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A Revolution in the Understanding of Pain and Treatment of Chronic Pain

Adapted from an article by Anoop Balachandran of **ExerciseBiology.com**

Many professionals and lay people alike believe that pain comes from an injury or damage caused by misaligned joints, weak and tight muscles, ruptured disks, bad posture and so on. This was based on the Cartesian model of thinking proposed by the philosopher Descartes almost 450 years back. Descartes wrote, **"***The flame particle jumps from the fire, touches the toe, moves up the spinal cord until a little bell goes off in the brain and says, 'ouch. It hurt'*."

Figure 1: Cartesian Model

With that understanding it made sense when physical therapists strengthened and stretched a muscle to treat pain, chiropractors tried to snap misaligned joints back to alignment, when physicians tried to diagnose and identify the damage causing the pain, and expensive tools like MRI and CT scans were recommended to spot the cause of pain. Once identified injection techniques and various surgeries are applied. More sophisticated chiropractors, osteopaths and physical therapists attempt to correct the patient's posture, identify movement dysfunctions, correct imbalances, and perform soft tissue techniques to 'find and fix' the cause of the pain in their patients.

In some patients one or another of these interventions work, in some they don't, and the rest 'act' like the intervention worked.

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Pain management left a lot to be desired, so a little research was in order.

So what is missing in our understanding of pain?

From what we remember from our undergraduate textbooks, when you get hurt the pain receptors send pain signals up the brain and we sense pain. If pain is indeed an accurate indication of tissue damage:

- Why do 40% of the people (alert, rational & coherent and "not in shock") admitted to an emergency room with horrific wounds feel no pain or pain of low intensity even after long delays? (1)
- Why do studies repeatedly show gross abnormalities, like disc bulges, spinal stenosis, herniations, meniscus tears, and so on in 20-70% of people who have no history of pain? (3,4,5).
- Which treatment would help in relieving the pain experienced by amputees in their "missing limb"? And 70% of the amputees report limb pain and sensation even years after the amputation (2).
- There are thousands of amputees running with prosthetic limbs and cerebral palsy patients walking with worst gait possible. These patients have gross movement dysfunctions. Why are they not in bed writhing in pain?

There are a lot more questions which the simple Cartesian model of pain has no answers.

So what is this revolution in the understanding of pain science?

The topic of pain is extremely complex. The following points are a short summary of some of the major advancements in our understanding of the science of pain. Mind you, the researchers knew about all this at least a decade ago, but practitioners lag behind in understanding these concepts.

1. There are no pain receptors

Pain is often thought of as a reflex mechanism. When you get hurt, the pain receptors send pain signals up to the brain and we sense pain, right? Wrong.

We have no 'pain' receptors. It is physiologically more correct to call them nociceptors because they are very similar to other receptors which sense temperature, pressure, and chemicals (called non-nociceptive receptors)**.** The only difference between the two is that the nociceptors have a higher threshold than the non-nociceptors and are only activated when the stimuli is in the higher range. Contrary to what most people believe they don't send 'pain' signals, they send the same signals as other non-nociceptors but just at a higher threshold.

2. Pain is in your brain

When these 'warning' signals from the nociceptors reach the brain, <u>it is up to the brain to decide whether it is indeed a real danger (threat) or not.</u> You will not feel pain unless and until the brain believes that there is a threat to the body and hence an action is required. This has been shown in numerous studies both in animals and humans 6,7,8). In other words, it's not the signals that go to

the brain from the body that matters, it's what the brain decides to do with these signals that matters.

This perhaps explains the countless examples we see of how people come to the emergency room with limbs missing and other horrific injuries room, but feel no pain whatsoever. The likely explanation is that if the brain indeed thought that the missing limb or the injury was highly threatening, you will be crouched, caring for your wound and will most likely succumb to your injuries. If you think about it, pain does not serve a protective purpose when survival is at stake.

