

Usability Comparisons of the Oculus Rift Head-Mounted Display and the Firsthand 3D-Stereoscopic Display in Virtual Meditative Walk

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The overarching goal of this research is to compare and test the usability – especially physical comfort – of two types Virtual Reality (VR) displays in the Virtual Meditative Walk (VMW) for chronic pain patients. VMW is an immersive VR environment developed in Pain Studies Lab (SFU Surrey, Room 2765) to help chronic pain patients learn to better manage their pain. It shows a virtual environment to patients and allows them to learn mindfulness-based stress reduction (MBSR), a scientifically validated form of meditation, in a 3D environment. Therefore, the 3D display, referred to as a head-mounted display (HMD) is a crucial component of the VR system, and might have either positive or negative influences on the potential treatment effects of VMW. Research assessing reported symptoms and side effects of using VR displays indicates that we need to determine out whether specific HMDs pose physical discomfort for users, especially chronic pain patients.

Well-designed, functional, and adjustable VR displays could increase the viewing comfort and usability, which in turn may have a positive effect on a sense of immersion and potential pain management outcomes. In this research, two types of displays are compared: the Firsthand 3D-stereoscopic VR display (Figure 1); and the Oculus Rift head-mounted display (Figure 2). Each has differing affordances, which may be experienced as more positive or negative, especially for chronic pain patients, who may have more sensitivities to issues such as tightness, weight, and ease of removing the device should they experience any potential nausea that 3D environments sometimes elicit. For the Firsthand display, users are required to sit still and position themselves in front of the 3D display, resting their forehead on a padded bar, somewhat akin to standard optometry devices. Most of a patient's visual field of his or her environment is occluded so that the focus is on the 3D simulation. While a patient's head must be kept relatively still, s/he can easily disengage from viewing the 3D simulation by simply moving their head away from the display. The Firsthand display is not mounted to a patient's head. For the Oculus Rift HMD, users need to wear it on their heads, adjust its tightness, and endure its weight. The visual field of the user's physical environment is completely occluded. However, a user can move his or her head and body comparatively freely within a certain spatial range that is restricted by the cable from the HMD to a computer.

The study will take place in Dr. Pamela Squire's pain clinic at 930-943 W. Broadway in Vancouver. Dr. Squire has accommodated prior research for SFU's Pain Studies Lab and is prepared to write similar letters of approval, as she has for prior studies. Any information gathered from the participants will be confidential, will not be disclosed to anyone, and will be kept strictly confidential. The hard copy data obtained from the participants will be kept in a locked cabinet in Dr. Gromala's locked office (SFU Surrey, Room 2813). The data gathered electronically will be held on a password-protected, removable storage device, in Dr. Gromala's locked office (SFU Surrey, Room 2813), accessible only by the project leader and faculty supervisor (Dr. Gromala and Dr. Shaw). SFU's Pain Studies Laboratory owns a confidential database of chronic pain patients who are willing to participate in its research studies by

trying out new, emerging, assistive technologies for chronic pain management. The database is stored in a password-protected removable storage device in Dr. Gromala's locked office (SFU Surrey, Room 2813). Thirty (30) patients will be randomly selected from the database and invited to participate in the study. Participants are patients who have been diagnosed as sufferers of long-term, chronic pain and older than 19 years old. This means that their pain response system is thought to operate at a higher level of sensitivity and as a result, must deal with constant pain in their routine lives.

Goals

This study is intended to compare and test the usability – especially physical comfort and simulator motion sickness – of two Virtual Reality (VR) displays in virtual meditation environment: the Oculus Rift Head-mounted Display (HMD) and Firsthand 3D desktop display. It is going to be tested in a 3D virtual environment named Virtual Meditative Walk (VMW).

Benefits

Potential benefit for participants is that they can develop skills in VMW to become aware of their inner senses, learn to correct their biological rhythms, learn how to better live with the chronic pain, and decrease its impact on physical as well as mental health. For researchers, the differences and similarities between those two commonly used VR displays could be found after the study. Researchers could also determine out whether specific HMDs pose physical discomfort for chronic pain patients and which type of VR displays to be used in pain management VR. Then the researchers could make further advanced adjustments to make the devices more comfortable for users.

Remuneration

~~They will be compensated by a gift 20 Canadian dollars upon completion of their participation in the 40-minute study.~~ All participants regardless of whether they complete the study or withdraw early will receive \$20 compensation.

Experiment

• Pre-trial

- Upon a patient's arrival to Dr. Squire's clinic, s/he will register with Dr. Squire's receptionist, who will then direct the patient to the research room and to the researcher.
- The researcher will formally greet each patient. The patient will be invited to sit on a comfortable chair.
- The researcher will provide each patient with a brief introduction to the study, and to the actions s/he is expected to take.*
- Next, patients will be instructed to read and sign the Consent Form. This form describes the study process, potential benefits, and their rights as participants.*

NOTE: one is their right to ~~quit-withdraw~~ the experiment at any stage, without penalty, if the environment is creating any sort of discomfort for them. ~~Their data will still be collected for analysis purpose after the participants withdraw.~~ If the participants withdraw from the study, we will ask for their permission to keep their data to the point of their withdrawal for analysis purpose. Their data will only be collected when they approve.

- Pre-trial questionnaire

The researcher will then instruct the patient to fill out two pre-trial questionnaires on paper (McGill Pain Questionnaire, and Simulator Sickness Questionnaire). It also

contains qualitative questions that are intended to help the researchers find out more about the participants' experiences during the study.

