

What Are You Afraid Of?

Computers Are Being Used to Cope With Pain and Cure Everything From Fear of Flying to Anorexia, From Stress Disorders to Smoking

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TOO TERRIFIED TO FLY FOR nearly a decade, Jenny Moore looked at the view out an airplane window and burst into tears: "I can't do this!" But the young Leesburg-area mother didn't have to deplane -- she just removed the digital-video goggles that made her feel she was inside a jet cabin.

After repeatedly seeing the video, Moore overcame her dread of the computer-generated plane flights. Then she tried the real thing -- and has been flying ever since.

What bank manager Charlice Noble-Jones saw at the World Trade Center on September 11, 2001 -- bodies falling from the Twin Towers and bleeding at her feet -- left her traumatized and beyond the reach of traditional counseling. But after several therapy sessions exploring digital simulations of the Trade Center scene, she overcame her posttraumatic stress disorder.

Even with morphine, plumber Mike Robinson suffered excruciating pain during wound cleanings for burns on both arms. But once he entered a computer-generated fantasy world that responded to his every gesture, he became so engrossed in cyber-snowball fights that the procedure's pain barely registered.

Welcome to virtual-reality therapy, where the cures are computer-generated.

From Bethesda to Milan, virtual reality -- VR for short -- is being used to treat crippling disorders and soothe physical and mental anguish. The therapies have shown promise against stubborn conditions from eating disorders and addictions to phobias.

The technology is so promising that the National Institutes of Health's National Institute on Drug Abuse -- which funded no virtual-reality research two years ago -- supports 16 such projects and has more grants in the pipeline. In February, NIDA summoned scientists to a sort of VR-therapy showcase to consider the possibilities.

"People are coming up with more and more clever ways of using this," says Dave Thomas, cochair of the NIDA working group that fosters the research. "We've advanced a lot -- but we're just scratching the surface."

In a typical virtual-reality experience, a helmet blocks out the real world and immerses the patient in the sights and sounds of a 3-D world supplied by computer software. The helmet positions goggle-size television screens close to each eye; the patient sees the screen views as a single 3-D image with realism and depth. The helmet's headphones supply sound; accessories such as joysticks and gloves let the patient manipulate the scene. This combined sensory input gives the patient the illusion of being in the virtual world.

Georgia Tech computer scientist Larry Hodges knew that the military had used VR for years, in flight simulators and to test battlefield scenarios. One night in the early 1990s, Hodges was having dinner with his brother-in-law, a military man and psychiatrist, and the two began brainstorming VR as a therapy tool. If running a flight simulation over and over could help pilots nail a landing, they reasoned, maybe riding a simulated elevator over and over could help acrophobics conquer their fear of heights.

To get a grant, Hodges needed a research partner. He called Emory University's Barbara Rothbaum, an expert in anxiety disorders.

Rothbaum recalls: "My first response was, 'You want to do what?'"

With a 1993 grant, the pair developed a VR program that made fear-of-heights patients feel they were ascending in a glass elevator, peering off a balcony, or crossing a rope-and-ladder bridge over a canyon. Rothbaum says she and Hodges weren't sure whether they were "on the cutting edge or the lunatic fringe" -- until their test subjects showed dramatically reduced fears of heights in the real world.

Why does treating a disorder in a fake world translate to curing it in the real world? For reasons that we're still learning about, says another VR-therapy pioneer, Hunter Hoffman of the University of Washington's

Human Interface Technology Lab. The basic principle is this: Experiences in the virtual world force patients to develop coping responses -- responses that still serve them in real life.

With phobias, VR gradually and repeatedly exposes patients to what they fear until they learn to manage their anxiety. With eating disorders, it helps patients rethink often-distorted perceptions of their bodies. With pain management, the therapy is so attention-grabbing that it overrides even severe discomfort. With addiction -- one of the newest frontiers -- VR can artificially trigger patients' cravings (for cigarettes, alcohol, crack) and let them practice not giving in.

At universities and think tanks around the world, new VR-therapy applications are in development. And throughout the United States, counselors can treat anxiety and stress disorders in their offices with off-the-shelf therapy software from Virtually Better, the Georgia company Rothbaum and Hodges founded.

