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# PAIN LESS

**Large-print book**

# PAIN LESS

## the future of relief

How many painkilling pills do you pop a year?  
A few dozen? More than a hundred?

Last year, nearly 6 billion painkillers were sold in the UK. Pain is a constant reality for some people, especially if you're one of the 1 in 5 who suffer from relentless, chronic pain.

We treat pain with drugs that haven't really changed for decades. Painkillers and powerful anaesthetics work for most people, but there are side effects. And some drugs can become less effective, or you may become addicted – especially as you take more of them.

Is there a better way to control pain?

You sense pain through receptors in your body that send signals speeding along nerves to your brain to interpret. Some scientists think that understanding the link between the brain and body will lead to new ways to treat pain. And they've come up with some unusual ways to study this.

**Antenna** investigates what scientists are doing to improve pain relief.

*'I willingly let someone inflict pain on me, for scientific research.'*

Melvin

## **How do your perceptions change your pain?**

Research shows that pain is much more than a simple physical response. How we experience pain is affected by many things including our genes, memories, expectations and emotions.

Melvin is helping neuroscientist Irene Tracey to understand how emotion affects pain. Irene explains, 'The power of our "mind" can drastically change the extent of our pain. When Melvin is anxious or feeling depressed he feels pain more intensely.'

So how does Irene measure Melvin's response to pain?

Could her research lead to future pain treatments that combine painkillers with therapies to target emotions, providing more effective pain relief?

## 1. Real-time pain

‘As Irene conducts her pain experiments on me, the fMRI scanner allows her to see what happens in my brain in real time,’ says volunteer Melvin. ‘It measures blood flow in my brain to see what areas are busy when I respond to her painful prodding.’

fMRI scanner

Image: Science Museum

## 2. Painful poke

‘To test pain responses and gain consistent, reliable results, I use special equipment like these von Frey filaments. Each filament applies a specific amount of pressure so all my test subjects experience the same degree of “poking” pain,’ says pain neuroscientist Irene Tracey.

VF1 OptiHair von Frey filaments

Source: MARSTOCKnervtest

Inv. No: E2012.195.1

## 3. Heat wave

‘There are many different types of pain. For instance, when I need to test responses to heat I might use lasers like this,’ explains Irene. ‘They use heat to stimulate pain receptors in your nerves that send signals that your brain perceives as “ouch, that’s hot”. The laser lets me precisely control the amount of stimulation I give, so it’s the same every time.’

Stimul 1340 laser stimulator

Source: Elen Spa

Inv. No: L2012-4119

# Seeing the brain in pain

By learning which areas of the brain activate when we're in pain, researchers such as Irene Tracey can find out what affects the amount of pain we experience, with or without drugs.

Today, brain scans can give a picture of what happens in your brain while you're in pain. Functional magnetic resonance imaging (fMRI) allows researchers to watch brain activity as it happens.

When you experience pain certain parts of your brain activate. Active areas of the brain use more oxygen, so more blood flows to these areas. The magnetic signal on the scanner will change as the flow of blood in the brain alters with pain.

Irene analyses the scans to understand the effect of emotions and expectation on pain. If you're feeling depressed, regions of your brain will light up more intensely when you are poked than they would if you were feeling happy. If you're anxious about a painful prod, you may experience more pain than if you didn't care.

*‘My only relief from pain is in virtual reality.’*

**Peter**

## **Is there a trick to chronic pain relief?**

Peter lost his arm to polio, yet he still feels pain in his missing limb. This phantom limb pain is common in amputees. Scientists think it happens because Peter’s body no longer matches the ‘mental map’ in his brain. It’s this mismatch that causes him constant pain.

When computer scientist Steve Pettifer read about Peter’s pain he thought virtual reality could provide a solution. Together with pain consultant Ilan Lieberman, he ‘created an immersive world for Peter’.

‘I’ve tried all kinds of pain treatment,’ says Peter, ‘but Steve’s games are more effective than any pill.’

