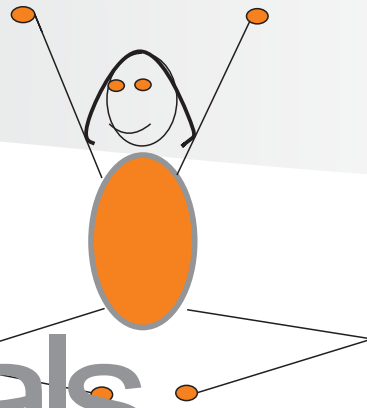


PAIN fundamentals



A Pain Science
Education
Workbook for
Patients and
Therapists

Greg Lehman
Physiotherapist and Chiropractor
www.physiofundamentals.com



You are free to use the material in this workbook with your patients provided the source of the material is referenced on the bottom of the sheet.

www.physiofundamentals.com

Toronto, Canada 2014

Purpose of this book

This workbook is an introduction to understanding why we have pain and what we can do about it.

The book should be used with a therapist and a patient.

Each page in the book introduces a concept about pain and that is followed by questions to be answered by someone in pain to make those concepts relevant to the person in pain.

To Therapists: Pain is a person specific event. Therefore, not every lesson about pain is relevant to each person. Feel free to choose which sheets are relevant.

Why should you read this book

This book is a start. It reframes how we see pain and injury. We know that if we understand pain and injury it is a great start to help solve the pain puzzle. This book should be part of a comprehensive treatment approach that can mix lifestyle changes, changes in how we think about pain, general exercise, specific exercise training, manual therapy (e.g soft tissue massage, joint mobilizations, chiropractic etc), graded motor imagery, goal setting and graded motor exposure.

This workbook is the foundation for all other treatment and helps start to explain how treatment can help. This book is part of a larger course on the simplification of the treatment of pain and injuries entitled **PhysioFundamentals: Reconciling Biomechanics with Pain Science** at www.physiofundamentals.com

Open Source this book is a work in progress

Ideally, this book will be updated regularly. If you have ideas on different pages or concepts to be added to the book please feel free to share and I will try to incorporate new and useful information.

Send to greglehmanphysio@gmail.com

Background reading

This booklet is the tip of the iceberg for pain science education. It is hugely influenced by the work of David Butler and Lorimer Moseley at noigroup.com. Reading the primary source is advised. Below is a list of great material to learn about pain and injury.

1. Explain Pain: Lorimer Moseley and David Butler
2. Graded Motor Imagery Handbook: Butler, Moseley, Beames
3. Progressive Goal Attainment Program (PGAP) by Michael Sullivan
4. Classification Based - Cognitive Functional Therapy by Peter O'Sullivan
5. Therapeutic Neuroscience Education: Adriaan Louw

Websites for pain

1. noigroup.com (A David Butler production)
2. bodyinmind.org (A Lorimer Moseley joint)
3. bettermovement.org
4. painscience.com (formerly saveyourself.ca)
5. bboyscience.com
6. gradedmotorimagery.com
7. dermoneuromodulation.com

Pain is an alarm

- ⦿ pain occurs when the brain perceives damage or the **threat of damage** to the body and wants action
- ⦿ the brain is of the **opinion** that the body is under threat
- ⦿ pain is meant to motivate action to protect the body
- ⦿ pain is created by the brain and is associated with other actions the brain also creates
- ⦿ just because pain comes from the brain does not mean that pain is in your head
- ⦿ the brain listens to the signals from your body and evaluates what those signals might mean



Pain is not a Damage Indicator



- ⦿ with trauma pain is pretty good at telling us that there is a problem **but** pain is poor at telling us how bad the problem is
- ⦿ when pain persists the link between damage and pain becomes very weak
- ⦿ pain is not good at telling us where the problem is
- ⦿ pain can occur without damage
- ⦿ we can even have **no pain** with lots of damage

You're having a Heart Attack yet it hurts in your ARM!

this is a pretty good example of how pain is an alarm but it doesn't tell us much about damage. A part of your heart can be dying yet you will feel minimal chest pain but might experience jaw, arm and back pain.