- **VR display**

Next, the patient will be asked if the chair s/he is sitting on is comfortable, or if it needs adjustments.

S/he will then be assigned one of two types of VR displays by random. One type is the Firsthand 3D-stereoscopic VR display; it is mounted on a movable arm (Figure 1). The other VR display is the Oculus Rift HMD; it allows participants to move their head and/or body in the room (Figure 2) to the degree its cable to the computer allows. The researcher will next ask the patient to position himself or herself with the VR display (Firsthand's), or to put the HMD on (Oculus Rift's). The researcher will verbally offer to help the patient with the VR display when the patient verbally asks for help.

NOTE: Each researcher has been instructed in how to interact with people such as chronic pain patients who are deemed to be "at risk" in workshops that are held annually in the Pain Studies Lab. Therefore, researchers know that they must ask if a patient needs help verbally or by gestures if there is a language problem. Researchers are instructed to never touch a patient until they get a patient's consent to do so.

- **Trial**

The patient is exposed to the 3D display which depicts a virtual forest. A narrator tells the patient that s/he will be instructed in how to perform Mindfulness-based Stress Reduction, a form of meditation that has been well validated; it is a method commonly recommended by pain doctors that help patients reduce their stress, anxiety and in many cases, their pain level. The narrator tells the patient when the study is over, and instructs him or her to look away from the display (Firsthand) or to remove the HMD (Oculus Rift), and to tell the researcher that s/he is finished.

NOTE: A patient may experience slight nausea during the trial if they are new to 3D environments.

The Oculus Rift HMD also may elicit a slight sense of nausea if the patient is not used to wearing a display that has a close view, or, it may cause a little discomfort in their head and/or neck area because of the tightness and weight of the display. We strived to design the VR systems to mitigate any potential nausea and/or physical discomfort as much as possible. In addition, patients are initially informed and then reminded, right before the study commences, that they have the right to quit the experiment at any stage, without penalty, if the environment is creating any sort of discomfort for them.

- **Post-trial**

After the trial, the participants are given a post-trial questionnaire that is very similar to the pre-trial one. The aim is to find out the statistical significance of the physical comfort levels of the patients with regard to the two VR displays. We hypothesize that patients who use Firsthand 3D stereoscopic VR display may feel less nausea and physical discomfort than the Oculus Rift HMD. The post-trial questionnaire also includes a qualitative section that poses questions regarding the patient's experience and possible observations that may not have been taken into account in the quantitative section.

The entire study has been carefully designed to minimize physical, mental health and the negative feelings that patients may experience, such as fear, anxiety, loss of self-confidence and embarrassment. The total time would be around 40 minutes long. The data collected from questionnaires will be stored for 5 years from the date it is being collected, and then the data will be disposed. All physical paper questionnaires and consent forms from the participants will be smashed and all electronic data will be completely deleted from the storage devices. We will collect the quantitative data from the anonymized paper questionnaires and we will log the anonymous data to our locked hard drive and analyze the data. Then keep the digital data and physical questionnaires safely in the locked hard drive in the locked office. All the results and analysis of the data will be anonymous.

After the study, the researchers from Pain Studies Lab will analyze the results and write up research papers based on the data they gathered, then publish the conclusions in relevant conferences, proceedings or journals. None of the participants' names, personal information and contact information will appear in any publications. If the participant would love to write their name or any identifying information, we will code the information with code (like P01 instead of the real name). Otherwise, all the information we collect will be anonymous. Participants can also obtain research results once the study is finished by emailing researchers: tongxint@sfu.ca, dimplek@sfu.ca.

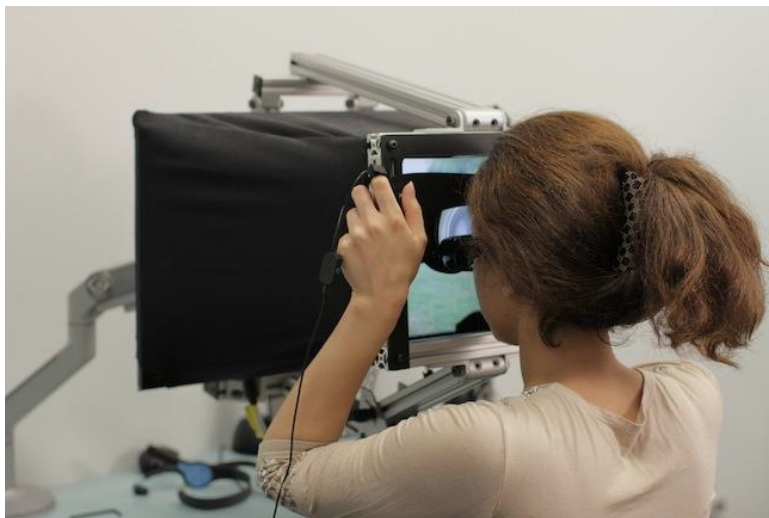


Figure 1. The current experimental setup with a user observing the VR environment through a Firsthand 3D--stereoscopic VR display. The user rests his or her forehead on a padded eyepiece bar (hands are not required except to initially adjust the eyepiece). To return focus to the physical environment (i.e., to “escape” the VR environment), the user simply tilts his or head back or moves the chair back and looks away.



Figure 2. The current experiment setup with the user immersed in the VR environment through an *Oculus Rift* Head-mounted Display (the one on the model's head). To return focus to the physical environment (i.e., to “escape” the VR environment), the user must remove the HMD.

* All the questionnaires and consent forms are submitted with the application.