



## The Pain Pathway and the Brain

After a quick introduction, and a look at the peripheral nervous system and the spinal cord, it's time to work our way up a bit further and take a look at what the brain has to do with the pain experience (hint: *a lot!*).

We'll start by revisiting our definition of pain:

Pain is 'an **unpleasant sensory and emotional experience** associated with **actual or potential tissue damage**, or described in terms of such damage'<sup>(1)</sup>.

Now I've highlighted a couple of points from that quite because they are particularly important. I'll touch on them now, and revisit them later.

The first part indicates pain is an '**unpleasant sensory and emotional experience**'. This looks at the fact pain is more than just a sensation, it is an *experience*. It also hints that while pain is often felt *physically* it is not actually a physical phenomenon. It is a sensation, which varies from person to person and is both affected by, and has an effect on, emotions.

The second point '**actual or potential tissue damage**' indicates that you don't actually need to have tissue damage to experience pain. Slightly counterintuitive for most, but something we began to explore yesterday when we started looking at the nervous system.

A lot of the time the two are synonymous, and we experience pain as a result of damage we have sustained (such as a broken bone, or muscle tear), but not always.

### A Pain in the Brain

Following on from our discussion of the spinal cord, we need to look at the role the brain plays. We can't really have one without the other. We saw how messages which travel from the peripheral nervous system hit the spinal cord, where they are then carried upwards. Once they reach the end of the spinal cord, they end up in the brainstem.

From here it enters a region at the base of the brain called the thalamus. The thalamus has a number of roles, but the one we are most interested in at the moment is that it relay's sensory and motor signals to the cerebral cortex, which is the outer layer of the brain (the wrinkled looking squishy bit which most people picture when they think of the brain).

So it is a relay station between the spinal cord and the brain.

Once this happens, the messages enter the central processing unit. The brain. The big kahuna.

And they get *evaluated*.

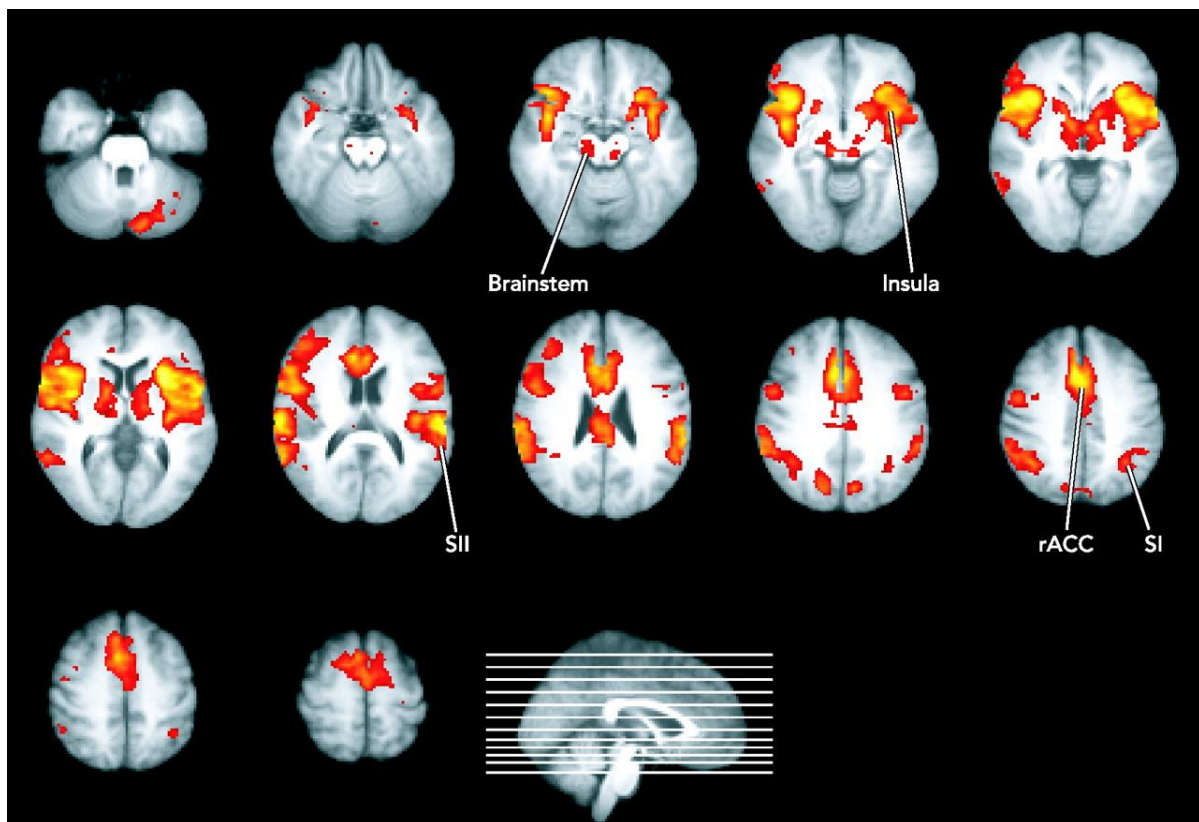
This is the point where the brain constructs as sensible a story as possible based on all of the information that is arriving<sup>(2)</sup>. This includes the signals coming up from the spinal cord, but also past

