Retrieved September 22, 2004 from http://www.hitl.washington.edu/projects/burn/

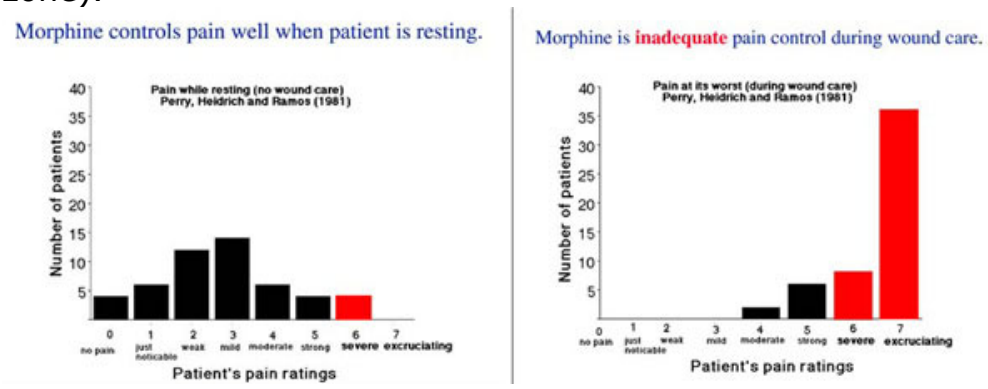
above image Copyright © Miss Howie Chambers.
All images on this webpage are copyrighted.

Harborview research nurse Gretchen Carrougher RN (left) and Verna Cain, RN (right) removing staples from a skin graft of a burn patient in virtual reality.

Introduction: The University of Washington Harborview Burn Center, directed by Dr. Nicole Gibran, is a regional burn center. Patients with severe burns from 5 surrounding states are sent to Harborview for special care. Harborview has pioneered a number of advanced treatments (e.g., early skin grafting). As a result of advances here and elsewhere, the chances of surviving a bad burn, and quality of living for survivors has improved dramatically over the past 20 years.

Unfortunately, the amount of pain and suffering experienced by patients during woundcare remains a worldwide problem for burn victims as well as a number of other patient populations.

As can be seen from the figure below, when patients are resting (most of the time), opioids (morphine and morphine-related chemicals) are adequate for controlling their burn pain (few patients are in the red zone).



In sharp contrast, during wound care such as daily bandage changes, wound cleaning, staple removals etc., opioids are not enough, not even close. As shown in the figure below, over 86% of the burn patients reported having severe to excruciating pain during wound care (shown in red), even when standard levels of opioids were used. The pain management techniques in use are not good enough. Patients are suffering,a fact particularly disturbing when the patients are children.

In 1996, Hunter Hoffman and David Patterson co-originated the new technique of using immersive VR for pain control. Hunter is a VR researcher from the U.W. Human Interface Technology Laboratory with a background in human cognition and attention. Since 1993 he has been exploring ways to increase the illusion of going inside virtual worlds (presence), how VR affects allocation of attentional resources, and therapeutic applications of VR. Professor David R. Patterson studies psychological techniques (e.g., hypnosis) for reducing severe acute burn pain of patients at Harborview Burn Center in Seattle. Dave is head of the Division of Psychology of the U.W. Dept of Rehabilitation Medicine. He is a recipient of the Milton H. Erickson Award for Scientific Contributions to Hypnosis, and has a grant from NIH to study VR burn pain control. Our interdisciplinary research team is using VR adjunctively, IN ADDITION TO TRADITIONAL opioids. This team includes Sam Sharar, MD., Gretchen Carrougher, RN, MN and Mark Jensen, Ph.D.

