

How virtual reality can help relieve chronic pain

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"VR has this real potential to encourage movement in people with chronic pain where they might be otherwise afraid to move," says Nancy Baker, here demonstrating a VR headset, while what she sees plays on the nearby iPad. Credit: Alonso Nichols/Tufts University

The first time Nancy Baker saw people use virtual reality to deal with

chronic pain, it was a revelation.

One patient had suffered from [complex regional pain syndrome](#) for years, experiencing unrelenting pain in one arm. "She tended to guard her arm—she didn't like people to touch it, she didn't like to move it," says Baker, an associate professor of occupational therapy.

Baker and a colleague put a [virtual reality](#) (VR) headset on the woman and gave her hand controls that allowed her avatar in the VR headset to move its arms. The VR is immersive—with the headset on, all you see is a vivid setting, encompassing 360 degrees as you move your head and move around. In this case, the setting was a [space station](#) in [zero gravity](#), and the task was to pull herself through the station by grabbing handholds on the walls, floor, and ceiling.

"She was moving both arms so naturally in real life—you could not tell which arm had the problem," Baker says. "Afterwards, she came out and said she would never have dared move her arm that way if it was real. She didn't have pain while in the virtual reality setting. And she was smiling. People with complex regional pain syndrome don't smile—because they're always in pain and miserable."

Another person had complex regional pain syndrome of the leg, and they also put him in the VR anti-gravity setting, where he roamed around. "He came out and said, 'Wow, I had no pain. That was amazing. I haven't had no pain in years,'" Baker reports. He said later that he'd had no pain for another hour to two on his drive home, which had never happened before.

"Here was this simple device that you could put on somebody and you could take them away someplace else," she says. It was the beginning of Baker's quest to understand how VR might be used to treat chronic pain. She's now published three papers on the topic, and is continuing with

research in this area.

Distraction and embodiment

Some 20% of Americans live with chronic pain, according to the [Centers for Disease Control and Prevention](#). It is "a disease in and of itself," says Baker. Those who suffer from it may have had an injury in the past that started the pain, and though that injury healed sufficiently, the pain persists.

"The pain is more intense and lasts longer than in typical healing, and now it is more of a bio-psychosocial disease," says Baker. "The pain can be extremely bad."

Some might say that such pain is "all in the person's head"—of course all pain is registered in the brain, Baker notes—"but people with chronic pain have legitimate, awful pain. It's not going to heal and go away in the same way that [acute pain](#) will," she says.

How does the VR experience help alleviate pain? For starters, it's very distracting, taking the person's mind completely away from focusing on their pain. That is especially apparent in dealing with sudden, acute pain, and VR has been used successfully to help alleviate suffering during things like dental surgery, childbirth, and treating burn wounds.

As physician Brennan Spiegel, A94, writes in his book "VRx: How Virtual Therapeutics Will Revolutionize Medicine," "It turns out our brains are designed to live in one reality at a time," and taking people away from the ability to focus on their pain diminishes the experience of the pain.

Another reason why VR is effective is it "feels hyper-real," says Baker. "It feels more real than real when you're in the headset. It might be the

fact that every aspect has been designed intentionally; there's nothing superfluous."

But it's not just distraction, Baker thinks. "When you're in virtual reality, you no longer have a body—your vision is completely occluded. That means you can no longer see, monitor, or be aware of what your body is doing in space."

People with chronic pain tend to always be monitoring what they're doing, she says, so in a VR system, "you can't be hypervigilant because your body's not there anymore."

Embodying the feeling

Some research suggests that by manipulating a person's perception of their body using VR, it is possible to change their perceptions of pain, not just distract them, Baker says, a process called embodiment. That's when people see a virtual object—something representing their arm, a leg, or even whole body—as actually being their body, and they respond to what's happening to that virtual body as though it was their own body.

To illustrate this, Baker pulls up a [YouTube video](#) of the rubber-hand illusion, a classic experiment. In it, a person is seated at a table, with their left arm resting on the table, and their right arm off to the side, hidden under a cloth, while a rubber arm and hand are resting parallel to their left hand on the table. The person running the experiment simultaneously rubs the right hand (under the cloth) and the rubber hand (visibly) in parallel, first vigorously, then softer and softer.

Eventually, only the rubber hand is being rubbed, but the person reports feeling the rubbing in that hand. If the rubber hand is then struck, the person flinches and reports feeling pain.

In VR, Baker suggests, the brain is being tricked in the same way, embodying the virtual self as its own. If the body in VR is moving with ease, the brain can be tricked into thinking it is no longer feeling pain at that moment.

"We are manipulating what people are seeing to reduce pain and enhance movement, through this idea that what's happening in the VR is happening to them," she says.

In her ongoing research, Baker is investigating how VR might be used to create embodiment. "I feel embodiment and chronic pain are going to go hand in hand, so to speak. I think that it's going to be a really powerful tool."

