use a mouse or a keyboard for extended periods of time." [P05] "The movement (in PC), I felt nauseous for sure, and I don't know if it's because I'm feeling a bit nauseous. When my pain is bad I'm nauseous. But that maybe made it worse. And it's just the walking. So I'm not sure the reason but I did feel really nauseous." [P07] The VR platform also cause certain problems for one participant as she mentioned, "(VR) just increase in neck pain" [P04].

For the navigation and movement in VR, participants have mixed view on the teleporting mechanics used in *Call for the Starseed*. P02 and P03 liked the teleporting experience after figuring out how it works, while P01 didn't like the idea and she said "so I didn't know that I could physically, like me moving, inside the environment for the fine-tuning. I couldn't figure out exactly how I would get myself to exactly where I wanted to be."

For the game control, all participants prefer the VR controller than the joystick controller of the PC games. As P02 mentioned "With the controllers in the PC, you are very static and stationary, whereas with VR, if you had gloves, you would have (a) full range of motion. "It's pretty cool, it's my first time playing with something like that, so it was really interesting. It was cool. I was impressed by how responsive it was. It was like really responsive; it was perfect" [P05].

5 Conclusion

In this case study, to evaluate the CP patients' preferences of playing PC and VR games, we recruited seven CP patients to play four off-the-shelf games. Two are PC and the other two are VR games. Most of the participants prefer VR games over PC games, since they feel more immersed in the virtual space. Most participants did not feel discomfort while playing the two VR games except two patients who had neck pain and arthritis pain.

In conclusion, we need to consider CP patients' individual differences, including pain conditions, player types (casual or hardcore players?) and the attitudes toward VR/PC game interactions. From this study, we understand that the choices of VR content should be validated first, which will be utilized in our longitudinal VR study in the near future. As the VR titles became widely and commercially available, the focus group in this pilot study provided important information about the choices of VR content and revealed important limitations of these games from the perspective of CP patients (such as the ability to sit or stand for certain lengths of time).

Acknowledgement. We thank all of the players who participated in this research and the Natural Sciences and Engineering Research Council of Canada (NSERC) for funding this study.

References

1. Hoffman, H.G., Prothero, J., Wells, M.J., Groen, J.: Virtual chess: meaning enhances users' sense of presence in virtual environments, pp. 251–263, November 2009
2. Mahrer, N.E., Gold, J.I.: The use of virtual reality for pain control: a review. *Curr. Pain Headache Rep.* **13**(2), 100–109 (2009)
3. Garrett, B., Taverner, T., Masinde, W., Gromala, D., Shaw, C., Negraeff, M.: A rapid evidence assessment of immersive virtual reality as an adjunct therapy in acute pain management in clinical practice. *Clin. J. Pain* **30**(12), 1089–1098 (2014)
4. Hoffman, H.G., Doctor, J.N., Patterson, D.R., Carrougher, G.J.: Virtual reality as an adjunctive pain control during burn wound care in adolescent patients [burn pain, virtual reality, presence, analgesia, distraction, attention]. *IASP* **1**(2), 305–309 (2000)
5. Staiano, A.E., Flynn, R.: Therapeutic uses of active videogames: a systematic review. *Games Health J.* **3**(6), 351–365 (2014)
6. Wiederhold, B.K., Gao, K., Sulea, C., Wiederhold, M.D.: Virtual reality as a distraction technique in chronic pain patients. *Cyberpsychol. Behav. Soc. Netw.* **17**(6), 346–352 (2014)
7. Jones, T., Moore, T., Rose, H., Choo, J.: The impact of virtual reality on chronic pain. *J. Pain* **17**(4, Supplement), S102–S103 (2016)
8. Hookham, G., Nesbitt, K., Kay-Lambkin, F.: Comparing usability and engagement between a serious game and a traditional online program. In: *Proceedings of the Australasian Computer Science Week Multiconference*, New York, NY, USA, pp. 54:1–54:10 (2016)
9. Gromala, D., Tong, X., Choo, A., Karamnejad, M., Shaw, C.D.: The Virtual meditative walk: virtual reality therapy for chronic pain management. In: *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, New York, NY, USA, pp. 521–524 (2015)

10. Shahrbanian, S., Ma, X., Korner-Bitensky, N., Simmonds, M.J.: Scientific evidence for the effectiveness of virtual reality for pain reduction in adults with acute or chronic pain. *Stud. Health Technol. Inf.* **144**, 40–43 (2009)
11. Malloy, K.M., Milling, L.S.: The effectiveness of virtual reality distraction for pain reduction: a systematic review. *Clin. Psychol. Rev.* **30**(8), 1011–1018 (2010)
12. Schonauer, C., Pintaric, T., Kaufmann, H., Jansen-Kosterink, S., Vollenbroek-Hutten, M.: Chronic pain rehabilitation with a serious game using multimodal input. In: 2011 International Conference on Virtual Rehabilitation (ICVR), pp. 1–8 (2011)
13. Mortensen, J., Kristensen, L.Q., Brooks, E.P., Brooks, A.L.: Women with fibromyalgia's experience with three motion-controlled video game consoles and indicators of symptom severity and performance of activities of daily living. *Disabil. Rehabil. Assist. Technol.* **10** (1), 61–66 (2015)