



Literature Overview: Analgesic and Medical Applications

THE OVERVIEW

Medical researchers have effectively used immersive virtual reality (meaning 3D, typically interactive digital environments projected through a headset that fully blocks out other visual stimuli) as an analgesic, anxiety reducer, and distraction intervention for patients undergoing painful and tedious medical treatments such as chemotherapy or burn wound care. Research has amply shown that distraction—whether with video games, books, or other activities—makes medical treatments easier to handle and more enjoyable for patients. But immersive VR also has the benefit of causing patients to underestimate the length of time spent in treatment, and may be more effective at reducing anxiety and the sensation of pain than other, less fully immersive, methods of distraction.

There is some evidence to suggest (and many successful studies done) that indicate this type of distraction is effective with children, who are likely to be highly accepting of, and engaged with, interactive digital technologies. “Presence,” or level of engagement in the virtual world, significantly increases the strength of analgesic and anxiety-reducing effects.

Notable Existing Analgesic Applications for Virtual Reality

VR acts as a powerful non-pharmacological analgesic and affective pain reduction method during medical treatments for patients suffering from acute pain. Patients report significantly less pain during treatment and therapy when immersed in an interactive VR environment.

- **Venipuncture/IV injection:** Children aged 7-12 (N=20) were either immersed in VR during injection or after injection. Using the Faces Pain Scale-Revised, which assesses worry and psychological discomfort regarding affective pain, children who participated in VR during their IV placement reported significantly less affective pain compared to children in the control conditionⁱ, demonstrating that VR immersions are highly effective at distracting patients from pain.
- **Burn wound range-of-motion physical therapy:** Severe burn wound patients (N=54) under 19 engaging in range-of-motion physical therapy interacted with a virtual “SnowWorld” while their physical therapist moved other affected limbs. Subjects reported a 44% decrease in cognitive pain (tolerance), a 32% reduction in affective pain (anxiety and bother), and a 27% reduction in sensory pain while using VR, an effect which did not diminish over multiple treatments.ⁱⁱ
- **Burn wound dressing and care:** Children aged 3-14 (N=42) using Augmented Reality (AR), a similarly interactive digital distraction method, reported significantly less pain while using AR versus traditional methods of distraction during burn wound care treatments longer than 30 minutes in duration.ⁱⁱⁱ
- **Cerebral Palsy physical therapy:** Patients with cerebral palsy participating in physical therapy intended to maximize range of motion and motor control reported 41.2% less pain while using virtual reality during therapy than patients who were not using VR.^{iv}
 - With notably smaller sample sizes, research has also been conducted with children who have cerebral palsy participating in rehabilitation exercises, which has shown that interactive VR can increase their postural control and feelings of self-efficacy.^v

ⁱ “Effectiveness of virtual reality for pediatric pain distraction during IV placement” (Gold et al. 2006)

ⁱⁱ “A randomized, controlled trial of immersive virtual reality analgesia during physical therapy for pediatric burn injuries” (Schmitt et al. 2011)

ⁱⁱⁱ “The efficacy of an augmented virtual reality system to alleviate pain in children undergoing burns dressing changes: A randomized controlled trial” (Mott et al. 2007)

^{iv} “Virtual reality in pediatric rehabilitation: A review” (Parsons et al. 2009)

^v “Benefits of a virtual play rehabilitation environment for children with cerebral palsy on perceptions of self efficacy: A pilot study” (Reid et al. 2003)

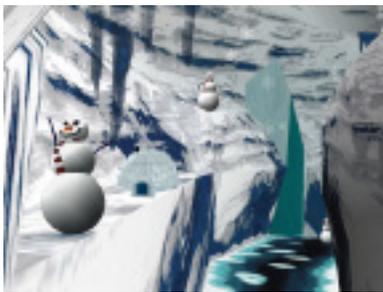


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- **Chemotherapy:** Patients who went through a VR distraction during chemotherapy reported significantly lower anxiety scores after treatment, compared to those who had not used VR or a comparable form of distraction.^{vi}

Virtual Environments Developed for use in Pain Management

SpiderWorld (1997) and SnowWorld (2003) were both created by Firsthand Technology under the direction of Dr. Hunter Hoffman.^{vii}



SpiderWorld was created to help treat serious phobia to spiders. The environment has since been used for patients without spider phobias to provide an immersive experience for distraction during painful medical procedures.