When Bethesda psychologist Keith Saylor first reviewed VR-therapy software, he thought, "This is so cartoonish." More than five years later, he's used VR in combination with other techniques to treat more than 100 patients' fears of flying, heights, storms, and public speaking.

Among those who complete treatment, Saylor says, the success rate tops 80 percent. Because VR is part of regular 50-minute, \$130 behavior-therapy sessions, it's covered for most patients whose insurance pays for behavioral-health or psychological services.

One corner of Saylor's office houses the gear: a PC wired to a small platform, a curvy high-backed chair, and a helmet with stereo headphones and video goggles. If an assessment convinces Saylor that someone could benefit from VR therapy, he brings the patient here.

At one time, Saylor would have taken those patients on field trips -- "in vivo" exposure therapy, where psychologists accompany patients as they gradually approach what they fear. But outings to tall buildings and airplanes are costly, and while airlines once let fearful flyers board parked planes as part of therapy, post-9/11 security has curtailed such practices.

In VR therapy, the patient can be "on a jet" while seated in Saylor's chair. As Saylor queues up the software, the patient sees a digital simulation of a familiar cabin view: aisle, overhead compartments, seats. To the left, the view out the window is real video of tarmac -- at Atlanta's Hartsfield-Jackson airport. Headphones deliver the hum of engines and a flight attendant's patter. The platform resonates with the ka-chunk of cargo-bay doors closing and the vibration of taxiing.

As patients experience the VR flight, Saylor asks how they're handling it on a 1-to-10 anxiety scale. If patients get too anxious, Saylor has only to

click the program off. If they can talk themselves through the panic, the "flight" proceeds -- and is replayed, with the patient feeling less fearful every time.

Mastering phobias, Saylor says, is about "making friends with the things that you used to fear."

Jenny Moore doesn't know why she became scared to fly. After years of jetting to family vacations, she was an Illinois high-school senior applying to California colleges when she found herself panicked on a 1990 flight.

"I promised myself I'd never get on another plane," she recalls -- and for ten years, she didn't. Dropping her dream of attending the University of Southern California, she chose a nearby college.

She says she still can't believe her husband married her in 1997, as she insisted on a honeymoon within driving distance of Chicago. The family moved to the Leesburg area in 2000. With an infant daughter, car trips to see Illinois relatives were nightmares. Moore tortured herself with the specter of "never being able to take my kids to Disney World," and she unsuccessfully tried traditional counseling.

In August 2000 she contacted Saylor and within a few visits had her first VR session. The simulated flight felt so real that Moore asked to stop, weeping. But during weekly visits for the next month and a half, her tolerance increased. Eventually, she "flew" calmly even when the software simulated storms. By November, she was ready to try what Saylor calls "the graduation flight."

Moore admits that, escorted by a Saylor staffer, she was nervous hearing the jet door close for the flight from Dulles to LaGuardia. But in-flight, she told her escort, "I'm flying! I can't believe it! This isn't bad at all." After a smooth return trip, a flight attendant used the intercom to offer "congratulations to the person who hasn't flown in ten years."

In the more than three years since, Moore, 32, has flown repeatedly. Among her most gratifying outings: taking her daughter to Disney World.

Rothbaum and Samantha Smith, a psychologist at DC's Walter Reed Army Hospital, compared fear-of-flying patients who did VR therapy with those who did traditional in-vivo exposure therapy. The findings: VR treatment did as well as traditional treatment in relieving fears -- and six months after treatment, among both sets of patients, 14 out of 15 had successfully taken plane flights.

NIDA's Dave Thomas says VR is potent against phobias because they're fanned by "cues in the environment -- and with VR you can control the cues in the environment in extremely slight ways. If you have someone who's afraid of snakes, and to treat them in the real world you have to

bring a snake into the room, you're not sure what the person's going to do. But in the virtual world, you can bring it in very gradually, to the exact degree that it's needed" -- or make it vanish with a click.

Hoffman says VR therapy may be especially helpful for phobics because it's less intimidating. Only about 15 percent of phobics ever seek treatment, he says, because a hallmark of the condition is avoiding the feared object or situation.