David Patterson

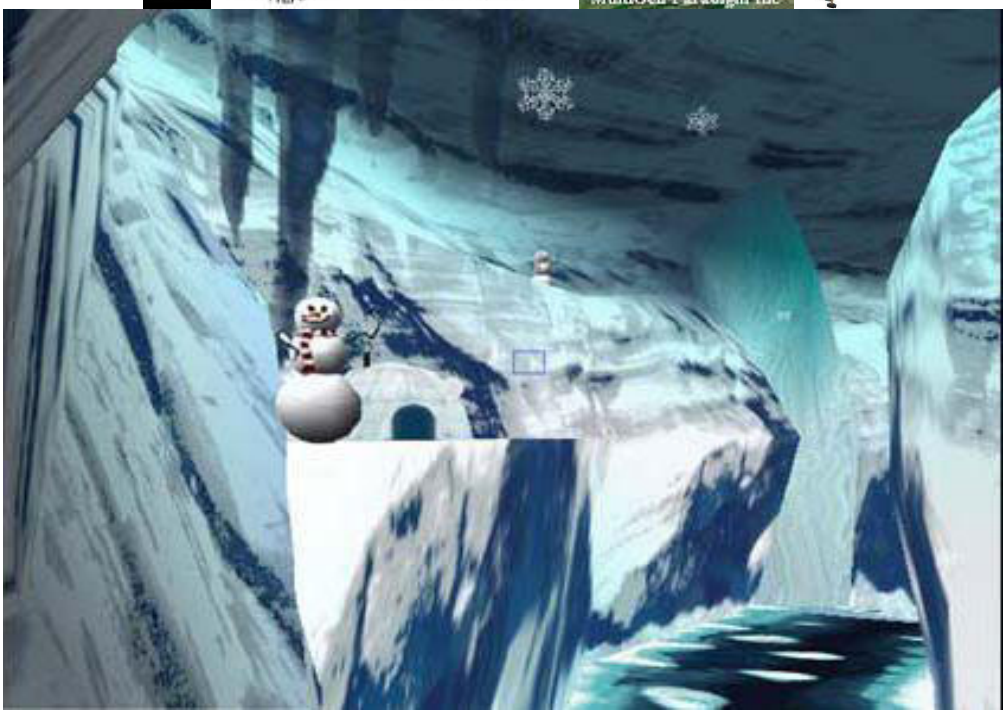
The first virtual world used was SpiderWorld. Spiderworld was originally designed to treat spider phobics, but has also proved quite distracting for burn patients.

With funding from the Paul G. Allen Foundation and local donors, we are now developing several new virtual environments specifically designed for treating pain (e.g., especially attention-grabbing virtual environments designed to minimize or avoid simulator sickness).

SnowWorld has been developed in a collaboration between Hunter Hoffman, Multigen-Paradigm Inc (Jeff Bellinghausen, and Chuck Walter), and SimWright Inc. (Brian Stewart), Howard Abrams, with support from the Paul G. Allen Foundation (Paul Allen and Bill Gates co-founded Microsoft).

In SnowWorld, patients fly through an icy canyon with a river and frigid waterfall. Patients shoot snowballs at snowmen and igloos (with animated impacts). Since patients often report re-living their original burn experience during wound care, SnowWorld was designed to help put out the fire.

Howard Abrams

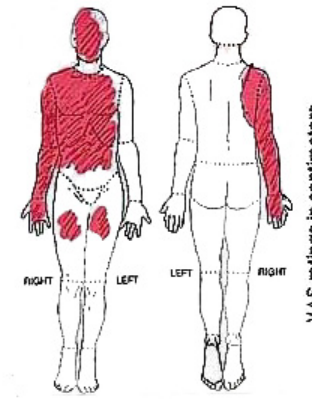


Our logic for why VR will reduce pain is as follows. Pain perception has a strong psychological component. The same incoming pain signal can be interpreted as painful or not, depending on what the patient is thinking. Pain requires conscious attention. The essence of VR is the illusion users have of going inside the computer-generated environment. Being drawn into another world drains a lot of attentional resources, leaving less attention available to process pain signals. Conscious attention is like a spotlight. Usually it is focussed on the pain and woundcare. We are luring that spotlight into the virtual world. Rather than having pain as the focus of their attention, for many patients in VR, the wound care becomes more of an annoyance, distracting them from their primary goal of exploring the virtual world.