Pain is so unique from other sensations such as touch, smell and taste that pain is defined as an 'emotion or experience'. Pain, just like your emotions, is influenced by your thoughts, culture, beliefs and attitude**.**

Henry Beecher was a military doctor in World War II. In the 1950's he looked at the magnitude of injury and the morphine dose soldiers took to control pain. As expected, the greater the injury, the greater the morphine dose. And hence he concluded that there is no influence of your emotions and thinking on your pain. In an attempt to generalize these findings, he repeated the same study on civilians. He found the same: the greater the injury, the greater the morphine. But there was one critical difference – for the same amount of tissue damage, the civilians took 3 times more morphine than did the soldiers! How is that possible?(9)

For a soldier, the injury meant he survived the war and he can recover and go back home. However, a civilian looked at the injuries from a completely different and negative perspective. For the civilian, the injury meant an awful situation which will dramatically change their life for the worse. Their emotions, attitudes and beliefs influenced how the brain perceived the threat level of the injury and modulated pain accordingly. It is now clear from brain imaging studies that that there is no single 'pain center in the brain' as we used to believe. Many areas in the brain are actively involved in constructing and modulating this multisensory experience called pain *(known as the Pain Neuromatrix).* It is very appropriate to say that pain is an output constructed in the brain and not an input to the brain as we used to believe *(10,11).*

Now think how differently a football player and a stay-at- home mom experience their pain after a knee injury of similar magnitude?

3. Pain can change your nervous system

Acute pain due to broken bones, cuts, surgery, burns and such usually goes away when the underlying injury has been treated or healed. It might last for a few seconds, hours, weeks or, at the most, 3-6 months which is the time it takes to heal and remodel connective tissue. But in a sub-set of people, even after the tissues had enough time to heal, pain persists for years. Pain that lasts for more than 3-6 months is termed as chronic pain and has remained a mystery for many years.

We always believed that the brain and the nervous system cannot change. But now we know that the brain is "plastic" and can indeed change (the science of neuro-plasticity). This was only discovered a decade ago and it is one of the groundbreaking discoveries in the field of neuroscience.

We now know from imaging and animal studies that persistent pain or pain which lasts for months and years can change the pain pathways – *peripheral receptors to spinal cord to brain-* physically,

functionally and chemically, to make it a lot more sensitive. And this hypersensitivity causes the brain to interpret anything related to those tissues to be highly threatening. Just like the concept, 'the more your practice, the better you become at performing the skill', the longer your pain persists, the more efficient the nervous system and the brain becomes in triggering and maintaining pain. Hence in chronic pain, pain has moved up to the nervous system and now has very little to do with the initial damage to the tissues that caused the pain (12,13,14). It is just the like the neurological adaptations that occur in strength training.

So sometimes when folks are in chronic pain, they did not get hurt or they did not re-injure themselves as many think. It is just that the brain and nervous system has become so good at constructing pain at the slightest of triggers –even those that don't cause damage- that you experience pain when a trigger is even mildly stimulated. These triggers could be in the form of a slight pressure on the affected tissues or nearby tissues or just even the thought of the injury-causing incident. Chronic pain has been a mystery because we were just looking at the tissues and joints while ignoring the nervous system and the brain. But it is in the brain and the nervous system that the action happens!

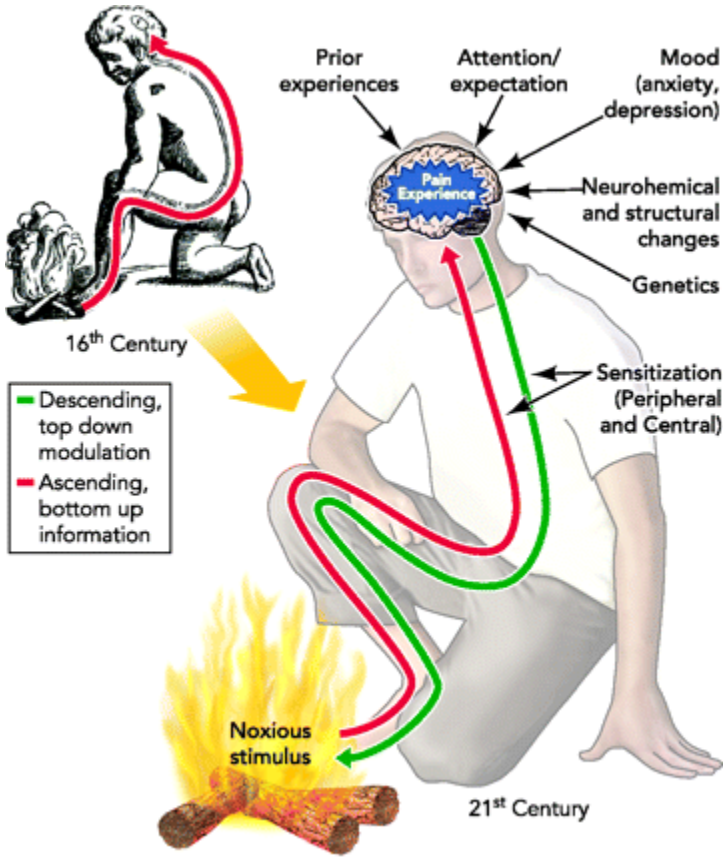

Figure 2: The figure shows the old Cartesian model of pain and the new model which shows pain as a multisensory experience affected by both bottom-up and top-down inputs.