You've broken your leg yet it doesn't hurt once its in the Cast!

We often hear stories of broken bones that people don't even know about. These are good examples of how pain is not a damage indicator. It tells us about the REAL or PERCEIVED threat to the body.

Pain is a Protective Response

- ⦿ pain motivates an action to help protect us from **perceived** harm or the threat of harm
- ⦿ when your hand gets near a fire you feel pain before damage occurs.
- ⦿ you automatically move your hand to protect it
- ⦿ when you sprain your ankle you feel pain to stop you from moving to allow for initial healing
- ⦿ with acute injuries pain is important to allow for protection and healing
- ⦿ as healing occurs sometimes pain persists and so do the protective mechanisms like limping even though we no longer need the protection



Pain is just one protective action

**SAFETY
FIRST**

- ⦿ movement changes with pain
- ⦿ our stress response increases
- ⦿ immune reactions occur
- ⦿ endocrine changes occur
- ⦿ swelling can occur

all can lead to increased sensitivity designed to heal and protect the body

How **Pain** is Created

The brain's opinion



Once the brain receives the nociceptive "danger" signal it needs to make some decisions. At its simplest it asks "how dangerous is this really?"

When the brain perceives a threat, pain, along with other responses, will be produced.

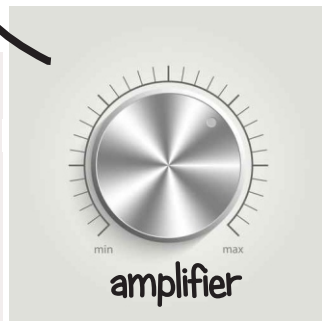
The brain can even "turn up" the amplifier in the spinal cord. It essentially will hear more "danger" signals. If it questions, whether it is really in danger it can "turn down" what it hears from the body as well. This is why context, opinions, our environment and **LEARNING** about pain and that you are truly strong can help decrease pain.

When you are concerned about the nociceptor signals the brain pays more attention and is now like a guard on high alert and ready to pull the **ALARM** and get help.

The brain is ready to protect you and marshal its forces to **HELP**

How much pain you feel is related to the SENSITIVITY of your system not necessarily the AMOUNT of Damage

The nociceptor "danger" signal is sent to the spinal cord. There it can be relayed to the brain. It can also be amplified or turned down. When pain persists the spinal cord receptors becomes sensitized and amplifies the signal to the brain. If the brain decides the information is not that important then the signal can be turned down. This is called **Descending Inhibition** and is one of the great benefits of exercise for decreasing pain.



