A magazine for alumni of the University of Washington School of Medicine

UW Medicine

IN THIS ISSUE

SnowWorld and Virtual Reality at UW Medicine

The UW Department of Global Health

Alzheimer's Research at UW Medicine

ALSO

Remembering Robert G. Petersdorf, M.D.

UW Medicine
SCHOOL OF MEDICINE
1946 60 YEARS 2006

virtualreality

RIDING THE WAVE OF INNOVATION AT UW MEDICINE

WITH SNOW AS FAR as his eyes can see, the boy begins to fly through the air down the twists and turns of the wintry canyon. On his right, a group of penguins greet him. Turning to the left, he spots his target: a large snowman. In one quick move, the boy tosses a snowball. And then another. In a puff, the snowman disappears. "Yes!" the boy proclaims with satisfaction.

With increasing concentration, the child winds his way through the rest of the canyon. He fells another snowman. Then, slowly, the snow scene disappears. The music fades. When the boy looks up, his nurse tells him he's done for the day. She has finished the painful process of cleaning his wounds.

Just another distracting video game? Not in the least. *SnowWorld* — a virtual reality program used at the UW Burn Center at Harborview Medical Center — has kept the boy's pain at bay.

The psychology of pain

The pain associated with severe burns is well established in medical literature as one of the worst kinds of pain that humans can endure. The process of follow-up care — the removal of dead tissue, stretching of tender skin to maintain elasticity, and exercise of muscles and joints involved in rehabilitation — retraumatizes nerve receptors and can be excruciating. Although medication helps alleviate the pain, patients still suffer.

Since 2000, the UW Burn Center has used the virtual reality program *SnowWorld* to help patients control extreme pain. As with many of the most innovative projects at UW Medicine, the development of *SnowWorld* has multidisciplinary roots.

In the early 1990s, Hunter Hoffman, Ph.D. '92, a UW research scientist with a background in cognitive psychology, started using virtual reality (VR) in his studies of human memory. Seeing the power of this new technology to capture attention, Hoffman began exploring other applications for virtual reality.

Across town at Harborview Medical Center, David Patterson, professor of rehabilitation medicine and staff psychologist at the UW Burn Center, had embarked on pain-control explorations of his own.

Photo and copyright Hunter Hoffman

***SnowWorld*, a virtual reality program developed at the University of Washington, helps reduce the excruciating pain felt by burn patients during rehabilitation and wound care. Here, a patient peers into goggle lenses that are miniature computer screens.**

"Pain from ongoing procedures such as wound care is the most challenging type of pain to control," says Patterson. While drugs can provide some pain relief, he was mindful of their limitations and drawbacks: negative side effects, tolerance, and dependency. Eventually, a grant from the National Institute of General Medical Sciences, a branch of the National Institutes of Health, allowed Patterson to launch a more formal study on non-pharmacological approaches to pain management.

Both Hoffman and Patterson understood that pain involves much more than a sequence of physiological reactions. It also has a complex psychology. A pain signal requires interpretation, and interpretation requires attention. If attention can be re-directed from the pain signals, pain can be greatly diminished. For this reason, distraction has been widely used to control pain.

Virtual reality takes distraction a step further. Given that virtual reality engages many senses, Hoffman theor-

Photo by Karen Orders

SnowWorld **does more than ease burn pain during wound care. In this photo, Maryam Soltani, a research coordinator at Harborview Medical Center, prepares to treat patient Kim Dwyer for chronic pain not associated with burns.**

ized that VR could distract patients in pain. By transporting a patient to a different world, says Hoffman, "virtual reality takes distraction to a whole new level."

"I wanted to capitalize on the uniqueness of virtual reality," he says. "Learning that Dave [Patterson] was using hypnosis and other psychological devices to help burn patients manage pain, I called him about a possible collaboration." With a partnership established and with seed funding provided by the Paul G. Allen Family Foundation, Hoffman and Patterson began designing a new technique for applying immersive virtual reality to control pain.

Not-so-weird science

SnowWorld was not the first VR program that Patterson and Hoffman used at the UW Burn Center. A program called *SpiderWorld*, originally created to treat arachnophobia, proved effective in distracting burn patients from pain during wound care and physical therapy. These results inspired the two researchers to develop a virtual world especially for burn patients.

For many, virtual reality is relegated to the realm of science fiction, and translating science fiction into scientific fact is an ambitious undertaking. For Hoffman, however, "part of the thrill is to be on the cutting edge."