Hoffman says these patients may be open to treatment using simulations; for example, spider-phobics who would never consider therapy involving a live tarantula often will try therapy with a cyber-tarantula. Among phobics who completed VR therapy, Hoffman's studies show, better than four out of five conquered their fears.

Other phobias being treated with VR therapy include fear of driving after a wreck; claustrophobia (for which the virtual world features walls that close in, with a scraping-concrete sound); fear of crossing bridges or riding in elevators; and fear of public speaking.

Though some VR worlds include "avatars" -- computer-generated humans -- the public-speaking software uses video of real people, whose actions the therapist controls. At George Washington University's Speech and Hearing Science Department, assistant professor Shelley Brundage is researching how stutterers could benefit from using VR.

"You feel like you're on a stage," Brundage says. "You can look around behind you and see your PowerPoint slides." Or you can look at written notes atop the podium, because the VR software allows actual slides or texts to be inserted.

"As the clinician," she says, "I can put a clock in there ticking down; managing time pressure is critical for people who stutter. I can program people to interrupt or cell phones to ring. I can make it a nice attentive audience or an inattentive audience where people fall asleep in the front row or get up and walk out."

Though the existing software is designed for anyone who struggles with public speaking, Brundage hopes to fine-tune it for use specifically with stutterers.

A key question about VR worlds is whether looking more real makes them more effective. NIDA's Thomas says researchers hold different views: "There are those who think a less-real world will get you more involved because you have to fill in the spaces with your brain."

There's more fantasy than reality in SnowWorld, a VR program Hoffman developed. Visitors fly through an animé ice canyon of blue and aqua crags, over an iceberg-dotted river, and past a frigid waterfall. Aiming

with their gaze, they shoot snowballs at comic-book snowmen, igloos, and penguins. When the snowballs land, visitors hear the river splash and feel the thud of impact -- and report strong sensations of being in the environment.

Sojourns in SnowWorld provide relief for patients undergoing painful medical procedures. Mike Robinson, 36, was working on a truck last November when its gas tank exploded, causing second-degree burns on his arms. During ten days in the University of Washington's Harborview Burn Center, the Tacoma plumber underwent daily wound cleansings that he says "hurt like hell -- 10 on a 1-to-10 scale" despite doses of morphine.

Robinson was exhausted by the pain and sickened by the sight of nurses removing burned flesh. But when he used the SnowWorld VR program during the cleansing procedure, he says, "I didn't even feel it."

Burn-pain researcher Dave Patterson's explanation: Feeling pain requires conscious attention -- and when they're engrossed in VR simulations, patients have "much less attention available to process pain signals."

Thanks to funders including Microsoft cofounder Paul Allen and NIH, the University of Washington is providing free copies of SnowWorld to other medical centers for use with burn and cancer patients.

VR's pain-management potential has caught the attention of the Baltimore-based Believe in Tomorrow National Children's Foundation, a group that grants the wishes of seriously ill youngsters. At the University of Maryland Baltimore County, the foundation is backing psychologist Lynnda Dahlquist's research into how VR pain-distraction tools work for children.

With University of Maryland Medical System pediatric hematology and oncology patients, Dahlquist will test VR programs and track what's most effective with different ages and genders. The goal: to put new VR tools into the hands of hospitals -- including Walter Reed and Baltimore's Johns Hopkins -- where Believe in Tomorrow already supports pain-management programs.

Virtual-reality tools show promise against other tough-to-treat conditions, too:

* Smoking. At his Pittsburgh lab, researcher Steve Baumann guided smokers through two versions of a virtual world: one with no references to smoking and one littered with ashtrays, cigarette packs, and advertisements (which he customized to resemble the test subject's favorite brand). On a 1-to-100 scale, subjects reported a 15-point jump in their cravings in the smoky world as opposed to the smoke-free one.

Baumann's research moves on to "the next question: Now that we can

manipulate their craving level, can we use that . . . to desensitize them to smoking stimuli so they go back into the real world without such strong cravings? Or to help them develop coping mechanisms in conjunction with other therapies, like the patch?"