While VR has potential to help those suffering from chronic pain, it is unlikely to eliminate pain entirely. Chronic pain exists in an ongoing way; using VR would help manage that pain, Baker says. "We'd love to get rid of their pain, but for many people that is not a feasible goal. The pain is with them forever," she says.

Instead, the goal is to teach people how to manage the pain and be able to continue living a full life despite the pain. Using the VR, a person gets temporary relief from pain by being distracted in the immersive VR world. However, [occupational therapists](#) can also use VR in a variety of ways to help people learn to cope with this chronic disease. For instance an occupational therapist can videotape a person while they are in the VR world, then show them how they are moving.

"We want them to see that they can do more than they think they can," she says. "We're trying to help them see the connection between what they're doing within the VR and how that could apply to their life outside of the VR."

Another benefit of the VR is that it may be able help modify peoples' views of their own bodies. "Often people with chronic pain see their bodies as different—they have body dysmorphia," Baker says. "In the VR, they can let go of these perceptions of their bodies."

The lingering effect

The helpful effects of the VR experience are clearly more than just distraction. Some people with chronic pain notice the pain-free period lasting for hours after being immersed in the VR world.

"To me that suggests we can use VR to change the way the brain is wired—it's something about how people think about their own body," she says. "My hope is that if we use it therapeutically, it might change things so that the pain is greatly reduced outside of VR or gone outside of VR—not just use VR as a bandage."

Now Baker is working with colleagues in an outside OT clinic to see how feasible it is to include VR in a therapy session and how to do it most effectively. "We're doing studies where my colleague is including VR for some of her clients and tracking things like pain and activity," she says.

While VR headsets and games are widely available and increasingly affordable, using them at home for therapeutic purposes isn't so clear, outside of, say, meditation programs, Baker says. Not too many OT and physical therapy practices use VR, but that is starting to change.

"When I see OTs and PTs doing virtual reality, it's mainly with people who have had something like a stroke where they're trying to get them to use an arm or other limb in the VR system," she says. "It's very much a new area."

Acute pain and emotion

Studying how VR affects chronic pain is a relatively new field of study. Most studies in the field have been done on VR and acute pain.

Acute pain is that which is caused by direct damage to tissue in the body, resulting in what's called nociceptive pain. "Your nerves fire and your brain interprets that as pain—there is a somewhat direct correlation between where the damage is being done and the pain that's being experienced."

VR is very good at alleviating acute pain because the distraction can block the attention normally given to the pain and redirect emotions and meanings about pain away from what's happening.

That's because part of pain is linked to emotion. "We're usually very emotional about the pain in a negative way," Baker says. "It will hurt less if you are not emotional about the pain, which is why [professional athletes](#) can play with a hurt ankle, for example—they've experienced it before and aren't emotional about it."

Some research suggests that the pain can be reduced through VR to the same degree that an opioid injection would achieve, Baker says. She did a [systematic literature review](#) on VR and acute and chronic pain, though most studies were on acute pain. "Generally it had a significant effect on pain," she says.

VR and exercise

Distraction and embodiment are two ways for VR to alleviate chronic pain, but there's a third path it works through—it can help improve existing treatments, such as exercise and mindfulness. "VR can enhance

how well people learn and use these particular techniques," says Baker.

Exercise is important for people with chronic pain, because they are often afraid to move, which leads to more stiffness and less movement, and more pain—a vicious circle.

Studies have found that people work harder at exercising in VR than when they're outside it, Baker says. Users report feeling like they are exerting themselves less than they are—and because of that, they work harder than they normally would.

"VR has this real potential to encourage movement in people with chronic pain where they might be otherwise afraid to move," she says, even if it's something as simple as Fruit Ninja—using your arms, that appear as swords in the VR, in a competition to slice fruit falling from the sky.

VR can also enhance meditation. VR programs offer many possible settings—whatever is most calming for you—for guided meditations. "I've seen, for instance, breathing exercises where if you breathe correctly, a tree grows," Baker says.

Looking ahead

At her lab on the first floor of the Collaborative Learning and Innovation Complex building on Boston Avenue, Baker has a 10-foot square space marked out on the floor with green masking tape. It's where she tests out some of the VR programs with volunteers.

Subjects stand in the middle, get outfitted with the hand controls, slip on the VR headset, do the tutorial on how to use the set, and then jump into a setting—from games like Fruit Ninja and golf to exotic beach locations. Baker sits close by, watching what the participant sees on an

iPad, giving instructions.

Baker does occupational therapy research. For work with patients, she collaborates with a partner in Pittsburgh who works with people with chronic pain.

It's an exciting time to be doing this work, she says. While VR is used to some extent for acute pain management, these are very early days for work with [chronic pain](#) sufferers.

"Still, I can imagine a time in the future when the patient and therapist could be in different physical locations," she says, "but networked together in a virtual space in a VR session, making it all even more accessible."

Provided by Tufts University

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