"We designed *SnowWorld* with a burn patient's special needs in mind," says Hoffman. He and Patterson realized that many burn patients might feel opioid-induced nausea, and so they designed *SnowWorld* to minimize simulator sickness. Although the patient has the sensation of flying through a canyon, there are no abrupt plunges, excessive speeds, or wild twists and turns.

Other factors also were taken into account. Because many patients' hands are burned, for example, *SnowWorld* employs a basic point-and-shoot interface. Throwing a snowball, then, involves a simple push of a button.

According to Hoffman, the cool, icy environment exhibited in *SnowWorld* was intended to counter the hot, searing pain that burn victims feel. Some of the design capitalized on existing technol-

In the illustration below, a patient using VR goggles is tested with functional magnetic resonance imaging (fMRI). In a recent study, fMRI scans were used to measure the activity in brain regions associated with pain. The resulting images (see page 14) show a decrease in pain-related brain activity in patients while using ***SnowWorld*****.**

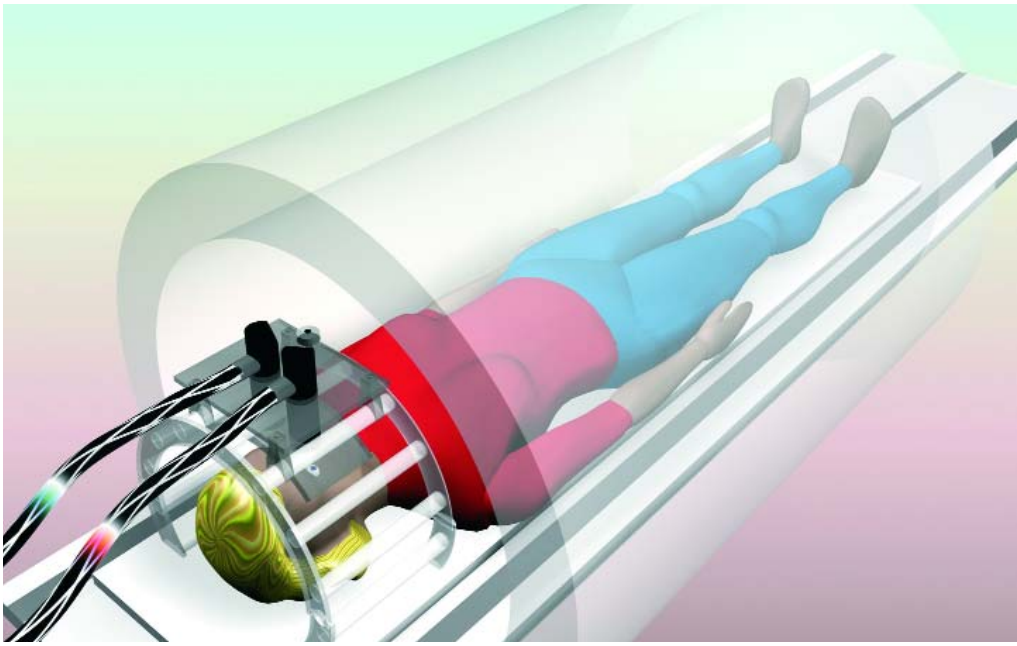

Image by Duff Hendrickson, UW; copyright Hunter Hoffman

'Less pain and less medication usually mean quicker recovery. Ultimately, patients can get on with their lives sooner. That's what we all want.'

— David Patterson

ogy. For example, the sensation of flying through a canyon "was a function of trying to develop an elaborate world with the budget we had at that stage of our research," says Hoffman, so existing flight simulation software was used.

New hardware also was created. In testing *SnowWorld*, it became clear that the helmets worn by users needed to be modified for use in hydro, or "scrub," tanks, where wound care often takes place. So Hoffman and UW instrument maker Jeff Magula created the world's first water-friendly VR helmets.

At the start of wound care or physical therapy, a burn patient puts on the VR helmet, with goggles positioned at eye level. The goggles contain miniature computer screens that allow the patient to see the virtual world. An electromagnetic position-tracking system is built into the device. When a patient turns his or her head or looks down the canyon, the scenery makes the appropriate 3-D adjustments, giving the sensation of moving through an icy canyon. Meanwhile, music and sound effects add to the feeling of being in a different world.

