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# Opportunities and Challenges in Social Virtual Reality for Pain Alleviation

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**Abstract**

Pain interferes with many people's mental well-being, quality of life, and general functioning. Non-pharmacological approaches which through distraction, hypnosis, and mindfulness, have been proven to be effective for pain relief. The development of Virtual Reality (VR) technology provides alternate solution to support pain relief in medical applications. Evidence from the analgesic effects of both VR and social support provides an argument for the effectiveness of social VR experiences to alleviate pain. Thus, in order to understand and provide optimizations on how we should adopt social VR to solve pain alleviation problems, this position paper presents the rationality of social VR for pain alleviation and discusses the opportunities and challenges of this topic for broader discussion.

**Author Keywords**

Pain management; social support; virtual reality; social VR; CSCW.

**CCS Concepts**

•Human-centered computing → Virtual reality; Human computer interaction (HCI);

**Introduction**

Pain interferes with many people's mental well-being, quality of life, and general functioning. Pharmacological ap-

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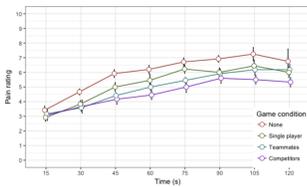
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proaches, such as using morphine-related drugs, are effective in pain reduction. However, these drugs have side effects such as nausea, lethargy, constipation, delirium, and reduced respiration. Also patients may become addicted to such medications. Non-pharmacological approaches which through distraction, hypnosis, and mindfulness, have also been proven to be effective for pain relief without those disadvantages [4, 16], although their analgesic effects are not satisfactory compared with morphine-related drugs. A more powerful psychological method that can utilize multisensory distractions is needed because it is hypothesized that higher distraction, hypnosis or mindfulness can be achieved with more sensory systems involved in the process [19]. VR technology is multimodal in nature, which becomes the new possibility emerged for non-pharmacological approaches in this area.



**Figure 1:** Participant playing the social VR system in the pilot experiment.



**Figure 2:** The effect of game condition on pain rating over time

Social Virtual Reality (VR) enables multiple users to join the identical virtual context, which creates a shared virtual space for social activities. It has been shown from a number of studies [1, 15, 17] that social support is correlated with pain deductions. Both passive and active support from nearby individuals has been shown to enhance pain alleviation when compared with non-supportive social interaction or being alone [1]. All these contribute to the motivation of explorations into the effectiveness of social VR on pain reduction.

In this position paper, we briefly summarize the related work and share what we have done focused on this question, and outline several opportunities and challenges for discussion with the broader workshop group.

## Related Work

### *Social Therapy and Pain Alleviation*

The broad definitions of social support is resources provided by other person, which could be useful information, things or feelings. There is wide evidence supporting the positive influence of social support in both physical and mental health. One possible explanation why social support is beneficial is that it provides people with consistent positive experiences and puts them in a stable position to receive social rewards. Another explanation lies in the stress reduction social support could serve to [7]. There are many studies as well [1, 7, 14] demonstrating that social support is both associated with pain-relieving behaviors and able to relieve pain in a variety of situations.

### *Social Support in VR for Pain Alleviation*

The seminal work of VR in pain management is done by Hoffman et. al in 2000 [11]. After that research, numerous works examined the effects of VR on pain reduction, such as burn wound care [6], dental procedures [21], and cardiac surgery [18]. However, social support, which highly associated with pain alleviation, has been neglected in these VR studies. Social VR can support multi-players' remote communications across the patients and medical professionals. It provides opportunities for remote medical consultation of typical psychological methods under the guidance of medical professionals [3]. Moreover, social VR is also capable of providing shared environments between the patients by using social elements in multiplayer gaming, such as competition and cooperation. The varied impact(positive/negative) of social elements under different scenarios is conducive to support future validations of how social support is acting on pain alleviation.

#### *Our Ongoing Work in Social VR and Pain*

Our ongoing work includes developing a social VR game with three modes (single-player, two-player competitive, and two-player cooperative) and conducting a user study with 12 participants (Figure 1). Our assumption is that the social modes would be more effective at alleviating pain than single mode. We use cold pressor test [5] to induce pain, and users rate their pain levels through self-reports pain level. The results from the pilot study verifies our assumption and show that the two social VR games can be associated with greater pain alleviation than the control condition (Figure 2).

#### **Opportunities and Challenges**

Perception of pain is a complex process with multiple influencing factors. In order to better shape the social VR interactions for pain alleviation and give inspirations for researchers, we propose the following opportunities and challenges in related area.

#### *Individual Differences and Social Elements*

Individual differences, including age, genders and ethnicity, affect how social elements could support pain reduction potentially. For example, men were more likely to be attracted by competitive instead of cooperative games, while women did not display their preferences. One explanation is about the cultural gender expectations that perpetuate a higher male need for competence, which drives their intrinsic desire to compete [13]. This suggests that different groups may prefer different types of social experiences, and could indicate that individuals adopting social VR applications to relieve pain may find suitable methods depending on their features.

The first opportunity is looking at how personality and individual traits affect the social VR performance on pain reduction. It is possible that certain types of users or groups are

more difficult to be distracted under specific social interaction. With more researches diving through the relationship between personality and Social VR effects, we can get an answer for this.

#### *Mechanisms of Social VR*

Although in theory social VR should outperform other psychological methods in pain management, that because the social support and VR offers rich information from multi-modalities that helped user feel immersion and presence, empirical studies of mechanism of social VR are still required to prove on it.

The second possible direction is understanding the underlying mechanisms of why social VR works well. This requires efforts into measuring the neural activities through MRI, EEG, or other measurements and also physiological signals such as heart rate and blood volume pressure. With the help of neuroscience and psychology studies, we can get a better understanding of how social elements in VR works differently from other approaches.

#### *Acute Pain vs. Chronic Pain*

Acute pain is provoked by a specific disease or injury which is directly related to soft tissue damage. Chronic pain is different clinical entities that may be considered a disease state [9]. Previous experiments primarily focus on VR's effectiveness in treating acute pain [2, 8], but is also helpful in alleviating chronic pain [10, 12, 20].

This demonstrates the wide adaptability of VR both in acute pain and chronic pain and gives new opportunities in designing different social supports for types of pain and figuring out the boundary conditions in different types of pain on when social VR works and does not work for pain reduction. Current studies only provide a small ranges of boundary conditions. Research efforts are needed to understand the

right cases that social VR could maximize its power on pain reduction.

#### *Types of Social Support*

There are many social relationships emerged in the process of treatment, not limited to the relationship between patients versus medical professionals and across multiple patients. Since in many situations pain management is a long-lasting period, we may need to seek for more social support from other groups, such as friends, relatives, acquaintance and health community, to provide auxiliary to support. As a result, Choosing the right social support based on different circumstances and different target users, and developing corresponding computational social VR system could be a promising research direction in the future.

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