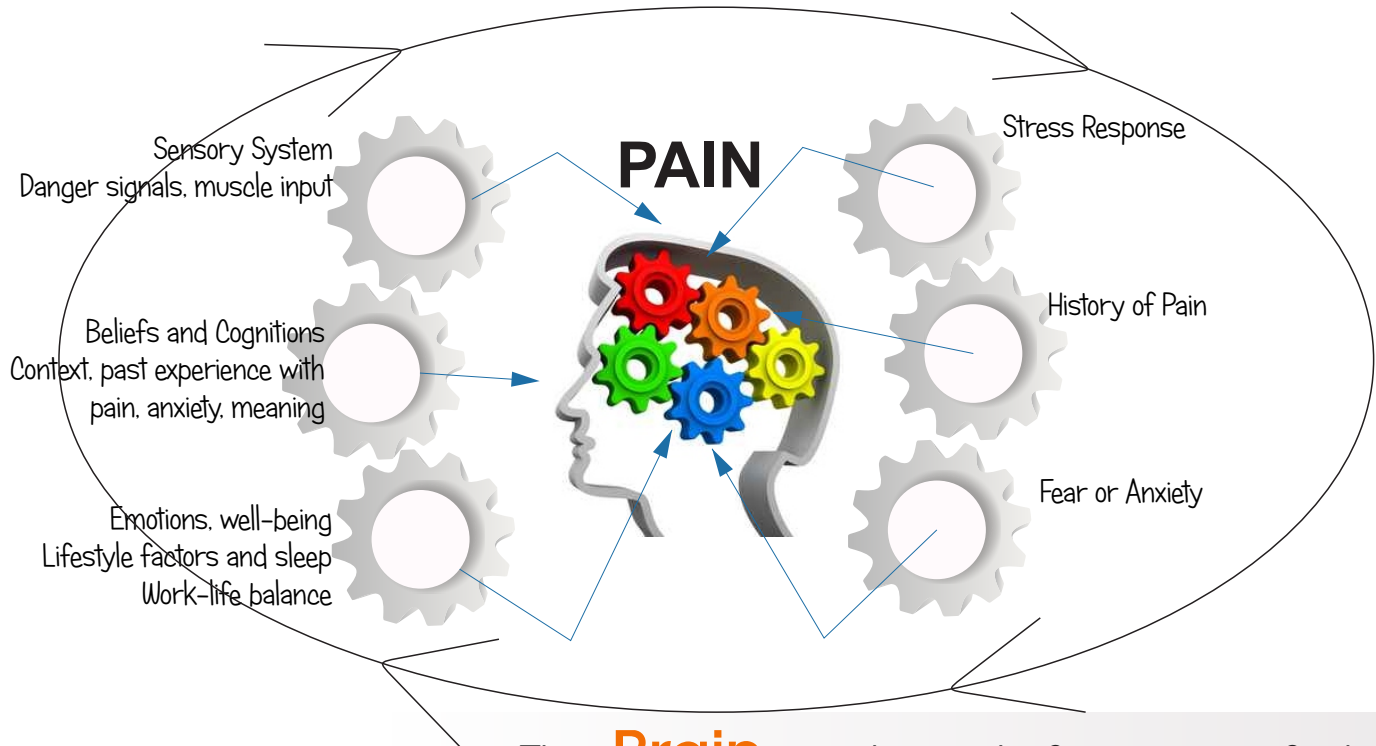
danger

There are "danger" receptors in the body that send signals to the brain when they are irritated. We call these **NOCICEPTORS**. They get activated with Heat/cold, Chemicals or Mechanical Pressure



START HERE

Pain is multifactorial



- ⦿ this often why different people have different amounts of pain even with similar injuries
- ⦿ it is also why your pain can change day to day
- ⦿ ever notice that stress can increase your pain?
- ⦿ or notice that pain can fluctuate when you are sick (immune)?
- ⦿ or that pain can be different depending on your location (context)?
- ⦿ ever notice that the Fear of pain increases your sensitivity at the dentist?

Have you noticed that children will often look to their parents after they fall and before they cry? They are considering the meaning of their fall. Are the signals sent to their brain something they need to worry about?

Painful questions

⊗ can you think of times that your pain changed and this was often for no reason?