Better than a video game

Involving multiple senses, programs like *SnowWorld* and *SpiderWorld* give the patient the feeling of physically being present in the virtual world. This illusion makes virtual reality more engaging than even the most technically stimulating and sophisticated video games. In a preliminary case study completed in 2000, patients rated this sense of "presence" much higher when using *SpiderWorld* than when playing a video game. They also rated pain intensity, pain unpleasantness, time spent thinking about pain, and anxiety much lower on the scale during VR than when playing a video game.

To capture additional data, Hoffman and a team of UW researchers used functional magnetic resonance imaging (fMRI) to measure pain-related brain activity. When volunteers received thermal stimuli without immersion in virtual reality, fMRI scans revealed a large jump in activity in the parts of the brain associated with pain perception. When volunteers used *SnowWorld*, the scans showed a noticeable drop in pain-related brain activity.

As encouraging as the test results are, the patient's experience remains the most meaningful gauge of *SnowWorld's* effectiveness.

Dana Nakamura, an occupational therapist at Harborview, often uses distraction while treating patients in pain. She is not surprised by *SnowWorld's* effectiveness and is "impressed with the impact of the immersive environment in helping patients reach their daily range-of-motion goals."

For patients with severe and extensive burns, even the slightest movement is painful; because of that, they often resist rehabilitative exercises. Since the introduction of *SnowWorld*, Nakamura has noticed that patients' attitudes about wound care and physical therapy have greatly improved. In fact, some patients now look forward to their treatments — so much so that Nakamura has been told that she's "in the way" when she takes hold of the hand or arm that the patient is using to navigate through *SnowWorld*.

SNOWWORLD AT THE SMITHSONIAN

SnowWorld is on display at the Smithsonian Institution's Cooper-Hewitt, National Design Museum in New York City, as part of the *National Design Triennial*: *Design Life Now*. The *Triennial* brings together experimental designs and emerging ideas at the center of American culture, and features 87 of the most innovative designs in fields such as product design, architecture, furniture, film, graphics, new technologies, animation, science, medicine, and fashion.

The version on display is an update of the VR tool currently used to ease patient pain at the UW Burn Center at Harborview Medical Center. With added depth, more sophisticated animation, and greater patient engagement, this latest version of *SnowWorld* draws patients more completely into the virtual world. Because *SnowWorld* is a hands-on exhibit, museum visitors will be able to experience the power and potential of virtual reality.

Design Life Now runs through July 29, 2007. Afterward *SnowWorld* will be displayed at the Institute of Contemporary Art in Boston, Mass. from Sept. 28, 2007 to Jan. 6, 2008.