So how can gaming technology trick the brain and kill pain? Will understanding this trick be useful to others with chronic pain?

## 1. Painful appendage

For Peter, wearing this prosthetic arm doesn't help with his pain. In fact, it makes it worse. 'I prefer not to wear my prosthesis. But with virtual reality I can wear a moving virtual arm.'

Prosthetic arm  
Source: Peter King  
Inv. No: E2012.244.1

## 2. More game, no pain

Peter wears this special visor to become immersed in a world of pixels. The Kinect and a sensor on Peter's head track his movements. Pain consultant Ilan Lieberman explains, 'As Peter moves his virtual limbs, his brain visualises his phantom arm. This reduces his pain. But we don't know why. Something is happening at a deeper level than just "tricking" the brain.'

Model of gyroscope sensor  
Source: Purchased  
Inv. Nos: E2012.265.1, E2012.265.2

Vuzix glasses  
Source: Vuzix Europe Ltd  
Inv. No: E2012.216.1

Kinect  
Source: Purchased  
Inv. No: E2012.219.1

# Magicians use mirrors to trick the audience. Neuroscientists use them to fool the brain...

Researchers hope that if they learn more about how to remap the brain, they can treat people with chronic pain and help them to rely less on painkillers.

When your mental map changes after an amputation your brain can believe that your amputated limb is in pain. Your brain wants to move the phantom arm, but there's no visual evidence of movement. This can make the pain worse.

Neuroscientist Vilayanur Ramachandran created the mirror box to help thousands of patients ease phantom limb pains. The mirror creates a virtual image of a patient's missing arm and gives his or her brain visual 'proof' that the missing limb is just fine.

Some neuroscientists now believe that mismatched connections in the brain could be responsible for other chronic pains that persist without any apparent cause.

*'I can't remember experiencing the pain of the needle in my spine.'*

Carol

## **Can understanding consciousness prevent painful recollections of surgery?**

One of your biggest concerns before surgery is likely to be whether there's any risk of being aware during the operation. But anaesthetists treat thousands of patients every day, and it's very rare for anyone to remember any pain.

But what about pain you don't remember? Carol had a routine operation under sedation using a low dose of an anaesthetic drug; at one point she appeared to feel pain during her procedure, and it was quickly relieved. When asked about it later she said she couldn't remember a thing.

Experiences such as Carol's tell us that consciousness is not a simple on/off switch. Can new research tell us more about how anaesthesia works, and help keep patients from being disturbed by painful memories?

## 1. Painful point

This epidural needle is the same as the one inserted into Carol's spine under sedation. Nine centimetres were pushed into her back.

Introducer needle for spinal cord stimulation lead  
Source: Andrew Morley

## 2. Zero recall

Carol made this Plasticine model of her partner under sedation. When the sedative wore off, she had no memory of the experience. Her anaesthetist, Andrew Morley, explains: 'Recollection of pain under anaesthetic is rare. But anaesthetists often report that patients move in response to painful stimulus during an operation.' Do we need to understand more about awareness and memory before we can improve anaesthesia?

Plasticine model  
Source: Carol Pretorius  
Inv. No: E2012.259.2

### **3. Conscious monitor**

BIS machines such as this measure the electrical activity of the surface of the brain. Using a mathematical formula it calculates the 'bispectral index' that helps anaesthetists assess the likelihood that their patient is unconscious. 'During operations under general anaesthesia, I judge the level of consciousness and adjust the dose of anaesthetic drugs, to make sure my patients don't remember anything,' says anaesthetist Andrew.

BIS Vista monitor and sensors  
Source: Covidien (UK) Commercial Ltd  
Inv. No: L2012-4118

### **4. Knockout machine**

Andrew uses anaesthesia machines like this every day. 'During surgery the machine helps me deliver powerful drugs to keep my patients unconscious and pain-free. The possibility of patients remembering the pain of surgery is a big concern for any anaesthetist. The cause can be as simple as disconnected tubes that stop the drugs reaching the patient.'