So what can be done about the pain?

The role of any pain treatment should be to lower the threatening inputs to the brain. As a reminder, we are talking about the treatment of chronic pain here and not acute pain (associated with tissue injury) which is pretty straightforward and well understood. What we are more concerned about is the chronic pain problem which has progressed beyond the normal healing timeframe.

Bottom-Up Approach (Nociceptive Mechanisms): This involves any treatments which lowers or inhibits the nociceptive signals (bottom) to the brain (hence called bottom-up approach). Most current pain therapies targeting the tissues and joints are based on this 'bottom-up' approach. A simple example would applying ice or heat to the damaged area. Another example would be lowering the weight for leg exercises if you have knee or low back pain (24).Mckenzie's method, postural correction, trigger point therapy, Graston®, Myofascial release, injections, manipulation all come under this category.

But the problem with this 'bottom up' only approach is that the treatment is rationalized in a context which reinforces the belief that there is something wrong in their tissues and joints (and thereby raising the threat level) and may only bring temporary relief (25).

Top-Down Approach (Non-Nociceptive Mechanisms): This is done by educating the person about the physiology of pain, the role of brain in pain, and "how pain does not mean harm" (hence called top-down approach).

If we explain pain based on our structural-pathology model, every time people feel pain they think they got hurt or re-injured themselves and naturally try to avoid pain-causing behaviors. This thinking process heightens the threat level in the brain leading to pain persistence (*fear-avoidance belief model*) (15,16). The fear-avoidance model is now seen as a central mechanism of how acute pain turns into chronic pain. Pain education should make them understand that "pain does not mean harm" Most of our current treatments based on the structural-pathology model may provide temporary pain relief, but pain explained based on our current model only helps to heighten fear of pain and anxiety in the patient.

It has been shown in recent studies that teaching patients about modern pain biology can change beliefs and attitudes about pain and lower the pain sensitivity. Further, when education about pain physiology is included into physiotherapy treatment of patients with chronic pain, pain and disability are reduced (17,18,19).

Therefore, is more scientifically correct to include both apporaches.

Graded Exposure Approach or Activity: In this approach, the person is gradually exposed to feared activities without causing pain and thereby lowering the threat level in the brain. These feared activities could be imagined movements, exercise, or daily functions. Many researchers believe that a large part of pain relief seen with exercise and other rehabilitation methods is from lowering the threat level in the brain using the graded approach. So when your clients talk about how they have less pain after lifting weights, is it because they got stronger lifting weights or were they just gradually exposed in a graded manner to the threatening exercise or both?(20,21)

Can you give a real-life example?

Yes. Person A hurts his low back doing barbell squats. Now every time he tries to squat he feels pain in his low back. He works in the fitness field and strongly believes that the key to getting stronger and bigger is performing big exercises like the squat and deadlift. And to make matters worse, he has read the works of Florence Kendall, Shirley Sahrmann, Gary Gray, Stuart McGill and other rehab experts who emphasizes the structural-pathology model and hence uses the 'bottom-up approach' in managing pain. All this has made him believe that there is something wrong in his joints and tissues. His beliefs, his attitude, and emotions have heightened the threat level in the brain and have made his nervous system a lot more sensitive to pain. He tries doing squats, but gets pain when he exceeds a certain weight. He has the pain now for more than 3-4 years and now he feels pain in the morning bending over the sink to brush his teeth, riding a bike or an elliptical or doing anything related to hips or low back for an extended period of time. Now he strongly believes his low back is very vulnerable to injury and he will never be able to squat or deadlift again.

But things are getting brighter. He reads how complicated pain can be, how pain is an experience constructed in the brain and how, in chronic pain, pain has moved up to the nervous system and the tissues may be totally fine. He reads Butler's book *Explain Pain* and the works of Patrick Wall, Melzack, Louis Gifford, Lorimer Moseley, Waddell and learns a lot from**Somasimple.com** discussions.