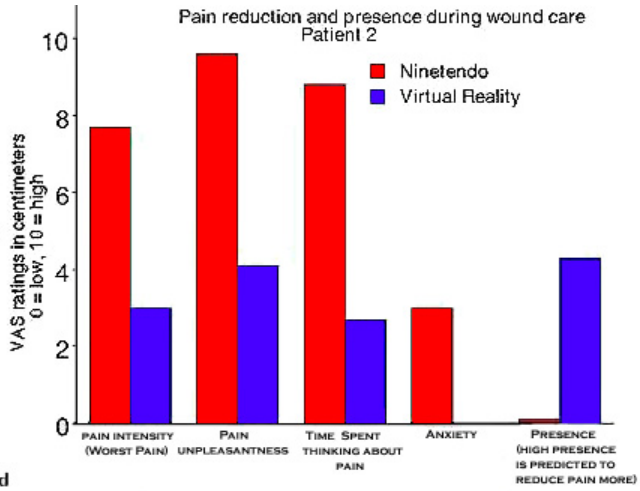
In our preliminary case study (Hoffman, Doctor, Patterson, Carrougher and Furness, 2000), two patients with severe burns went into SpiderWorld. They saw a virtual kitchen complete with kitchen countertops, a window with a partly cloudy sky, as well as 3-D cabinets, and doors that could be opened and shut. Patients could pick up a teapot, plate, toaster, plant, or frying pan by inserting their cyberhand into the virtual object, and clicking a grasp button on their 3-D mouse. Each patient also physically picked up a virtual wiggly-legged spider possessing solidity and weight, using a mixed-reality force feedback technique developed by one of our team members.

Patient 1 had 5 staples removed from a burn skin graft while playing Nintendo, and six staples removed from the same skin graft while in VR. He reported dramatic reductions in pain during VR.

Patient 2 was perhaps a bigger challenge. He had a severe burn covering over 33% of his body.



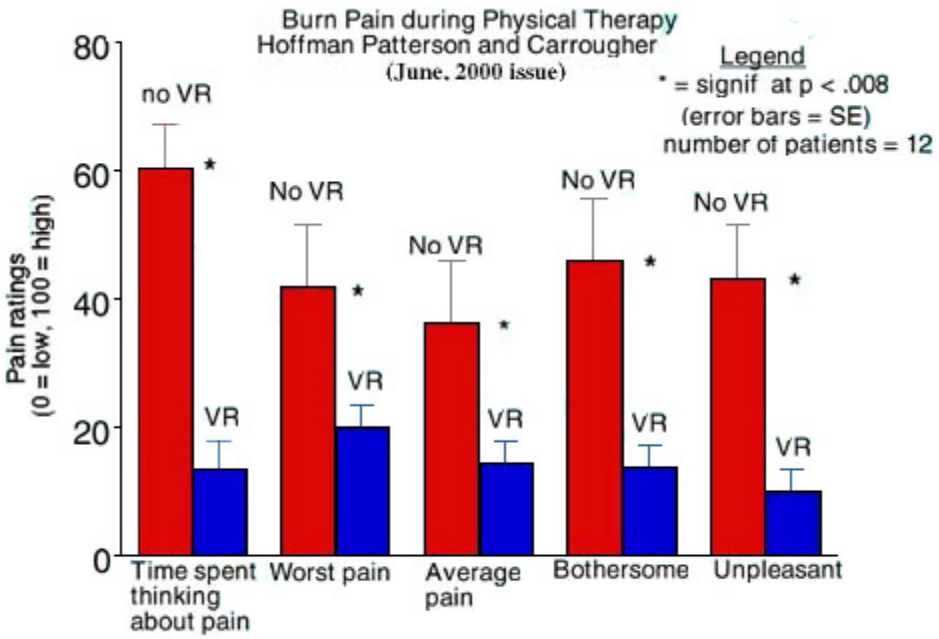
Burned area of Patient 2, much the unburned skin was harvested for extensive skin grafts.



VR pain distraction worked

Patient 2 showed a similar large but less extreme pattern (reduction of pain during wound care while in VR compared to while playing a video game). The results of these two patients are described in a clinical note in the March 10th, 2000 issue of the medical journal PAIN. Clinical notes are inconclusive by nature, and larger studies are needed (and underway).

In a related preliminary clinical study that is now completed, (Hoffman, Patterson and Carrougher, 2000), have found additional support for the efficacy of VR for pain control. Twelve patients with severe burns at Harborview reported highly significant reductions in pain levels during physical therapy when in VR compared to no VR (conventional treatment). In addition to distracting the patients, VR can likely be used to motivate patients to perform desired stretching motions, using behavioral reinforcement techniques (e.g., they could get more gas for their jet by gripping and ungripping their healing hand 10 times).



(Figure above shows results from Hoffman, Patterson and Carrougher, 2000).

A controlled analog laboratory study using healthy volunteers has also shown encouraging preliminary results.

As shown in the graph below, a controlled analog laboratory pain study using healthy volunteers has also shown encouraging results (Hoffman, Garcia-Palacios, Kapa, Beecher, & Sharar, 2003). With no distraction, pain went up and up every two minutes, as is typical of 10 min blood pressure cuff ischemas. During the last two minutes, subjects went into virtual reality, and their pain dropped dramatically.

