Design for Mindful Self-Awareness: Meditation, VR and Chronic Pain

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Abstract:

Although immersive VR designed for alleviating pain has proven to be more effective than the standard treatment involving opiates, the reason for its success is not yet known. This approach lacks examinations of the design of interfaces, the role of "content" and various media forms, and relies on a passive, short term approach. The authors re-orient the focus of such VR work from short term, acute pain to long term, chronic pain, and address the various roles of design, media and technology in past and present works.

Introduction:

More than a technology, immersive Virtual Reality (VR) is a media form. Once the subject of media hyperbole and technophilic dreams, VR has been quietly growing, in real world applications and research areas, ranging from art, architecture, cultural heritage and entertainment to archaeology, engineering and medicine, to name a few. One of the most successful applications has been in medicine, most notably in surgical planning and surgical training and as a therapeutic modality for psychological disorders and pain alleviation. Surprisingly, VR applications developed to address acute pain have consistently proven to be more effective in alleviating pain than the centuries-old, standard use of opiates (Hoffman et al., 2004a); it is therefore considered to be a form of analgesic (Hoffman et al., 2004b). This is surprising because *a form of media* consistently proves to be more effective than the pharmacological use of opiates. Furthermore, over time, higher and higher doses are required to achieve the same level of pain relief. This often leads to dependency.

Although the reasons why immersive VR proves to be more effective than opiates is not yet fully known, it effectiveness for pain relief has almost exclusively been explained in terms of "pain distraction." That is, it is thought that diverting and holding attention may be a primary reason that VR is effective (Hoffman et al., 2005). However, while distraction is well recognized in pain medicine as a moderately effective way to address pain, we contend that simple "pain distraction" does not fully account for its effectiveness. For example, other forms of media such as videogames, film or books could be argued to be distracting, as evinced by claims of "immersion" or the "suspension of disbelief." Yet VR far outperforms other media it has been tested against, including videogames (Hoffman et al., 2004a). Further, VR pain distraction does not meet the schema of focused attention or open monitoring in neuroscientific literature (Lutz et al., 2008). For these reasons, VR pain distraction can be viewed as both a short term and a passive form of distracting attention, with long term results of which are unknown. Finally, our prior work combining immersive VR with biofeedback and meditation demonstrates that people can learn how to actively self-modulate their

experience of pain. Because this is a self-directed, self-focused activity that requires agency of the user, and because it meets the requirements that neuroscientific research use to explain why meditation and active attention regulation works, we believe our approach may prove to have longer-lasting results.

In addition, VR applications developed for the alleviation of pain have focused on acute or short-term pain, not on the persistent, chronic pain that affects an estimated one in five people, according to the World Health Organization and the Canadian Pain Society (Canadian Pain Society, 2007). Because chronic pain persists over time, the effects of VR necessarily must extend beyond a one-time, immersive experience, and beyond temporary distraction of attention if it is to be effective.

Finally, the aspects of "content" and media forms that comprise immersive VR worlds, such as visuals, sound and spatialized sound, vibration, bodily movement and perception[1] such as proprioception, and many aspects of interface design have not been examined. As well, the crucial relation of how the technology and media forms are designed to work together has barely been explored. For instance, the relation between technological performance and media forms such as visuals, sound and vibration, if not carefully designed, often lead to a "break" in a sense of immersion. The reasons for these gaps in research are unclear, but seem to not have been approached because the vast majority of VR pain distraction has been conducted by computer scientists, engineers, and other scientists. These issues may be considered to fall outside of their disciplinary purview, or may be viewed to be less important than technological issues, with few exceptions.[2]

Building on our prior work, we are continuing to re-orient VR pain research from acute to chronic pain by developing work that focuses on traditional and alternative forms of immersive media, and from short term "distraction" to longer term means (Shaw et al., 2007). We also seek to expand this research by addressing the unexplored areas outlined above. The members of our core collaborative team are: Dr. Pamela Squire, a physician and internationally prominent pain expert; Dr. Diane Gromala, an artist and designer; Meehae Song, an artist and computer scientist; Dr. Steven Barnes, a Neuroscientist and psychologist; and Dr. Chris Shaw, a computer scientist who co-authored the first VR application. Other experts and researchers contribute as necessary.

Chronic Pain

Chronic Pain is most often defined as pain that persists for more than six months (Gatchel et al., 2007). The etiology, or the causes of chronic pain are in many cases unknown (Loeser et al., 2001). Further, if chronic pain persists for months or years, even if the

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[1] 'Sim-sickness" or simulation sickness is an exception, and has been studied since the inception of immersive VR.

[2] A notable exception is Virtual Vietnam, a VR work created by computer scientist Dr. Larry Hodges and psychiatrist Dr. Barbara Rothbaum. Used as a form of psychological therapy for PTSD sufferers, Hodges states that he did not attempt to create a photorealistic jungle, but chose to use only a few "indicators" such as the sound of a helicopter, grass and palm trees so that patients could relive their traumatic experience by "filling in" the environment with their own individual memories.

cause is determined and the underlying problem treated, pain pathways persist (Melzack, 1998). Chronic pain, experienced over many years, is akin to being in an unrelenting state of stress. Thus, chronic pain progressively and negatively affects many aspects: the mind, body and quality of life (Gatchel et al., 2007). Although it is the primary cause of disability in many industrialized nations, the amount of disability compensation ranks among the lowest due to the fact that chronic pain is more often viewed as a symptom rather than a disease. Because chronic pain is so complex, pain medicine was a leader in an interdisciplinary approach in medicine as early as the 1950s. Moreover, because chronic pain is so often intractable, the goal of pain medicine centres is to manage pain, to help patients develop strategies to self-manage pain where possible, and to increase their quality of life. (Melzack, 1990.)

