Why hacking the nervous system could be the next big medical treatment

July 7 2016, by Patrick Degenaar

Credit: Unsplash/CC0 Public Domain

The nervous system that commands and controls your body is beautifully constructed, but occasionally things go wrong. Defects in our DNA can cause lead to a range of disorders. Accidents, old age and even poor diet can equally cause havoc. Pharmaceutical therapy can sometimes help but not all conditions can be treated. And, in any case, such therapy is generally less effective with neurological disorders than other diseases.

An alternative treatment that's been practised for millennia involves electrically stimulating the nervous system. Some early Roman doctors used electric eels to provide shock treatment for pain relief. Almost 2000 years later we use a similar technique with electrical devices called TENS (trans-cutaneous electrical nerve stimulation).

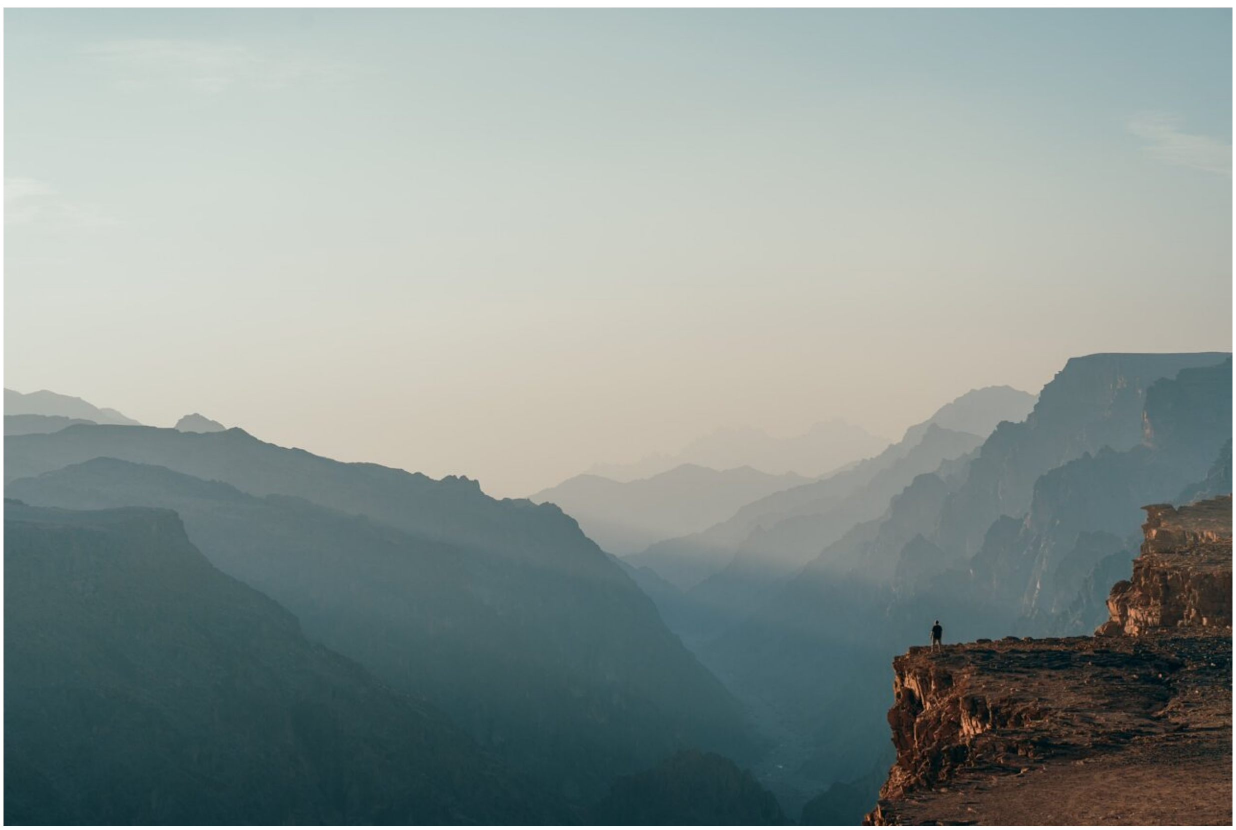
More advanced treatments involve "neuroprosthetic" devices that link directly with the nervous system to replace lost functions. These include pacemakers and sensory prosthetics to replace visual and audio senses for the blind and deaf. Upcoming technology may even hack directly into our autonomous nervous system to treat a range of chronic conditions such as diabetes.

