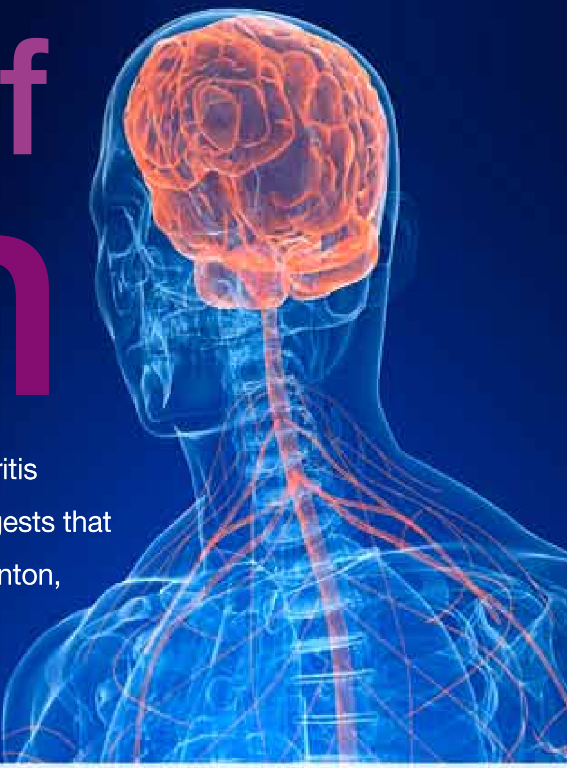
the power of illusion



Recently, British researchers stumbled upon a way to reduce arthritis pain through video illusions, adding to existing evidence that suggests that the key to relieving chronic pain resides in the brain. Dr. Tasha Stanton, a Canadian researcher in Australia, believes the discovery could someday play a role in relieving SCI neuropathic pain.

At SCI BC, we try to feature pain research in The Spin *for two reasons. First, pain is a top issue for people with SCI, and in a world that often seems to be obsessed with "cure" research, we believe it's important to generate more support for SCI pain research and the researchers involved in it. Second, we believe we have an obligation to keep our readers—many of whom suffer greatly from neuropathic pain—informed of any new developments in the field of pain management. This story provides an overview of fascinating research, but we want to make this disclaimer: it's not going to lead to any type of treatment or breakthrough in the short term. We do, however, believe the longer term implications are important.*

Many of mankind's greatest scientific and medical discoveries have come via a combination of chance and astute observation. Of these, the discovery of antibiotics stands out. In 1928, Scottish physician and researcher Alexander Fleming left a culture plate smeared with Staphylococcus bacteria on his University of London lab bench and went on vacation for two weeks. When he returned, he discovered that the bacteria's growth had been stopped dead in its tracks by the arrival of a fungus. The fungus was penicillin, and it and other antibiotics have been saving lives ever since.

Recently, another case of scientific serendipity in jolly old England has changed the way many researchers are thinking about chronic pain—pain that is persistent for long periods of time. The discovery revolves around a device called the MIRAGE—a kind of virtual reality box that uses a system of cameras and mirrors that the subject inserts their hand into. When the subject looks down to see their hand, they see a real-time video image of their hand reflected in a mirror. This video image appears to be in the same location as their actual hand, which is hidden below the mirror.

The video image can then be distorted—for example, the fingers can appear to be stretching or shrinking. At the exact same time as the distortion takes place, an assistant sitting on the opposite side of the device applies a gentle pull or push to the subject's fingers from within the box. The result is a combination of tactile and visual stimuli that can be extremely convincing for the subject.

This powerful bit of multi-sensory trickery was originally developed by Dr. Roger Newport of the Nottingham University's School of Psychology. He believed the device would help him study the way our brains put together what we see and feel happening to our bodies.

In 2010, during an open house at the university, researchers were busy demonstrating the device to some school children. A grandmother of one of the students wanted to try the device. But she cautioned the staff to be gentle, explaining that she had painful osteoarthritis in her fingers.