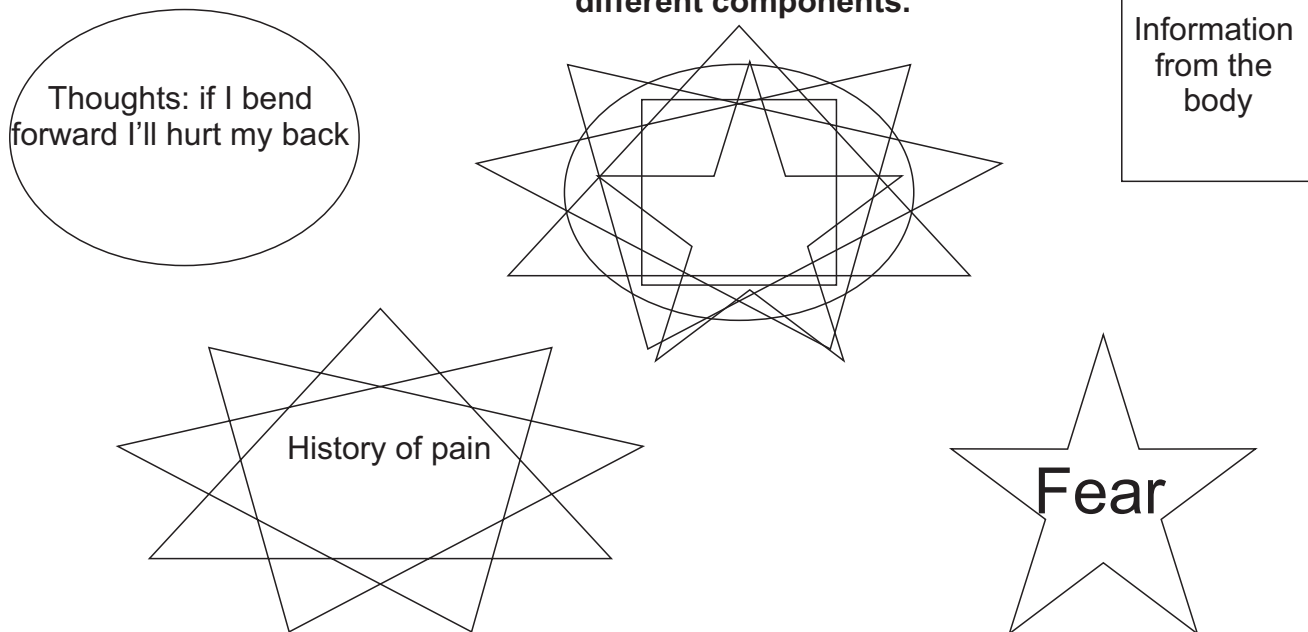
⊗ when your pain started can you think of anything in your life that could have influenced the pain?

⊗ can you think of areas in your life now that might be influencing your pain?

Pain as a **Neurotag** in your brain

When we have pain different brain cells throughout the brain become active. We also have parts of the brain that turn on to help us “feel” our body or plan to move our body. When these areas turn on that activation creates a pattern of activity that can be called a neurosignature or neurotag. Parts of the brain involved in interpreting sensation, memory, emotions and movement are involved in triggering a pain response or pain neurotag. Remember, pain is not simply about tissue damage...other factors can help ignite the pain neurotag. This is why danger signals from the body are often not enough to create pain or why other things like fear or stress can contribute to your pain. Memories or beliefs about how strong your back is can also help trigger the activation of a neurotag and give you pain. Below is a schematic of some different components that can make up the neurotag.

The Pain Neurotag is made up of different components.



When pain persists...

The neurotag becomes more easily activated. It becomes sensitized. It become coupled with other neurotags for movement, thoughts, beliefs and emotions. This coupling allows the neurotag to be more easily turned on. In addition to this ease of activation other brain cells or neurotags can become DIS-inhibited. Meaning they turn on when they shouldn't. This is called Smudging. This can lead to some pretty strange sensations which don't often make sense like:

- pain spreading
- pain moving around

One key thing that happens is that other factors get better linked with pain and this makes pain more easily felt. The best example is movement. The following pages talk about smudging and the coupling of pain with different things other than injury. It is almost like we learn to have more pain even though our body is healing.

Painfree questions

Can you think of movements, thoughts, emotions or habits that have become linked with your pain?

If a certain movement or habit is coupled with pain have you ever noticed situations when that linkage didn't exist? For example, you might often have pain with putting your socks on but when away on vacation or on the weekend you don't feel that pain.

The promise of complexity...

What is great about the complexity of pain is that many factors can help influence pain. There isn't one answer to decreasing pain. Because so many factors influence pain we have a lot of options on how to decrease pain.