Braun Encore 1250 anaesthetic machine  
Source: Braun and Company Ltd  
Inv. No: L2012-4122

# Views from inside the anaesthetised brain

Electrodes like these attach to the fEITER machine, which is no bigger than a suitcase. The machine - of which there are only two in the world - measures electrical activity in your brain. Scientists use this data to create moving images of the brain in action.

Anaesthetist Brian Pollard's team were the first to use fEITER to see the brain as it slips into unconsciousness. The fEITER video shows that as you lose consciousness under anaesthetic, rather than becoming less active, some areas of the brain show lots of activity.

Brian's team were astounded by the images. They think that although the brain's different areas are still active, they just don't work together in the same way when you're knocked out - especially areas responsible for awareness and memory.

Once scientists and anaesthetists understand consciousness more they could use portable imaging kit like this to help lower the chance of awareness during surgery.

*'I can hold burning embers - I sense no pain, just the sizzle of my flesh as it burns.'*

Steven

## **Does unusual DNA hold the key to the perfect painkiller?**

You might think not feeling any pain would be a brilliant super power. But Steven disagrees. He is ordinary in nearly every way, but unlike most of us he can't feel any pain. Steven explains, 'When I'm overcome with exhaustion or aches, it may just be a cold, but it could be deadly serious like a burst appendix. My life is full of potentially dangerous situations because I feel no pain.'

Clinical geneticist Geoff Woods was the first to report that some people who don't feel pain carry a genetic mutation that affects pain-sensing nerves in their bodies. None of their pain receptors send signals to their brains.

Can understanding this 'no pain' genetic mutation help researchers find the perfect painkiller, one without serious side effects? It's led scientists to look in some unexpected places...

## 1. Extra protection

Steven Pete has never felt pain. 'When I was younger I used to enjoy banging my head against the wall. I liked the feeling of the vibrations. My mom had to make me wear a helmet like this so I didn't fracture my own skull,' explains Steven.

Helmet

Source: Purchased

Inv. No: E2012.267.1

## 2. In the blood

Clinical geneticist Geoff Woods uses kit like this to collect blood for genetic tests. The key to Steven's condition may be in his genes. 'By studying people like Steven's DNA we can eventually understand why they don't feel pain. More importantly it tells us how the rest of us do,' says Geoff.

DNA sampling kit

Source: Geoff Woods, University of Cambridge

Inv. No: E2012.266.1

## 3. Crack the code

Powerful gene sequencers such as this one can read an entire human genome in one day. 'Some painless people have a small mutation in an area of code that is essential to make a pain channel in their nerves. Without the channel it's impossible to send pain signals to the brain,' explains clinical geneticist Geoff Woods. 'If scientists can find something that puts the channel out of action, then we'll have a perfect painkiller for everyone to use.'

Proton DNA sequencer shell

Source: Life Technologies Corporation

Inv. No: L2012-4086

# Take one part poison for a perfect painkiller...

Since people with a no-pain genetic mutation have no major side effects, scientists are searching for chemicals that mimic the block to the nerve signals that results from the mutation. These chemicals will be key ingredients for a side-effect-free super drug. Could they be found in venom?

Venom is a cocktail of different molecules used to incapacitate prey and deter predators.

Biochemist Glenn King is investigating some molecules in this noxious mix that stop pain in the same way as the no-pain genetic mutation. These molecules block a channel in the body's nerves to stop pain signals from reaching the brain.

So rather than start from scratch to synthesise these complex molecules, pharmaceutical companies look to venomous sea snails, spiders, snakes and scorpions to provide vital ingredients for the next generation of painkillers.

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Find out more:

**[sciencemuseum.org.uk/painless](http://sciencemuseum.org.uk/painless)**

Please note that this exhibition contains topics that some visitors might find anxiety-provoking. We do not recommend this exhibition for children under the age of 12.

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[sciencemuseum.org.uk/painless](http://sciencemuseum.org.uk/painless)