During the demonstration, the woman stunned

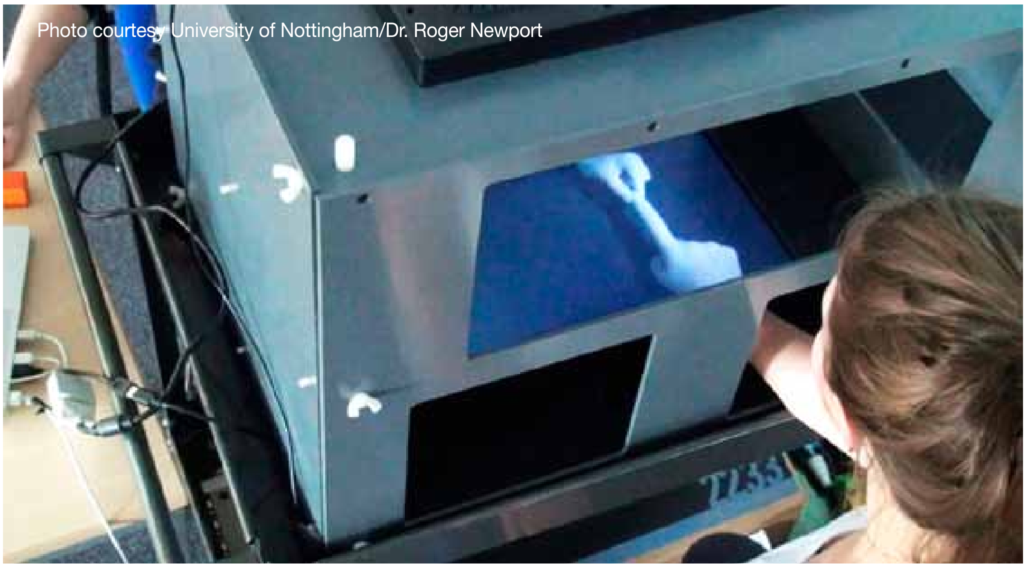


Photo courtesy University of Nottingham/Dr. Roger Newport

the researchers with a simple pronouncement. "My finger doesn't hurt anymore," she said. And she asked whether she could take the machine home with her.

The researchers flew into action to find out if the result could be replicated. They recruited 20 volunteers, all around the age of 70, and all with osteoarthritis and arthritic hand pain.

The results were striking: 85% of the participants reported immediate and significant reduction of their pain, and almost a third reported that their pain had completely disappeared. The researchers also determined that the illusion only worked when the painful part of the hands was being manipulated. And follow-up suggested that, at least for a small number, the effect had some staying power—some reported still feeling less pain as they were leaving, and one even reported feeling less pain weeks later.

Since that time, the researchers have been developing more rigorous experiments with MIRAGE that will help them rule out placebo effect or other causes beyond what they're really hoping is happening—that the brain can be influenced to turn pain off, or not turn it on at all in the first place. Along the way, they've generated quite a buzz worldwide, with many researchers seeking to play a complementary role and contribute to this new and emerging body of knowledge.

Among them is a transplanted Albertan who now lives and works in Australia—Dr. Tasha Stanton. Stanton is a Canadian Institutes of Health Research Postdoctoral Fellow who investigates pain neuroscience at both the University of South Australia in Adelaide and Neuroscience Research Australia in Sydney.

Once Stanton completed her PhD, she focused her research interests on the neuroscience behind chronic pain—how the brain processes painful stimuli and decides something is painful, and other factors that influence pain. In fact, much of her postdoc research focused on the use of illusions to evaluate the brain's role in pain, as well as the use of illusions as a targeted treatment for chronic pain. So when her supervisor, Professor Lorimer Moseley, saw Newport demonstrating the MIRAGE at a conference in 2011, he saw a perfect opportunity for collaboration, with Stanton taking the lead in Australia.

Neuroscience Research Australia completed the purchase of a MIRAGE, and in January, 2012, Stanton flew to England to train with Newport on the device. When she returned, she brought the new MIRAGE home, so that she and her colleagues would have hands-on access to the device and begin actively collaborating with Newport and his team in England.

There are many aspects to the work—confirming through more rigorous tests the results that have already been witnessed, and learning about how illusions can influence reactions in the body that we can't consciously control—for example, temperature, which is relevant because people with certain types of chronic pain have impaired temperature control of the painful body part. Stanton is enthusiastic about all of this work, but she hopes that MIRAGE ultimately brings the field closer to understanding how illusions reduce chronic pain.

"In order to talk about how we might think illusions work, we have to talk about why chronic pain occurs," says Stanton. "There are two main 'brain' theories regarding why people have chronic pain. The first relates to a problem with our brain getting faulty information. With this theory, when different parts of the brain talk to each other, one part has faulty information and one has correct information. And this mismatch is thought to cause pain."

The mismatch, says Stanton, may be related to faulty 'maps' in the brain.