Pain persists past **Healing**

- ⦿ sometimes pain becomes its own problem
- ⦿ initially it is good at telling us about possible tissue damage
- ⦿ but as time progresses and healing occurs pain can stick around
- ⦿ this often makes no sense at all since we have been taught to believe that if there is pain there must be damage
- ⦿ for some reason the brain and body still feels that it needs protecting
- ⦿ thus pain and many of the protective responses stay
- ⦿ pain now becomes more about **Sensitivity** and much less about **Damage**



Hurt does not equal **Harm**

- ⦿ this means that if your pain started after an injury then that might indicate some damage
- ⦿ but as pain persists it becomes less about damage and more about sensitivity
- ⦿ meaning you Hurt but you are NOT harming yourself
- ⦿ **all of this is real** - there is no difference in the pain felt with damage than with the pain felt that persists
- ⦿ much of the same protective responses are still occurring



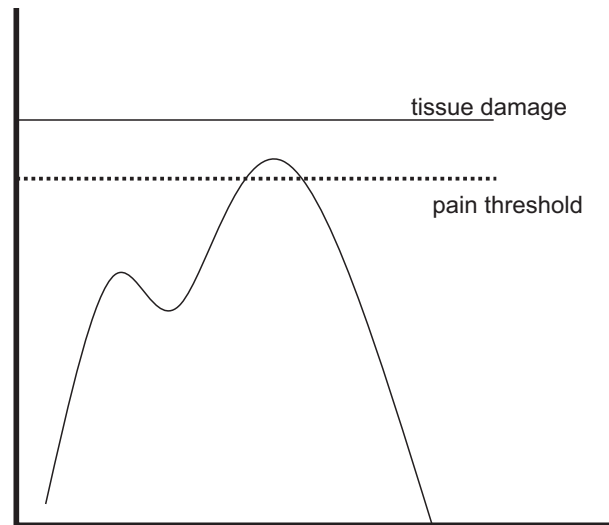
Painful questions

⊙ if hurt does not equal harm can you just ignore pain and do whatever you want?

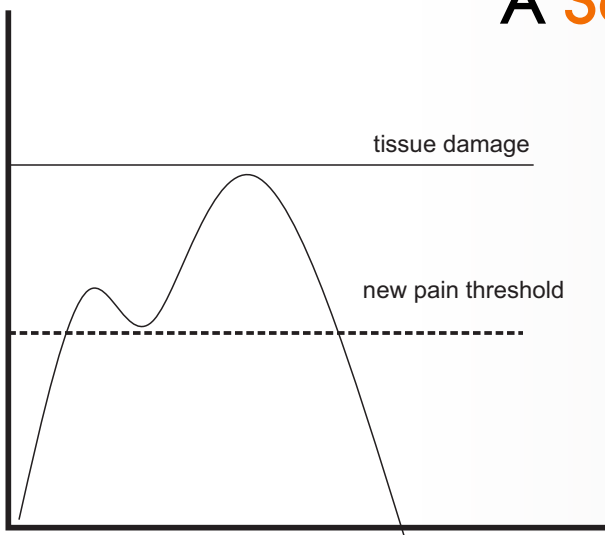
⊙ what are some things that might help pain persist?

Pain is about Sensitivity

- ⦿ in the chart on the left you can see that in a healthy state there is a close relationship between pain and tissue damage
- ⦿ but also notice that pain can be active before tissue damage occurs
- ⦿ again, this is because pain functions as an alarm to prompt you to do something
- ⦿ we can stress tissue and when we get close to our damage threshold we might experience pain
- ⦿ when we go past this threshold of stress we might then experience tissue damage



A Sensitive system has lowered thresholds



- ⦿ when pain persists we change our pain thresholds
- ⦿ no longer is the pain threshold close to where our damage threshold is
- ⦿ people start to feel pain sooner with less stress placed on the body
- ⦿ it doesn't even have to be physical stress. Other stressors can lead to the pain experience

- The pain and tissue damage thresholds are plastic. Meaning they can change and are influenced by a number of factors.
- Pain does not mean you are weaker or more fragile...just more sensitive
- **Treatment is ultimately about convincing YOU (or your brain) that you are strong and no longer require protection**