Our research addresses ways to help patients self-manage pain and addresses two of the important areas that affect quality of life: increasing immobility and a perception of a lack of agency or ability to manage pain.

Walking Meditation

Our current work-in-progress, *Walking Meditation,* directly addresses the issue of self-agency and mobility. It is conceived of as an adjuvant form of pain management. An innovative combination of immersive VR, biofeedback and a treadmill, it is a method of training users to meditate while walking. Meditation, particularly the form known as "mindfulness meditation" (Kabat-Zinn, 2006), has been used as a way to help those who have chronic pain to manage their experience of it. Results over the past decade indicate that it is effective in reducing the perceived levels of pain, that it persists over time, and that it often reduces the amount of medication needed to control chronic pain (ibid.). While learning to meditate does not require technology, our prior work, the *Meditation Chamber,* demonstrated that immersive VR, combined with biofeedback enhanced teaching patients how to meditate (Shaw et al., 2007). This is because it provides real-time feedback as users attempt to lower their physiological states. Users, particularly those who had never mediated, reported a greater sense of confidence and agency than did a control group who did not use technology (ibid).[3] [4]

By combining knowledge-bases from medicine, psychology, art and design, with VR with biofeedback technologies, we are designing and developing a virtual environment (VE) that draws on a millennia-long tradition: meditation. Referred to in popular terms as mindfulness meditation, this training is a well-known skill that leads to greater self-awareness and hence greater agency over managing one's experience of pain, which we refer to as "self-modulation." Our integration of VR with biomedical technologies

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[3] Biofeedback, like lie-detectors, is useful in indicating certain physiological states, such as galvanic skin response (GSR), which indicates emotions (fear, anger, startle response, orienting response and sexual feelings). However, biofeedback cannot tell us precise experiences, moods or emotions, approximate.

[4] The *Meditation Chamber,* originally tested on over 400 users, was refined and is now in use in over 20 hospitals and clinics. In recognition of its technological innovation and artistic merit, it was exhibited between the *Emerging Technlogies* and *Art Gallery* areas of SIGGRAPH 2003.

enables the users to develop and accelerate their ability to reach embodiment since it provides them with real-time feedback. While we acknowledge that it is impossible to measure this ability and experience in quantitative terms, our research confirms that the methods of affective computing provide rough approximations that are useful, especially when combined with first-person accounts.

Because chronic pain often results in decreased mobility, we are focusing on walking meditation. People suffering from chronic pain often avoid exercise but it is especially important for chronic pain patients to keep up the exercise to strengthen their muscles. (Turk & Nash,1993) outline 6 self-management strategies for coping with pain: relaxation, biofeedback, cognitive restructuring, problem solving, distraction, and exercise. The virtual walking meditation application we are proposing in this paper focuses on 3 of the 6 self-management strategies: relaxation, biofeedback, and exercise.

According to Tibetan Nyingma master Tarthang Tulku (Tulku, 1977), meditation is a method of seeking truth or understanding, of trying to discover the nature of existence and of the human mind. As Jon Kabat-Zinn (2006) explains in his book *Coming to Our Senses: Healing Ourselves and the World Through Mindfulness,* the form of walking meditation is another door into the same room as sitting, lying down, or standing meditation. The spirit and orientation are the same, but the scaffolding is slightly different because meditators are moving. In contrast to sitting meditation, meditators are much more aware of their own bodies and the environment since their bodies are in constant motion, making walking mediation a much more intense practice.

To successfully combine the motion of walking with VR, we designed the Walking Meditation application by integrating a treadmill and biofeedback technology with immersive VR technology. The interface connects the meditator to a computer and biofeedback equipment that measures breath rate and GSR (Galvanic Skin Response) in real-time. This data is fed back to the computer, which alters the visual and auditory media that is displayed in real-time to the meditator via a head-mounted display (HMD) and headphones. We are comparing this method with a stereoscopic wall display. This media is also affected by the motion of the walking as the meditator "walks through" the virtual landscapes. The uni-directional treadmill is designed so that the meditator has full control over walking speeds and stopping. The visual media consists of abstract trees and biophilic elements that continually respond to the meditator's self-directed, physiological interaction. Four different ways of rendering the visuals are being developed to test possible roles of visual "rhetoric," and their connotations. In addition, from prior experience, we learned that visuals tend to keep attention focused outward, while ambient sound does not. Further examinations of this phenomena are planned, in addition to the need for some visual cues to assist in guiding the walking, instead of disappearing as they did in the sitting version of the *Meditation Chamber.* Through this design, we also explore the crossover between how one concurrently experiences the "real" and the "virtual" space and how a sense of immersion in turn may affect the self-modulation and management of chronic pain.

Conclusions

Over the years, immersive VR technology has proven to be an excellent media form for a wide range of applications from heritage preservation to factory simulations to medical surgical training. More importantly, it has consistently been proven to be a better platform for alleviating acute pain over traditional, centuries-old, standard use of opiates. We tap into this media form to address the issues of chronic pain and how we can successfully integrate VR to assist patients suffering from this serious disease that affects an estimated one in five people. Building upon prior work, we extend the form of sitting meditation from the *Meditation Chamber* to a *Walking Meditation* application by combining VR, biofeedback technologies and a uni-directional treadmill. Through this work-in-progress application, we hope to assist chronic pain patients increase their mobility and find new ways to self-modulate the pain.

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