"Your brain has a map, or representation, of your entire body—this is how we know where we're being touched," she explains. "In people with chronic pain, these maps are altered. We're not sure why—it may be from not moving the body part very much or other more complex reasons that involve our immune system. The problem—and the pain—is thought to occur when we move. If you want to move your hand, the area of your brain that controls movement activates, and then you actually move your hand. Importantly, the movement centre makes a copy of that movement command and sends it to another area of the brain, just to say, 'Hey, this is what we just did, so this is where you should expect our hand to be.' However, if the movement command centre based its information on the faulty brain maps, then where you expect your hand to be is not where it actually is. It's thought that this incongruence may cause pain."

She adds that illusions may work by temporarily 're-setting' those faulty brain maps so that, suddenly, where you expect your hand to be is where it actually is. "Many people with osteoarthritis respond best to the illusion where the fingers or hand are stretched and then appear longer than normal," she says. "Preliminary work suggests that many people with osteoarthritis seem to perceive their hand as smaller than it actually is, suggesting that their brain maps for that hand are altered. Thus the stretching illusion may work by temporarily 're-sizing' the brain map for the hand."

The second theory, says Stanton, relates to how our brain analyses incoming information. "The brain's role is to interpret all the incoming information about a specific body part or area, and then make a decision on whether or not this information warrants a pain response in order to deflect further damage—real or perceived—to that body part. In other words, our brain evaluates how much threat something poses to us. In the case of chronic pain, we believe the brain is wrongly assigning increased threat value to incoming information."

In this theory, brain maps are again involved. "The maps help us localize where information is coming from on our skin. However, to be able to move around in the world, our brain also has to know where our body part is in space, in relation to our body. In order to do this, our brain has to combine the information coming from our skin with information about the space surrounding the body. This is a complex process. Perhaps illusions work by giving us visual information that is different from the actual information coming from our hand. For example, in the MIRAGE, our eyes tell us our fingers are being stretched, but our fingers are telling us they haven't. It's possible that this conflicting information is difficult to process and reduces our brain's ability to produce pain. Or because our vision is giving us 'faulty' information about our hand, perhaps our brain disregards all the incoming information from the hand because it can't be trusted, and thus the threat value is reduced, and pain is also reduced. Yet another possibility is that illusions may work because we may 'disown' the body part involved—the vision doesn't match how our hand feels, so it must not be ours, so let's ignore incoming information from it."

Stanton concedes that illusions may also just work via distraction—we're paying less attention to the painful body part and so pain decreases.

"However," she says, "if this is the case, we would expect an illusion to decrease pain in a painful hand even if we did the illusion on a non-painful body part. We don't see this in our experiments."

Regardless of which theory proves to be correct, Stanton and her colleagues believe that control of chronic pain lies in the brain, as do many other scientists. "The difference is that our aim is to target pain via rehabilitation strategies instead of pharmacological strategies," says Stanton. "The brain's role is to interpret incoming information and, at the end of the day, decide whether or not this information should be painful. Thus, if we can target this faulty analysis of incoming information—which one would argue is present in people with chronic pain—then we may be able to influence pain levels."

She adds that it's important to remember that targeting the brain isn't about improving the pain sufferer's willpower or ability to bear the pain better. "Rather, it's about treating an improperly working nervous system," she says. "One might argue that instead of trying to get the brain to turn pain off, we're trying to avoid having the brain inappropriately switching pain on."

So where does SCI come into the picture? Stanton and her colleagues believe that SCI neuropathic pain at or below the level of injury appears to be an ideal model of chronic pain to study with illusion-based research techniques.

"I think because SCI pain is so resistant to various forms of treatment, both drugs and invasive surgeries, it makes good sense to follow up avenues that aim to determine the role of the brain in maintaining and potentially generating pain," she says. "And I think this is where the MIRAGE and illusions in general fit perfectly, since there is altered sensory information going to the brain for the body parts below the level of the lesion, which then likely results in altered brain maps of the body."

There's another reason why SCI neuropathic pain could become a targeted area of study: there's already been some success testing the power of illusions for pain relief in people with SCI. That work was done in 2006 by none other than Professor Lorimer Mosely, Stanton's supervisor.

Mosely's experiment created the illusion of walking for five people with paraplegia. The participants sat with their lower bodies concealed, facing a mirror stacked on top of a projector screen. The mirror reflected the participant's upper body and head, while a perfectly-aligned image of legs walking was projected onto the screen below.

