Key Points

1. Chronic pain can be very difficult to treat, not just for Chiari/syringomyelia patients
2. Recent pain theories have focused on how higher-order cognitive processes can influence how pain is perceived
3. Research has shown that given proper feedback and training, people can control what are normally unconscious functions such as heart rate and EEG rhythms
4. This study examined whether people could be trained to control activity in a specific brain region thought to influence pain perception, and whether that would have an effect on pain levels
5. Researchers used healthy subjects and chronic pain patients; subjects were trained using real-time functional MRI to control activity of the rostral anterior congulate cortex
6. Once subjects were able to consciously influence activity in this region, it had a significant influence on how they perceived pain
7. Chronic pain patients reported a 44%-64% improvement in their pain levels after the session
8. Further studies needed to show if the effect lasts or if people can learn to do this without the MRI

Definitions

conscious - when referring to thoughts and actions, those that are intentional

EEG - electroencephalogram; device which records the electrical activity of the brain

real-time functional MRI - type of MRI which can show activity in certain brain regions based on blood flow and provides the data

Thinking Away Pain: MRI Enables People To Control Pain

January 20, 2006 -- Is it possible to think away pain? Results from a recent study conducted by a cross-discipline group of researchers from Stanford and Harvard indicate it might be. That's good news for the millions of Americans who suffer from chronic pain everyday.

All chronic pain, not just the kind felt by Chiari and syringomyelia patients, can be very hard to treat. Although scientists don't know all the details, it appears that when pain is present for more than a short period of time, it actually changes how the body - and mind - perceive pain. These changes can lead to the chronic, intractable pain which some of us know so well.

With drugs only having a limited effect in treating many types of pain, most pain patients end up trying many different types of treatment, from acupuncture to massage to injections, in searching for relief. The impact of chronic pain is far reaching, from lost wages to expensive treatments, to depression and withdrawal. In addition, as this publication has reported, chronic pain can also lead to other health problems, such as high blood pressure, and even has been shown to shrink the brain.

Given this, it is no wonder that a research group, led by Christopher deCharms, got significant media attention when they reported in the December, 2005 Proceedings of the National Academies of Science that they were able to use real-time functional MRI to help people control pain. The team's idea was to use MRI to provide real-time feedback to people in order to train them to consciously increase and decrease activity in a specific brain region thought to influence how pain is perceived.

It has been documented that people can consciously control bodily functions which are normally in the realm of the unconscious (or subconscious), such as heart rate, skin conduction, and EEG rhythms. In addition, research has shown that people can be trained to use real-time functional MRI - which produces images of brain activity in specific parts of the brain - to consciously control brain activities. deCharms' team decided to take this a step further and see if people could be taught to control brain activity in a way that would have a clinical impact.

To do this, the researchers recruited 36 healthy subjects and 12 chronic pain patients. All the participants were told they were going to try to learn how to control activity in a localized brain region associated with pain by using feedback from the MRI they would be placed in. In addition the subjects received written instructions on strategies for how to accomplish this (note, this is taken directly from the research publication):

1. **Attention.** Attend toward the painful stimulus vs. away from it (to the other side of the body).
2. **Stimulus quality.** Attempt to perceive the stimulus as a neutral sensory experience vs. a tissue-damaging, frightening, or overwhelming experience.
3. **Stimulus severity.** Attempt to perceive the stimulus as either low or high intensity.
4. **Control.** Attempt to control the painful experience, or allow the stimulus to control the percept

Next, the healthy subjects were divided into an experimental group and 4 control groups. People in the experimental group were given a pre-test, a series of training sessions, and a post-test inside the MRI. During the MRI sessions feedback from the images - which showed activity in the rostral anterior congulate cortex - was provided in both line form and in video form (see Figure 1). The subjects cycled through periods where they were supposed to increase activity in the brain region, decrease activity in the brain region, or rest. During each phase, a painful stimulus was applied to their hand with a temperature probe and they were told to rate both the intensity and unpleasantness of this on a scale of 1-10 (a computer mouse was provided in the scanner to do this).