experiences, location, knowledge of the body and beliefs just to name a few. It then decides on the most appropriate response from what it *perceives* is happening.

It takes information from many different areas of the brain. Think of it like a board meeting. A roundtable discussion where all of these areas of the brain come to put their 2 cents worth in, and once it is all weighed up and a conclusion is reached, then action is taken.

A lot of this we have come to know only recently (over the last 15 years or so, which is a short time, given how long we've been around for). One of the big steps forward is due to the imaging we can now use. MRI for example, has been important, and in particular functional MRI (fMRI), which has allowed us to see real-time brain activity under different scenarios.

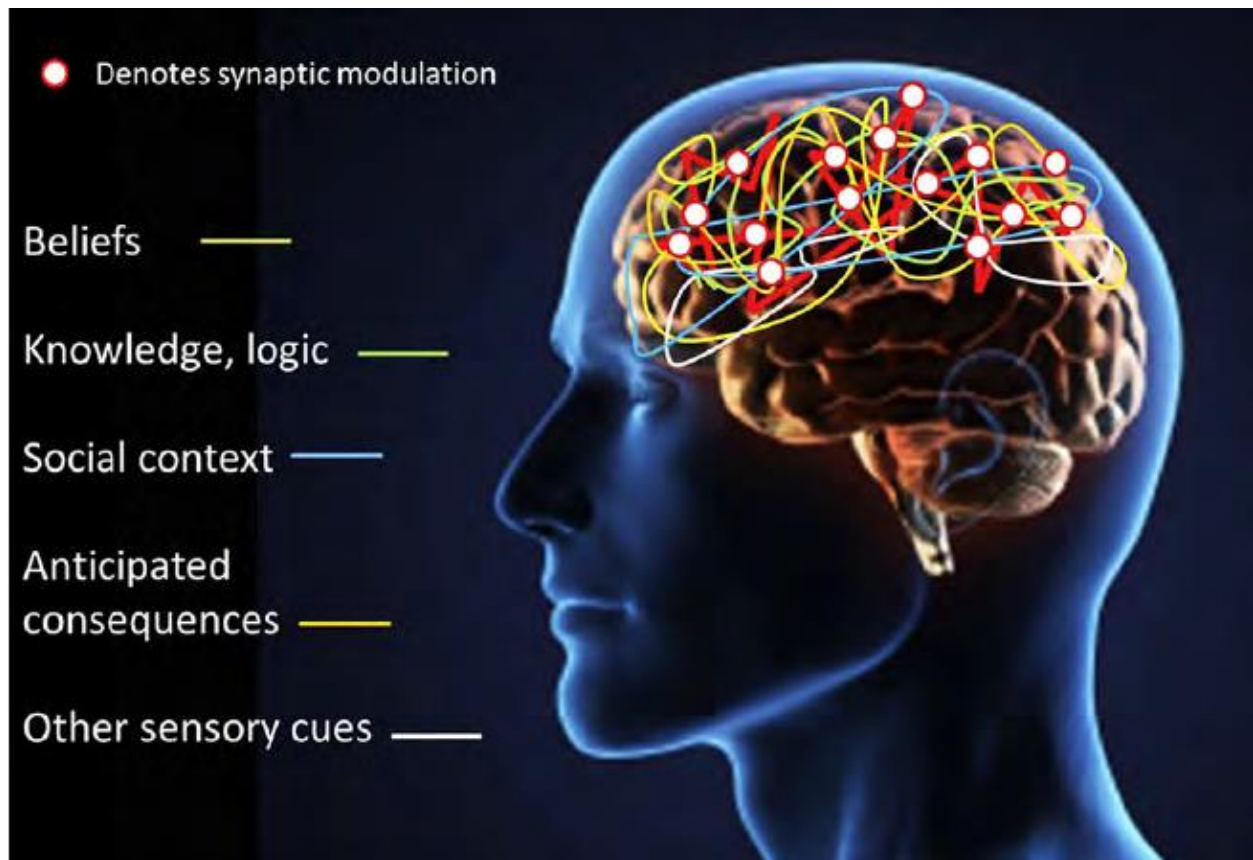
Below, you can see what such an image looks like for someone who is in pain:



**The cerebral signature of pain<sup>(3)</sup>: The aight areas are all active during pain.**

As you can see, many different areas are active. Very much a team effort.

When these areas ignite, it is called a neurotag, and is represented a little something like this:



**The pain neurotag (4): This activates many areas of the brain, including the premotor/motor cortex, the cingulate cortex, the prefrontal cortex, the amygdala, the sensory cortex, hypothalamus/thalamus, the cerebellum, the hippocampus and the spinal cord.**

A neurotag is basically a pattern of neuron activation which creates a certain output of the brain, such as a perception, thought or movement. Or pain. This will be individual to each person, a representation of that experience.

Only once the brain has come to a conclusion of potential danger or threat does it produce pain. Notice the key words I've used there. *Danger* and *threat*. Nothing to do with *actual* damage.

So coming back to our definition again, that pain 'an unpleasant sensory and emotional experience associated with **actual or potential tissue damage**, or described in terms of such damage', we see the bold.

Pain is *protective*.

The signal the brain receives from the tissues via the spinal cord is just *one* of the inputs. While it is important, particularly in acute pain, it is not enough on its own<sup>(2)</sup>. It then also accesses the prefrontal cortex, dealing with problem solving and memory, the Hippocampus, accessing memory and fear conditioning and the premotor/motor cortex, which organizes and prepare movements. Information from these areas, amongst others mentioned above would be added to the information from the spinal cord to provide context.

It would then access these same areas to provide a response, an *output*.

They might cause the motor system to increase muscle tension, aimed at reducing movement in a potentially affected area.

It may stimulate the immune system to sensitise the area, or promote healing through inflammation.

The sympathetic nervous system might then be activated to increase your heart rate and increase vigilance.

Then pain would be formed as an output *back through the nervous system* to draw attention to the affected area, so that you take notice.

All in an attempt to make you take action. This will continue until your brain is satisfied you have taken the appropriate action, and the threat is reduced.

So from that, we see that pain is produced by the brain.

Full stop. End of story.

But it only does this with the information it receives through the rest of the nervous system.

And this is the case with *all* pain, not just chronic pain.