One participant withdrew from the study just 45 seconds into the test—the illusion was emotionally overpowering.

Dr. Tasha Stanton

But for the four remaining participants, the results were quite dramatic. It was found that ten minutes of watching this illusion decreased pain intensity and duration compared to performing control activities—watching a funny comedy movie and performing guided imagery of an enjoyable, painless activity. Furthermore, repetition appeared to improve results. After 15 days of ten minute training sessions, pain intensity levels decreased by 50%, duration of pain relief significantly increased (up to two hours in one participant), and the total area of pain also decreased.

When he published his work, Mosely conceded that there were many variables and possible explanations for the pain-relieving effect. But he also felt that the results warranted further investigation. Stanton agrees, adding that the MIRAGE could play a role.

"In the MIRAGE's current form, an SCI study wouldn't be possible given the size of the device. But there are some adaptations that we can make that will allow us to apply similar type illusions without needing to use the whole MIRAGE equipment set-up. However, we don't have any direct plans to follow this up in SCI yet. The priority is more preliminary work to try to understand how the MIRAGE might actually work to decrease pain—for example, using electroencephalography to measure brain activity during the illusion."

But she adds that any MIRAGE research has the potential to ultimately benefit every person with chronic pain, regardless of the source. In the short term, it could lead to confirmation of the brain's role in controlling chronic pain, which could prompt more funding and more research about how it does that. In the longer term, all of this could lead to discovering how chronic pain for many conditions can be switched off in the brain, and ultimately, development of a therapy or therapeutic device based on the MIRAGE could be developed for SCI and other causes.

"Even without the addition of the MIRAGE to SCI research, illusions have provided us with a unique opportunity to understand and evaluate how the brain can influence pain," says Stanton. "We're in the early stages of understanding exactly how the brain does this, and in the next decade or so, I have high hopes that we will make great strides forward with this knowledge."

On a personal note, Stanton says her work down under is incredibly gratifying. "To target pain in a body part without really doing anything to that body part itself is just plain cool," she says. "And it opens the door for so many treatment possibilities if we can understand why this happens!" ■

ask the SPIN DOCTOR

Welcome to the first regular instalment of The Spin Doctor. In each issue, we'll ask one of our BC-based SCI medical experts to address our peers' most pressing medical issues. Our first instalment is provided by Dr. Rhonda Willms, Medical Manager of the Spinal Cord Injury Program at GF Strong Rehabilitation Centre in Vancouver.

Many people with SCI are prescribed spasticity medication, and it's important for these individuals to have a clear understanding of how to manage this medication for maximum benefit and safety. Here are some tips on managing your spasticity medication.

Baclofen, the most common spasticity medication, is metabolized (broken down) by your liver, and in some individuals it can be irritating to the liver. Talk to your family physician about having your liver enzymes and liver function periodically checked by a blood test. Typically, this would be done two to three times per year.

The "half-life" of any medication is the time that it takes your body to metabolize half of the dose that you have taken. If you take your medications in such a way that all of the medicine is out of your system before you take the next dose, your blood levels of the medication are on a bit of a roller coaster. Taking your medications as directed will help to keep the blood levels more even, which will hopefully allow you to have more consistent symptom control. For example, the half-life of baclofen is about four hours, which is why it is typically prescribed to be taken three or four times per day.

Tizanidine (Xanaflex) is another medication used to manage spasticity. It has a drug interaction with another commonly prescribed antibiotic called ciprofloxacin (Cipro). These medications should not be taken together as the ciprofloxacin will increase the blood levels of tizanidine, making its side effects such as fatigue or weakness much more pronounced.

Never suddenly stop your dose of baclofen. It works by mimicking an inhibitory neurotransmitter. In other words, it helps to suppress the (overactive) nervous system. If you suddenly take away suppression, the response is excitation. Excitation of the nervous system can mean agitation, a sudden increase in spasticity, confusion or even seizures. With this in mind, always taper down your dose of baclofen gradually—you can ask your physician for help in how to do that. And if you are admitted to the hospital, make sure that your baclofen is ordered for you.

Got a question for The Spin Doctor? Email it to Brad Jacobsen, our SCI BC Peer Program Coordinator (bjacobsen@sci-bc.ca), who will recruit the most appropriate SCI expert to provide an answer. Remember, the advice provided is general in nature and is not intended to replace advice specific to your personal situation provided by your family physician or SCI specialist.