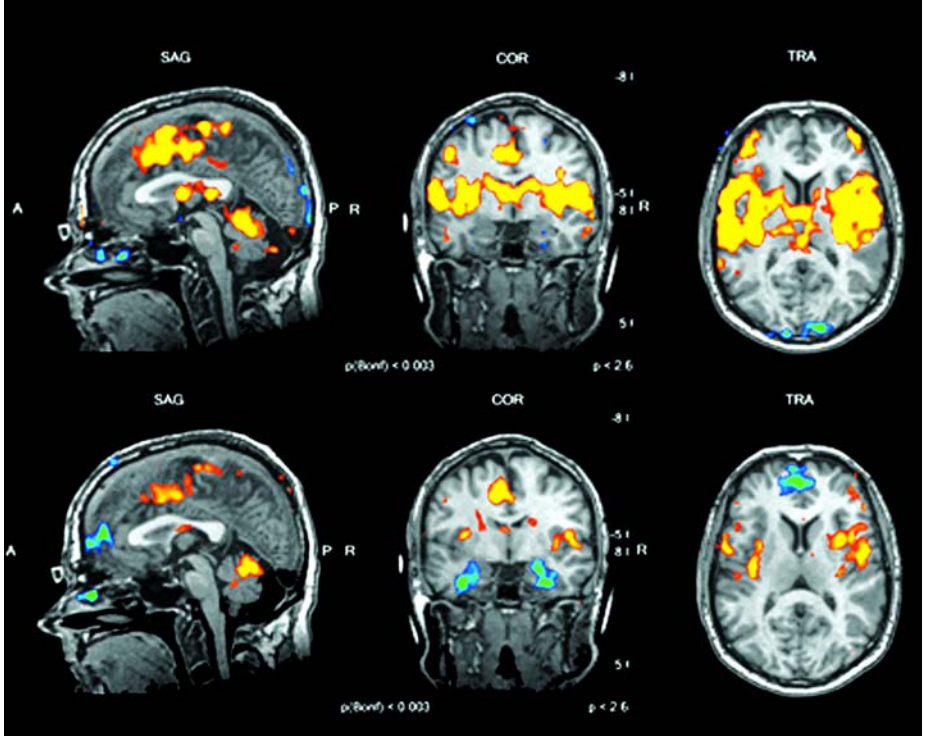

Image by Todd Richards and Aric Bills, UW; copyright Hunter Hoffman

Although patients report feeling less pain during VR use, UW researchers wanted more objective proof. Hunter Hoffman, in collaboration with Todd Richards, professor of radiology, and Sam Sharar, M.D. '83, Res. '90, professor of anesthesiology, used functional magnetic resonance imaging (fMRI) to assess activity in brain regions associated with pain perception. In the images at left, yellow indicates the greatest increase in activity associated with pain stimuli; red indicates some increase. For the scans in the top row, pain stimuli were given, but VR was not used. Scans in the bottom row, taken during immersion in *SnowWorld,* show a marked decrease in pain-related brain activity.

Beyond *SnowWorld*

Thoughtfully designed and artfully constructed, *SnowWorld* has proven to be more than just a good idea.

Launched at the UW Burn Center, which serves the Northwest, the program soon will be available at other locations across the country. Shriners Hospital for Children in Galveston, Texas has begun using *SnowWorld*. The William Randolph Hearst Burn Center, an affiliate of New York-Presbyterian Hospital/Weill Cornell Medical Center and the nation's largest and busiest burn facility, also is exploring the use of the program as part of its pain treatment process. The U.S. Army Institute of Surgical Research, part of the U.S. Army Medical Research and Materiel Command, will soon use *SnowWorld* to care for people suffering from combat-related burn injuries and for patients undergoing amputation rehabilitation.

"These early adopters reflect the medical community's understanding that virtual reality is a good way to manage pain," says Patterson. "Less pain and less medication usually mean quicker recovery. Ultimately, patients can get on with their lives sooner. That's what we all want."

Given its efficacy in treating burns, researchers are also investigating other patient-related uses.

At UW Medicine, virtual reality projects in radiology, anesthesiology, and urology are taking place, and a colleague of Hoffman's and Patterson's, Sam Sharar, M.D. '83, Res. '90, is developing and testing the use of *SnowWorld* to distract pediatric cancer patients during painful treatment procedures. And although *SnowWorld* offers an escape from pain, programs like *SpiderWorld* provide a safe way for individuals to confront specific phobias. Hoffman and his team have created the first VR program for people suffering from post-traumatic stress disorder related to the attacks on the World Trade Center in New York City on Sept. 11, 2001.

Patterson has devised yet another creative application for virtual reality: using it with hypnotic suggestion. With the helmet in place, patients visually engage in the virtual world at the same time that they hear hypnotic suggestion; such suggestions can last long after the helmet is removed and help address a number of health problems, such as chronic pain, habit disorders (e.g., smoking), and general anxiety. "This work has the potential to enhance the field of hypnosis in general," says Patterson.

The promise of VR is partially limited by the availability of resources. Besides securing funding for projects like *SnowWorld*, researchers must also consider technological feasibility. "The pool of programmers who have the creativity and ability to bring our ideas to life is small," says Hoffman. Ari Hollander, a UW engineering alumnus, currently constructs all of their virtual worlds.

Despite these challenges, Hoffman, Patterson, and others at UW Medicine continue to advance the field of virtual reality and expand its applications. The next step in improving and focusing pain management is developing a multitude of increasingly complex, multi-sensory virtual worlds, possibly targeted for age and gender. "We want to treat chronic as well as acute pain," says Patterson, "and we want to treat more phobias and psychological trauma."

Patterson predicts that the cost of virtual reality hardware and software will drop substantially in the future, making the technology more widely available. "Such approaches will hopefully shorten the length of time in the hospital, lessen dependence on medication, and offset health-care costs," he says.

"We're still in the Stone Age of immersive virtual reality. The fact is, we don't know all of the possibilities," says Hoffman. "They have yet to be discovered. We're just riding the wave of innovation." And what a ride it is.

To learn more about SnowWorld*, please visit www.vrpain.com.*