Pain becomes coupled



There are multiple triggers and amplifiers of pain. One trigger is the initial tissue “danger” signals that you felt when you twisted your ankle, sat on a lumpy couch for too long or did too much of something that you weren’t used to. It’s normal to feel pain in these situations. But what those complicated neurotags and the neuroscience teaches us is that when you feel pain there are other variables that influence how much pain you feel. **Remember your brain is always evaluating the situation and can make a decision of how much protection you need.**

If the brain is worried about bending forward then bending forward can trigger pain. It might be worried because of beliefs you have about the risk of bending and lifting. Or it’s worried because 6 years ago you had some back pain after you were bending when shoveling. For whatever reason, you have learned to associate pain with bending. You are unconsciously protecting yourself from bending. **Pain is the means to stop you from the threat of spine bending.** These other factors help trigger or ignite the protective pain neurotag.

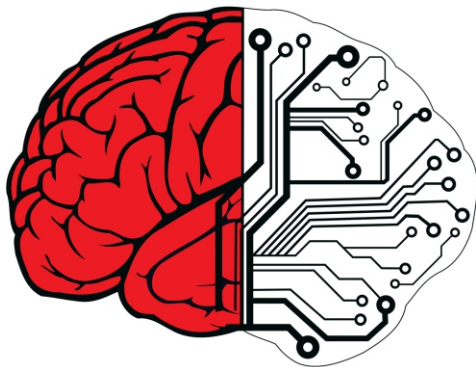
Overtime we get more sensitized to those triggers. **We learn to have more pain** even when our tissue is healing or is healed. It’s like learning a skill...we get better with practice. If you tweaked your back when bending and have been avoiding bending you will start to associate bending with having pain. Every time you bend that movement will trigger your pain experience.

Avoiding movement is sometimes the right thing to do when we initially have an injury. But if we keep avoiding that movement we reinforce in our brains and in our actions that those movements are bad and dangerous. These avoidance behaviours lead to fear and lead us to feeling more pain as a protective response.

We end up coupling pain with movements. They go hand in hand. Treatment needs to break that link.

Pain Tips - Breaking the links

Working with your therapist you can slowly expose yourself to painful activities. In effect, you confront the pain or the movement that is coupled with pain and resolve the threat. Your pain can also be driven by false beliefs about pain, injury, posture or the strength of your body. Working with your therapist you can find what these drivers are..



Painful questions

- ⦿ What are your trigger for pain?

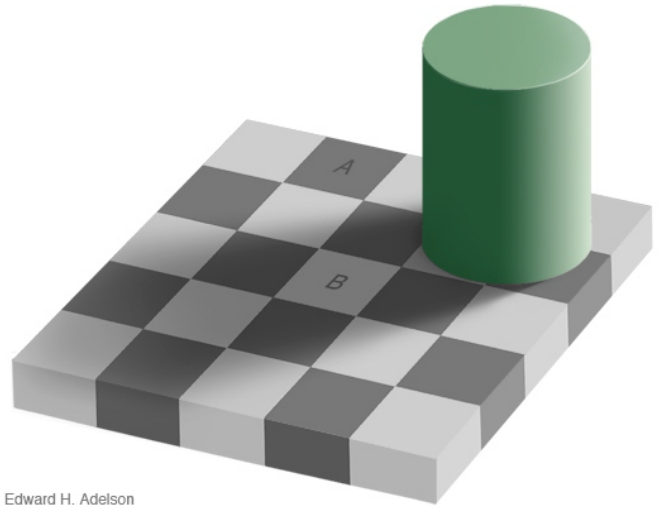
Can you think of other habits you have that are triggered by other events?

A great example is the habit of smoking. When smoking was being banned in coffee shops, coffee store owners were worried about their profits. They knew that drinking coffee was linked with their customer's smoking habits. One fed into the other. The context or environment of being in a coffee shop created the desire for coffee and for smoking. This is why breaking habits often requires an overhaul of all the drivers of the habit. Pain is the same thing. We can break the pain habit by changing many of the associations with pain. It is really great and encouraging means of helping get out of pain. And much like a smoker who can go back into a coffee shop and not feel the need to smoke you will be able tolerate the old drivers of pain and still not have pain.