Some Baumann subjects underwent brain scans during the VR treatment; the data on which brain areas were activated and deactivated by smoking stimuli could help scientists develop more-targeted smoking-cessation tools.

* Drug addiction. Rothbaum has developed a "virtual crack house," where addicts can be exposed to people or things that make them want to use. While the VR program could help addicts learn to fight their cravings, it also gives drugmakers a safe environment in which to test anti-craving medications. Similar VR programs are in development for abusers of alcohol and other substances.

* Eating disorders. At the Istituto Auxologico Italiano near Milan, Italy, research professor Giuseppe Riva treats anorexia and bulimia patients with an inpatient program including VR.

Traditional eating-disorder counseling aims to get patients to think and behave differently about their bodies. Riva's program reinforces that goal on several fronts. Showing patients virtual items and scenes from their everyday lives can help them identify -- and avoid -- things that spur destructive eating behaviors. And showing patients representations of themselves -- computer-drawn avatars built to scale for their height, weight, and measurements -- helps dispel, say, a gaunt girl's distorted view of how "fat" she is.

Riva says that while traditional eating-disorder therapies can require 6 to 12 months and lots of patient engagement to be effective, VR therapies can show "significant results after six weeks."

Though anorexia patients often can see photos of themselves and still deny how emaciated they look, researcher Azucena Garcia-Palacios says, "there's something about the computer that patients find an authoritative source of information." Garcia-Palacios is a member of a Spanish VR research team that collaborates with Riva's.

So when a VR-therapy program shows patients an average-size avatar and lets them digitally adjust it to be the size they think they are, patients often plump up the figure -- and then can't deny the discrepancy when the computer shows them how skeletal their true-size avatar looks in comparison.

Posttraumatic-stress disorder often defies treatment because numb, angry patients can't always do what would heal them: retell their trauma and relive painful memories until they lose their potency. In the late 1990s, a

VR world of rice paddies, Huey helicopters, and B-52 strikes was created to treat Vietnam veterans for PTSD. Rothbaum and colleagues found that veterans' illusion of being in the virtual Vietnam helped them work through pent-up emotions.

Then came September 11. Within days of the World Trade Center attack, JoAnn Difede, a PTSD expert at Cornell University's Weill Medical College, began working with survivors including burn patients, rescue personnel, and witnesses from Ground Zero. She and Hoffman began work on a VR simulation of the day's scenes and events.

Howard University graduate Charlice Noble-Jones stood in the Trade Center's shadow on 9/11. At 25, she had just completed a fast-track management-training program at Deutsche Bank. She managed a 26-person team that oversaw billions of dollars in currency transfers every day -- in a building linked by a pedestrian bridge to the south tower.

That morning, Noble-Jones got off the subway about 8:50 at the Trade Center station and emerged to see the north tower with a hole in it.

"I don't remember seeing the flames," she says, "but I remember the sounds -- as noisy as New York City is, that's the only sound that I remember, the sound of that fire. That moment seemed like it lasted forever. . . . I got close to the south tower, and the people started jumping out of the windows. You were stunned by it -- it wasn't real. The people in there had decided which way to die. . . . There was a man and a woman who held hands and halfway down started to drift apart. . . . A man behind me points out this plane, and you see it cross the street -- it was the loudest sound . . . and then this large explosion, and your reaction is: Run."

After the second plane hit, Noble-Jones tripped over people kneeling in prayer and fell under a stampede. Reciting the 23rd Psalm, she struggled free of a trampled woman clutching her and ran through showering debris.

"The man in front of me got hit in the head -- he just fell out," she says. "A lady with beautiful red hair -- I had just seen her standing there, but now she was lying on the ground with her legs gone from the knee down. I said 'I'm sorry' to the man and the woman, and I ran. . . . About an hour later, this lady stopped me and said, 'You don't have any shoes on, and you're bleeding.' "

Though Noble-Jones can recount it all now in horrific detail, for months after 9/11, she says, "I was a zombie. People said, 'You have to keep living' -- but when I thought I was going to die, I had said goodbye to everyone who meant something to me."

She felt no grief, no joy, just "days of anger" -- and yet insisted to her mother that nothing was wrong.