Top-Down Approach: He now clearly understands that the structural-pathology model, which relies solely on the 'bottom-up' approach is incomplete. Just by understanding the physiology of pain or the '*top-down'* approach, his threat level has lowered in the brain**.** His nervous system is much less sensitive to pain and the brain finds no reason to induce pain because there is no threat and no action required. He feels much less pain now.

Bottom-Up Approach and Graded Exposure Method: He gradually starts incorporating dead lift and squats with light weights thereby lowering the nociceptive input (*'bottom-up approach'*) and stays away from the pain flare up point. Within a few months, he is squatting and dead lifting with very little pain.

Non-specific effects: Some of the pain relief with every pain treatment could also be attributed to the effects which are not specific to the treatment. These could include the person's beliefs, expectations and experiences with other illnesses, previous use of the current treatment or other treatments, context and the interaction between the patient and the practitioner and so on (placebo effect). But, mind you, they all work by affecting how the brain perceives pain (22).

Every pain treatment out there, whether it is injections, acupuncture, postural correction, movement dysfunctions, trigger point therapy, stretching, Graston®, manual therapy, McKenzie methods, meditation, yoga and so forth, works by the above mechanisms to affect the brain since the experience of pain comes from your brain and may have very little to do with eliminating the 'pathology' in the body as claimed. While many people do have "issues in the tissues", that's far from the only consideration.

I think we all can learn a lot from what Louis Gifford, a physical therapist and one of the leading authors in the field of pain, has to say about pain and dysfunction, *"It is important to note that we are full of dysfunctions whether we are in pain or not. If we are in pain it is easy to find something*

wrong relevant to a precise tissue model but which may not be relevant at all to the patients state"(23).

Exercise for providers: Next time when you come across a client who complains about low back pain that he or she had for years, the two disc bulges seen on the scan, and how she or he has to be extremely careful not to hurt it again, what are you going to say?

1. Acute pain in an emergency clinic: latency of onset and descriptor. patterns related to different injuries.
2. Immediate and long-term phantom limb pain in amputees: incidence, clinical characteristics and relationship to pre-amputation limb pain.
3. Abnormal magnetic-resonance scans of the lumbar spine in asymptomatic subjects. A prospective investigation
4. Are "structural abnormalities" on magnetic resonance imaging a contraindication to the successful conservative treatment of chronic nonspecific low back pain?
5. The Clinical Importance of Meniscal Tears Demonstrated by Magnetic Resonance Imaging in Osteoarthritis of the Knee.
6. Theoretical Perspectives on the Relation Between Catastrophizing and Pain
7. Pain: Past, Present and Future
8. Response expectancies in placebo analgesia and their clinical relevance
9. Relationship of significance of wound to pain experienced.
10. A pain neuromatrix approach to patients with chronic pain
11. Reconceptualizing pain according to modern pain science
12. Phantom limb pain: a case of maladaptive CNS plasticity?
13. Extensive reorganization of primary somatosensory cortex in chronic back pain patients
14. Central nervous system plasticity and persistent pain
15. The fear-avoidance model of musculoskeletal pain: current state of scientific evidence.
16. Fear of Pain as a Prognostic Factor in Chronic Pain: Conceptual Models, Assessment, and Treatment Implications
17. A randomized controlled trial of intensive neurophysiology education in chronic low back pain.
18. Widespread brain activity during an abdominal task markedly reduced after pain physiology education:

19. 2001 Volvo Award Winner in Clinical Studies: Effects of a media campaign on back pain beliefs and its potential influence on management of low back pain in general practice
20. Graded Activity and Graded Exposure for Low Back Pain
21. Systematic review and meta-analysis of randomized controlled trials of cognitive behaviour therapy and behaviour therapy for chronic pain in adults, excluding headache
22. Low back pain symptoms show a similar pattern of improvement following a wide range of primary care treatments: a systematic review of randomized clinical trials
23. Rehabilitation of Movement Chapter 5: Pain by Louis Gifford
24. The mechanisms of manual therapy in the treatment of musculoskeletal pain: a comprehensive model.

25. The back pain beliefs of health care providers: are we fear-avoidant?

Complete citations can be found at:

http://bretcontreras.com/wp-content/uploads/Recommended-Reading.pdf