### **Central Sensitisation**

But what about when the peripheral nervous system is less involved and the pain is not really related to the tissues at all? In this situation, the brain and spinal cord (the central nervous system or CNS) become more highly sensitized<sup>(2)</sup>. Just as I talked yesterday about ***descending inhibition***, it can work the other way too.

This is called central sensitization (can't go making the name too obscure, can we?).

The process of central sensitization usually happens over a longer period of time, and when it does, trying to diagnose or label damaged tissue as the cause of pain doesn't really work. Often a person may end up with multiple diagnoses, or be told something different by every health practitioner they see. Which normally come with different treatment options (or none at all).

The never-ending search for a reason for your pain can be exhausting and frustrating.

Because in this situation the issue is less related to the tissues and more to the CNS, it is often unhelpful to search for a diagnostic label and better to look at the symptoms. The symptoms of central sensitization can include:

- **Persistent pain:** Pain which persists well beyond the normal healing time of the initially injured tissues;
- **Spreading Pain:** As mentioned yesterday, there are no fences in the nervous system. Because the CNS is sensitized, your brain tends to erroneously include more of your body in the pain experience, thinking there is increased danger;
- **Worsening Pain:** As time goes by, the pain increases. It also takes a lot less to make you hurt than it had previously done;

- **Even small movements hurt:** While to begin with, only particular movements brought on pain, now it feels like every movement does. Often the sensitivity of the alarm system is so heightened, it tends to go off with any movement;
- **Unpredictable Pain:** It may hurt one day, but not the next. Certain activities which you were able to do yesterday suddenly cause you pain;
- **Additional threats:** Multiple traumatic events, both physically and emotionally can increase the potential threat.
  - Adapted from Butler and Moseley (2006)<sup>(2)</sup>.

Better understanding this mechanism and the reason for your symptoms can be the key to better management and, hopefully, improvement.

**If an amputee can experience pain in their non-existent limb because of the CNS, then why wouldn't the CNS be able to stimulate pain in a body part which is still there?**

I think that is important to remember.

#### **IMPORTANT NOTE**

At this point I think it is particularly important to point something out. I've spoken about how the nervous system, including the brain, are the key to the pain experience. It is at this point that sometimes the message can get misconstrued.

For those people who have experienced chronic or persistent pain, you may have heard similar explanations before, particularly the part about pain being in the brain.

What can happen is the person is told this and hears one thing:

**"The pain is all in your head."**

Now let's be honest. If you had been experiencing pain for quite some time and struggling to cope, hearing that would not be a pleasant experience. In fact, it might royally piss you off, and I'm sure there would be other words that would come to mind as well.

Hopefully what you can see from the information presented is that, while there is certainly an element of truth in that comment, it is *much* more complex than that.

It also does not mean the pain isn't real.

If you are experiencing pain, then the pain is real. The question isn't 'are you experiencing pain?' but 'why are you experiencing pain?'

It also doesn't mean that because the pain is created in the central nervous system, and the brain in particular, that you can simply *think away* your pain.

The idea that this is possible is missing the point, and telling someone who has been suffering with persistent pain that the pain is in their head and them getting the impression they should be able to just think themselves out of it is both frustrating and guilt inducing for them.

It doesn't work that way, and I'll expand further in articles to come.

I just wanted to make that clear.

Tomorrow, I'll talk about the importance of that context in relation to pain production, as well as ongoing, persistent pain...

## References

1. H. Merskey and N. Bogduk, 1994, Part III: Pain Terms, A Current List with Definitions and Notes on Usage" (pp 209-214) Classification of Chronic Pain, Second Edition, IASP Task Force on Taxonomy, IASP Press, Seattle
2. Butler, DS, and Lorimer, GL, 2006, *Explain Pain*, Noigroup Publications, Second Edition
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4. Puentedura EJ, and Louw A. A neuroscience approach to managing athletes with low back pain. *Phys Ther Sport*. Aug 2012;13(3):123-133.