Her mother made her an appointment with JoAnn Difede. Though some PTSD patients can overcome their trauma by repeatedly reliving it in "imaginal therapy" discussions, others can't open themselves to that, Difede says. However, "even for people who are numb, VR creates such a great sense of the experience being real that your brain just begins processing the memories, begins to think and feel about what happened to you."

After a few unsuccessful attempts to help Noble-Jones with imaginal therapy, in January 2002 Difede suggested VR.

Noble-Jones remembers scoffing: "I stopped playing video games years ago." But a few minutes into her first viewing of the Trade Center VR world, she was in tears. She had needed to remember "exactly what I saw that day, and this was just a simulation -- but when I opened up to it, I did see those things again in my mind."

Where the VR program showed simulated buildings, she saw her bookstore and dry cleaner; where it used human avatars, she saw the falling pair holding hands and the woman with red hair.

After six sessions of VR treatment, watching successively more-detailed scenes of the tragedy, Noble-Jones no longer showed symptoms of severe PTSD and depression.

With her research in the pilot-study phase, Difede says, "As a scientist I can't say, 'This is it, we've really found something.' But as a clinician seeing the rapid improvement of patients who've gone all the way through the protocol, I'm impressed."

After therapy, Noble-Jones reconciled with the boyfriend she had pushed away; they married and moved to Georgia, where they're running family businesses and raising their six-month-old son. This month, she turns 28. She grants that there may always be "things that will draw me back" to 9/11 -- a low-flying plane or an explosion in a movie -- "but I don't have to stay there."

Like most promising technologies, VR has drawbacks. The chief obstacle, says Ro Nemeth-Coslett, cochair of the NIDA working group, is cyber-sickness -- the nausea, dizziness, and eyestrain that older users, especially, can experience as they watch VR scenes.

Another issue: the availability and cost of the technology. Over the past decade, basic equipment has become easier to obtain and afford: An office setup like Saylor's can be put together for about \$15,000, but more-sophisticated VR experiences would require computer-wired "cave" rooms that helmeted patients can walk around in -- and only about a dozen of those exist in the United States.

NIDA, the NIH branch where most VR-therapy research and development is focused, has awarded about \$3 million for it in the past two years. Although that's a fraction of the institute's nearly billion-dollar budget, Thomas says VR-therapy research ranks "among the fastest-growing NIDA-funded areas."

As the therapy goes into its second decade, innovations crowd the horizon. USC researcher Skip Rizzo uses a "virtual classroom" to learn how screening out distractions may help students with attention-deficit hyperactivity disorder. Researchers are testing whether VR worlds can help autistic children establish eye contact and focus their attention for longer periods.

Environments like Baumann's Smoker World may soon deliver smells as well as sights and sounds. As technology becomes cheaper, Thomas suggests, why not put VR gear in patients' homes, for 24-7 access to cyber "support groups" that help them resist alcohol, drugs, or overeating?

In the next decade, Nemeth-Coslett predicts, VR treatments will be possible "that we couldn't even imagine now." And they'll work, Hoffman predicts, because the technology will meld ever more powerfully with the key element in therapy: the patient's mind.

"The virtual world is not in the computer," Hoffman says. "The virtual world is in the person's brain. We're just helping people create the virtual world in their minds." And start healing.

At a burn center, patients are distracted during painful wound cleanings by this: SnowWorld, a virtual-reality program where they fly through an icy canyon and shoot snowballs at targets.

Photograph by Hunter Hoffman, U.W. HITLab

JoAnn Difede is an expert on treating the stress brought on by events such as 9/11.

Difede photograph by Weill Cornell Medical College Art & Photography Dept.

Within days of the 9/11 attack on the World Trade Center, psychologist JoAnn Difede and researcher Hunter Hoffman began work on a virtual-reality simulation to help survivors and emergency workers.

Twin Towers photograph by VR programming by www.howard-3d.com, and Duff Hendrickson, U.W.

Image credit and copyright Hunter Hoffman, U.W. HITLab

Bank manager Charlice Noble-Jones at first scoffed at the idea of using virtual-reality therapy to get over the trauma of seeing people jump from the Trade Center on 9/11.

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JoAnn Difede, Cornell