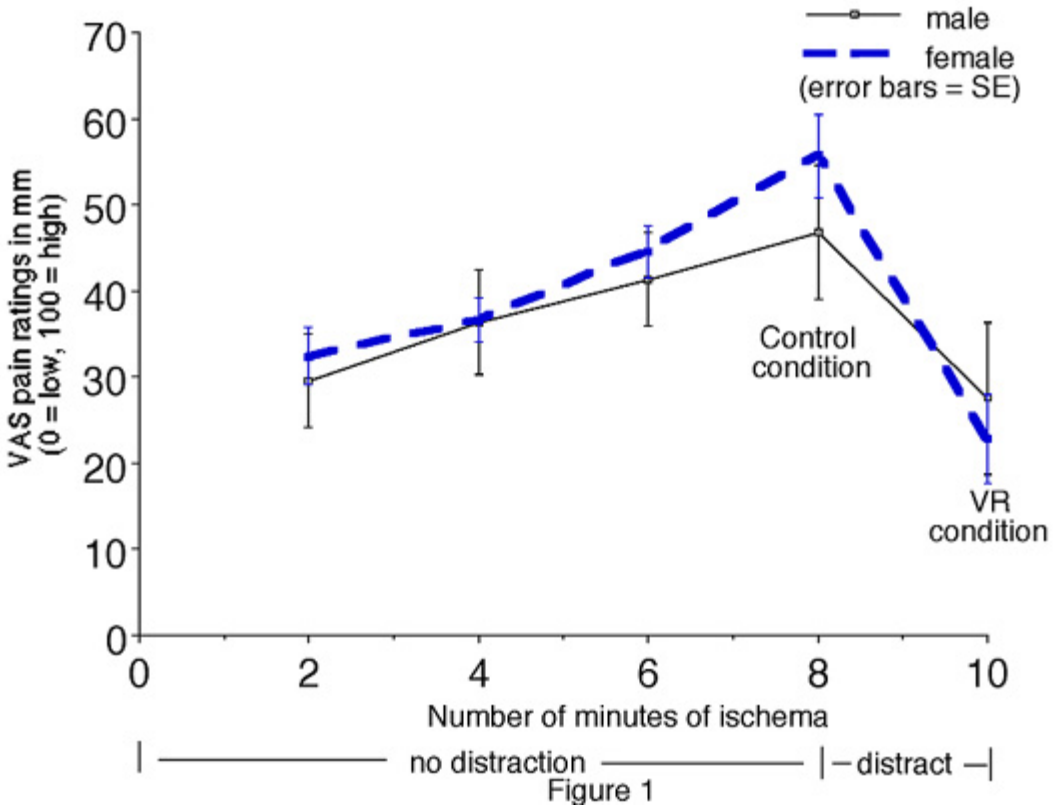
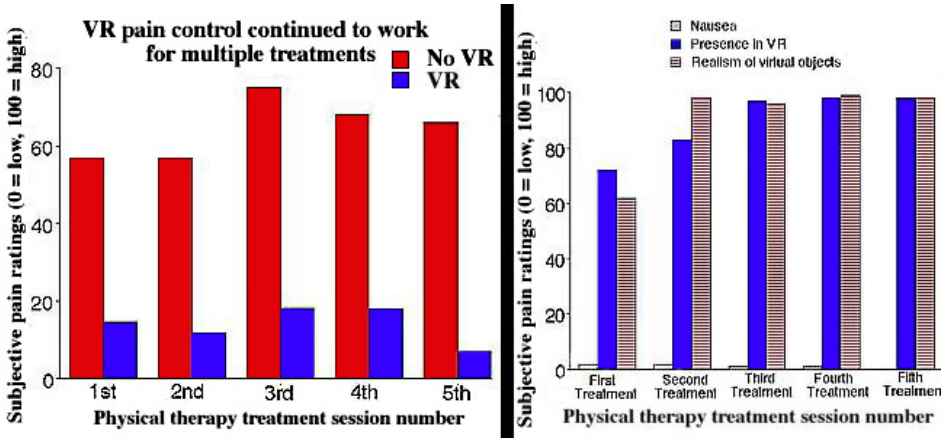


Figure 1

In all of our VR pain control studies, patients, (especially children and teenaged burn patients) have shown enthusiasm about participating.