The control groups - all healthy volunteers - underwent variations in this routine designed to eliminate factors that could confuse the results. One group received extended practice but without any MRI feedback; one group received twice the training on focusing away from the pain, but was not given MRI feedback; one group was given MRI feedback from a different region of their brain; and finally, one group was given MRI feedback from a different subject.

The researchers found that not only were the people in the first group able to learn to control the activity in the selected brain region, but that it significantly influenced how they rated the painful stimulus. Specifically they exhibited a greater ability to increase and decrease brain activity with each practice session. Then during periods of increased activity in the rostral anterior cingulate cortex, pain was perceived as more intense and unpleasant. Similarly, and perhaps more importantly, during periods where they were decreasing activity in this brain region, the painful stimulus was rated as significantly less intense and unpleasant. Overall, the group was only 1-2 seconds after the image is taken

rostral anterior congulate cortex - small portion of the brain thought to be involved in perceiving and processing pain

unconscious - in this case refers to activity in the mind which occurs without a person being aware it

cerebellar tonsils - portion of the cerebellum located at the bottom, so named because of their shape

cerebellum - part of the brain located at the bottom of the skull, near the opening to the spinal area; important for muscle control, movement, and balance

cerebrospinal fluid (CSF) - clear liquid in the brain and spinal cord, acts as a shock absorber

Chiari malformation I - condition where the cerebellar tonsils are displaced out of the skull area into the spinal area, causing compression of brain tissue and disruption of CSF flow

magnetic resonance imaging (MRI) - device which uses a powerful magnet to create pictures of soft tissues inside the body

syringomyelia (SM) - neurological condition where a fluid filled cyst forms in the spinal cord

syrinx - fluid filled cyst in the spinal cord

tonsillar herniation - descent of the cerebellar tonsils into the spinal area; often measured in mm

Source

Decharms RC, Maeda F, Glover GH, Ludlow D, Pauly JM, Soneji D, Gabrieli JD, Mackey SC. "Control over brain activation and pain learned by using real-time functional MRI." Proc Natl Acad Sci U S A. 2005 Dec 20;102(51):18626-31

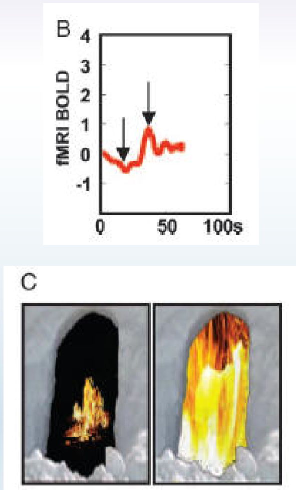
able to influence the pain intensity by 23% and the pain unpleasantness by 38% compared to the initial pain ratings. This was a significantly larger change than any of the four control groups.

Having established that healthy people can control brain activity using the MRI, and that this leads to significant changes in pain perception, the team also wanted to determine whether the technique worked for people already in pain. The chronic pain patients went through similar training sessions in the MRI, however no pain stimulus was given, rather they were asked to rate their existing pain after the session using both a simple 1-10 scale and a pain questionnaire.

Just as with the healthy subjects, the pain subjects reported significant changes in their pain perception. On average, they experienced a 64% decrease in pain as rated by the questionnaire and a 44% decrease as rated by the simple number scale. Also as with the healthy groups, this change was much larger - three times - than that reported by a control group of pain patients who did not receive MRI feedback.

This research has shown that given the proper training and feedback, people are not only able to control the activity of a specific brain region, but that this can translate to real changes, such as pain reduction. As this research continues, it will be interesting to see if the effect is short or long term and whether people can learn to do this outside of the laboratory environment for lasting relief.

Figure 1
Type of Feedback Presented To Subjects During rtFunctional MRI



Note: B) scrolling line chart used to help subjects increase/decrease activity of brain region. C) snapshot of video images presented to subjects; left image is low activity, right image is high activity

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