SnowWorld was created to distract and soothe patients during treatment for burn wound care. It transports the patient through an icy canyon filled with snowball-hurling snowmen, flocks of penguins, woolly mammoths and other surprises.

Patients are drawn in, throwing their own snowballs as they fly through gently falling snow. Often, patients become so deeply engaged, they don't realize their procedure is already over.

Features and Advantages of Virtual Reality Distraction Interventions

VR serves as an anxiety reducer, even in the long-term when VR is not being used during treatment.

- Adult patients who had used a VR intervention during their first chemotherapy treatment reported significantly reduced anxiety during subsequent chemotherapy treatments, even if VR was not being used during those subsequent treatments.^{viii}

VR causes patients to under-estimate the length of time in treatment.

- Adult patients using a VR intervention during chemotherapy treatments underestimated the elapsed time of treatment by 28% on average.

The efficacy of VR does not decline after repeated treatments.

- According to the burn wound range of motion studies cited above, effectiveness of VR in pain reduction remains equally strong across multiple treatments.^{ix}

The more immersive, interactive, and high-tech the VR, the more effective it is.

- When comparing interactive VR to "passive" VR (in which the digital environment is merely viewed), adult participants report a 32% greater reduction in time spent thinking about pain and a 75% greater reduction in affective pain (anxiety and bother) using interactive VR.^x

vi "Virtual Reality: A Distraction Intervention for Chemotherapy" (Schneider et al. 2007)

vii For more information, visit <http://www.VRpain.com>

viii Ibid. (Schneider et al 2007)

ix "Effectiveness of Virtual Reality-Based Pain Control with Multiple Treatments" (Hoffman et al. 2001)

x "Interactivity Influences the Magnitude of Virtual Reality Analgesia" (Wender et al. 2009)



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Patients enjoy using VR during medical treatments, and would like to continue to use it.

- 86% of adult patients using a VR intervention during chemotherapy treatments reported enjoying the distraction intervention, and 82% would use it again during treatment.^{xi} Universally, across studies with both young and old patients, the majority of patients report wishing to continue to use VR during subsequent treatments.

Additional Health-Related Applications to Explore

Enhancing surgical and medical training

- Virtual reality training simulations have been developed for medical first responders, allowing trainees to improve situational reactions through practice in a controlled environment.^{xii}

Therapeutic treatment for PTSD, body dysmorphia, and other psychological disorders

- VR provides an advantage to traditional cognitive-behavioral therapy (CBT) by allowing participants to “practice” coping mechanisms in realistic environments that may trigger disordered behaviors.
- In a controlled study of obese women (N=211), ExCT (a combination of VR and CBT) was the only treatment out of four types of more common treatments, including traditional CBT alone, that had significantly improved body image satisfaction and self-efficacy after 6 months.^{xiii}

Increasing physical activity and healthy eating behaviors

- Watching a virtual representation of one’s self (“doppelganger”) engage in exercise in immersive VR increases physical activity in the real world. Those who spent five minutes watching their doppelganger running in VR reported engaging in, on average, an hour more of voluntary exercise in a 24-hour period than those who watched a non-doppelganger avatar (resembling someone else) running or those who watched a doppelganger avatar loitering.^{xiv}
- A VR immersion that showed reinforcement (changing “weight”) on a doppelganger depending on the participant’s food choices during the VR immersion inspired changes in eating behaviors outside of VR. Males ate more candy and females ate less candy, depending on how highly present (engaged) they were in VR.^{xv} indicating that high presence in VR can change post-VR behavior, regardless of the directionality of the change.

xi Ibid. (Schneider et al. 2007)

xii “Medisim: A Prototype VR System for Training Medical First Responders” (Stansfield et al. 1998)

xiii “Virtual reality based treatments in eating disorders and obesity: A review” (Ferrer-Garcia et al. 2013z)

xiv “Virtual Self-Modelling: The Effects of Vicarious Reinforcement and Identification on Exercise Behaviors” (Fox et al. 2009)

xv “Virtual Experiences, Physical Behaviors: The Effect of Presence on Imitation of an Eating Avatar” (Fox et al. 2009)