Harborview occupational therapist Dana Nakamura stretching a young female patient's healing skin during physical therapy,while the patient explores SpiderWorld.



Use of VR on multiple occassions with the same patient have been reported by Hoffman Patterson, Carrougher and Sharar, 2001; and Hoffman Patterson, Carrougher, Nakamura et al., Other burn centers are becoming interested in trying VR for pain control, and researchers will likely investigate whether this new non-pharnacological analgesia can be of use to other suffering patient populations.

Major Contributors, info on contributing:

Additional downloadable VR Research Papers.

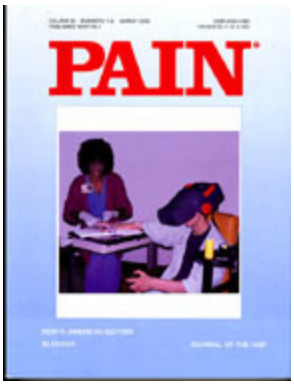
Information about CyberTherapy 2004: January 10-12 2004, San Diego, California

---

Publications in scientific journals in 2000-2003.

Hoffman HG, Doctor JN, Patterson DR, Carrougher GJ, and Furness TA III. Use of virtual reality for adjunctive treatment of adolescent burn pain during wound care: A case report. Pain, 2000 85:305-309.

Thanks to the generosity of Elsevier Publishing. A short version of this paper (not the full text) is available for download (CLICK HERE TO DOWNLOAD SMALL PAIN MANUSCRIPT).



The image above shows Verna Cain, RN, treating our first burn patient during wound care with VR analgesia (VR is used in addition to traditional opioids). Photo by Gretchen Carrougher, RN, and female computer graphics artist wonder Miss Howard Chambers (a talented young woman named Howard).

For the full text article please see http://www.elsevier.nl/inca/publications/store/5/0/6/0/8/3/for reprint or subscription info.

Hoffman, H.G., Garcia-Palacios, A., Kapa, V.A., Beecher, J. & Sharar, S.R. (2003). Immersive Virtual Reality for reducing experimental ischemic pain. International Journal of Human-Computer Interaction, 15, 469-486. (not presently available for download).

Hoffman, H.G., Patterson, D.R., Carrougher, G.J. Use of virtual reality for adjunctive treatment of adult burn pain during physical therapy: A controlled study. *The Clinical Journal of Pain.* 2000 16:244-250.

Thanks to the generosity of Lippincott, Williams and Wilkins, results from Hoffman, Patterson and Carrougher, 2000, abstract, graphs and summary (but not full text) are available for download (CLICK HERE TO DOWNLOAD SMALL "VR physical therapy" MANUSCRIPT),

Please see http://Lww.com for reprint or subscription information to get the full article.

Hoffman, H.G., Patterson, D.R., Carrougher, G.J., and Sharar, S.R. The effectiveness of virtual reality-based pain control with multiple treatments. *The Clinical Journal of Pain.* 2001 17:229-235
Microsoft Word Version (536kb) HTML Version (86kb)

Hoffman, H.G., Patterson, D.R., Carrougher, G.J., Nakamura, D., Moore, M., Garcia-Palacios, A., and Furness, T.A. III Effectiveness of virtual reality pain control with multiple treatments of longer durations: a case study. *International Journal of Human-Computer Interaction.* 2001 13:1-12
PDF Version (4.4mb)

Hoffman, H.G., Richards, T., Coda, B., Richards, A., and Sharar, S.R. The illusion of presence in immersive virtual reality during and fMRI brain scan. *CyberPsychology & Behavior*. 2003 6(3):127-131.
PDF Version (308kb)
Please see CyberPsychology & Behavior for reprint or subscription information.

Difede, J., Hoffman, H.G. Virtual reality exposure therapy for World Trade Center post-traumatic stress disorder: a case report. *CyberPsychology & Behavior* 2002 5(6):529-535.
PDF Version (149kb)
Please see CyberPsychology & Behavior for reprint or subscription information. We have also submitted several additional VR pain scientific papers for publication. Please check back in a few months in case we have posted these additional results for download (once they go through the review process and are accepted for publication)!

Garcia-Palacios, A., Hoffman, H. G., Carlin, C., Furness, T.A. III, Botella-Arbona, (2002). Virtual reality in the treatment of spider phobia: A controlled study. Behaviour Research and Therapy, 40:9;983-993. Microsoft version.

Contacts

Dr. Hunter Hoffman, *hunter@hitl.washington.edu*