It is a bit hard to grasp and a challenging concept that pain is not just something that comes from the body but rather something that the brain creates with all of its own experience. But this is how the brain works for a number of things. Vision is a great example of how the brain creates the world that we see.

What we can learn from **Vision**

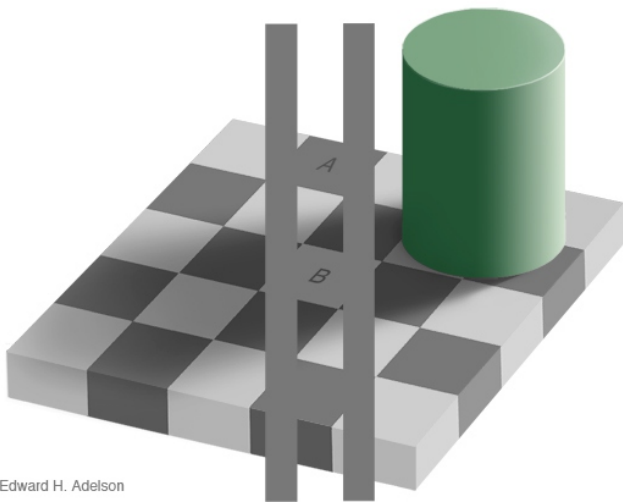
- ⦿ light enters the eye and receptors and nerves transfer the information to the back of the brain
- ⦿ the brain then creates what we see based partly on the information that the receptors sent
- ⦿ however, the brain creates it based on past experience and context as well.
- ⦿ because the brain uses other information the brain is subject to illusions which are essentially mistakes in what is truly happening in reality
- ⦿ For example, look at the picture on the right
- ⦿ in the picture on the right which square is darker A or B?
- ⦿ Obviously A looks darker when in fact A is the same shade as B. What? Guaranteed you don't believe me.



Edward H. Adelson

The **Brain** creates vision from many factors

- ⦿ now looking at the image on the left you can see that A is the same shade as B when you have a visual cue that changes the environment around the squares
- ⦿ when the brain is left to interpret the shadow and the colours of the other squares it thinks that A is darker



Edward H. Adelson

none of this is to say that pain is an illusion. It only illustrates that it is something created by all of the inputs that the body and brain experience. The sensations (nociception) from the body are just one input and that input is evaluated with all the experience, history, emotions, beliefs and other sensations that the brain considers.

Painful questions

⊙ if pain is created by many factors how might this be relevant to your pain?

⊙ do you think that this all means that the pain is in your head?

PAIN IS NOT IN
YOUR HEAD!

There is a lot of discussion in this booklet about the brain, the nervous system, beliefs and emotions. Enough to make many people think that pain is just about the brain and psychology. There is nothing imagined or not real about pain. While psychological factors can certainly influence the pain we feel, there is still a body that influences the brain and a brain that influences the body.

The Body as a driver of pain



The traditional view of pain has been that tissues from the body send "pain" signals that indicate damage and the brain just relays this information. We now know that the body sends nociceptive (aka, danger signals) information to the brain that indicate the threat of damage. At the very least those signals some form of irritation from the nerves. Nerves get irritated enough to send nociception when they are stimulated with:

1. **Chemicals:** the acute inflammation after an injury and immune response is a chemical event that triggers nociception.

2. **Mechanical deformation of nervous tissue:** ever sit in the same spot for a long time and your butt starts to hurt. This is mechanical deformation. It probably involves many of the little nerves in the skin and tissues not quite getting enough oxygen or blood flow and the nerves then get cranky.

Usually, we resolve this mechanical deformation by moving

around a bit. But in persistent pain cases we might fall into movement habits that consistently irritate tiny little nerves. Or we stay in a protective pain habit (e.g muscle tightness) that continues to irritate the little nerves.