We already have pacemakers that don't just provide electrical stimulation but also wire-tap our autonomous nerve system to listen in to our subconscious emotions. Closed loop stimulation (CLS) pacemakers and defibrillators use this technique to make the heart beat faster when the patient is experiencing feelings such as fear and excitement, allowing them to enjoy scary movies and better appreciate the critical moments of a date.

Seeing the light

Visual prostheses for the blind are potentially even more life-changing. After many decades of development, devices are now available that wirelessly connect a chip in the eye to an external video camera and processing system. For people who suffer from retinitis pigmentosa, which causes the light-sensitive retina cells in the eye to gradually die, these devices transfer visual information to the remaining retina cells using electrical stimulation. However, so far, they can only reproduce a crude image that looks like a handful of flashing dots.

The latest revolution in neuroprosthetics has the potential to go far further. And unlike many of the advances in this field that have come from developments in electronics, this new development comes from biological research. In 2003, German scientists researching algae discovered a protein that could make nerve cells sensitive to light. It led to a new technique known as "optogenetics" that involves using gene therapy to make cells light sensitive. This new technique is significantly more powerful and accurate than previous techniques and makes high-resolution communication with the nervous system possible.



Credit: Unsplash/CC0 Public Domain

In the case of retinitis pigmentosa, instead of replacing retina cells with a chip, optogenetics allows us to restore the remaining cells' ability to detect light. Special electronic goggles can then be used to relay optical information in a form that these newly sensitised cells can understand.

The first human patients have now been treated with this gene therapy technique in the US. If the method works as expected, the results will transform the patients' lives. Some groups have claimed that near-normal visual return is possible. Others, including my own, are a little more cautious but believe it could allow patients to walk without a stick and, in the medium term, perhaps even recognise faces again. We also hope to be able to adapt the technique to a larger group of patients including those blinded by glaucoma and trauma.

Similar progress is hoped for in hearing implants, which can currently allow patients to join in small group conversations but make music sound like death metal performed underwater. Teams in the US and Germany are hoping to use optogenetics as a more accurate way of stimulating hearing nerve cells than conventional electrical implants. They hope this could produce devices that offer near-normal music appreciation.

Conversations with the brain

Optogenetics also holds the potential to treat tens of millions of people with epilepsy and other brain disorders. Part of the problem with traditional neuroprosthetic techniques is that it is difficult to electrically stimulate the nervous system and record electrical neural activity at the same time. It is like trying to hear someone whisper while shouting at them at the top of your voice. But with optogenetics it is possible to stimulate using light without affecting the electrical recording. This means it is now effectively possible have a conversation directly with the brain.

A key early application is epilepsy. We intend to send signals to sections of the brain exhibiting seizure-like behaviour that tell them to calm down. In the world-leading CANDO project, we hope to be the first team to try this technique in epileptic patients in 2021. If it works, it will be a life-changing treatment to those whom drugs have proved ineffective.

In the coming decades, we will see neuroprosthetics increasingly combined with gene therapies such as optogenetics and possibly even stem-cell therapies. Even traditional pharmaceutical companies are starting to explore the possibilities of bioelectronic medicine –- stimulating the body's own organs to produce therapeutic biochemicals. The advantage this brings is that it will allow doctors increasingly to personalise treatment, at least for certain conditions.

For those who have been brought up with films such as Blade Runner, we might have expected all humans to now be enhanced and augmented with bionic implants. In reality, we are a long way off this vision of the future. On the other hand, science fiction authors are only beginning to catch up with the reality of genetically enhanced bionics. In the end, nature is difficult to beat, but if we can bring back near-normal function to the disabled it could radically improve their lives.

This article was originally published on The Conversation. *Read the* original article.

Source: The Conversation