3. **Heat/cold can irritate nerves.** If you have different types of sensitization then the advice many give (oh, just put some ice on it) can flare you up.

When pain persists our nociceptors can become more sensitive. This is called hyperalgesia. Most treatment has typically involved attempts at decreasing nociception. This is most often done via rest, avoiding certain activities, massage, taping, bracing or manual therapy. All of these techniques are a good start but can you see from what you now know about pain that are other areas should be addressed too?

Moving differently in pain

What happens when you think you might get hit with something? You tighten up. It's a normal protective response. It also occurs after an initial injury and we also move differently to try to protect the area. Think about the limp someone has after spraining their ankle. However, after a time that protective response of tightening or 'guarding' is no longer necessary. Yet we can persist in maintaining this protective behaviour.

This changes how we move and decreases the options of how we move. We move less and often move in stiff and rigid ways. We stay in **PROTECTION** mode. We can lose the ability to move in Fluid, Confident and Fearless ways. Not only can moving in these protective ways help trigger a pain neurotag through thoughts and emotions but it can contribute to nociception or the danger signals coming from the body via a mechanical pressure on nerves. Tiny nerve receptors in muscles, tendons and the skin don't like to be squished. But the tension we place on them during our defensive postures or stiff movements can contribute to more danger signalling. And since we might be sensitized we pay more attention to these signals.

Fear of movement

Kinesiophobia is the fear of movement. It is the fear of injury or the fear of pain. This fear changes how we move. Sometimes it is self-driven but often it is driven by the advice you might receive. If you are in pain and you are told to avoid a number of movements because it will harm your back then you will naturally stiffen up and become afraid to move. This fear will increase the sensitivity of your system and will change how you move and can increase your pain. If you are told you must sit up straight and not slouch (bad advice by the way) then you will work extra hard to hold your spine in a rigid and upright posture. You will stop moving fluidly and begin to fear the normal things that your body should be able to do.

Healthy movement is fearless. A goal in working with your therapist is to identify ways that you move that lack fluidity and that you fear. You can then slowly build your tolerance to these activities. Healthy movement will convince you **that your tissues are truly strong** which they are when in pain...they are just sensitive

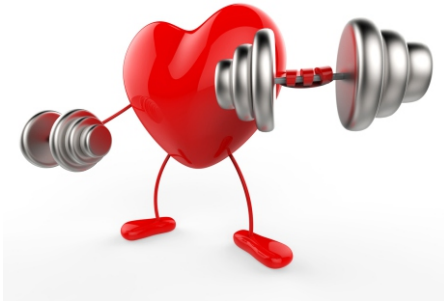
Changes in muscle function and posture

Too often we blame our muscles for the pain that people feel. Health care providers say you have pain because your muscles are weak and your joints lack stability. Or we say that you are tight and that's why you have pain. But we know that pain can cause these changes or the same thing that caused the pain can cause these changes in muscle function. Those changes in muscle function are associated with pain but may not be the cause of it. Weakness, tightness and changes in muscle function can also be considered protective outputs much like pain is. They can also be caused by the pain itself.

Although those different movements are not necessarily the cause of the pain they might now be linked with the pain. These changes are often helpful in the beginning but may now be maladaptive and could be contributing to the problem.

Working with your therapist you can determine whether your movement habits are helpful or part of the problem

Pain changes MANY FUNCTIONS



Muscular Function Changes

Decreases in Strength
Changes in Balance
Changes in Proprioception
Muscle timing changes and how the muscles are used

All of these changes can then change how you move and those new movements can be linked with pain

Immune, Endocrine and Stress Systems

Pain involves multiple systems of the body. Our immune system (responsible for defending ourselves), our endocrine system (controlling the chemicals of the body) and our stress system (the part of the nervous system involved in fight or flight or repair and digest) all change with pain



Your Nervous System Changes

Every body part exists in the brain in what is called a body map. With persistent pain that body map changes. It becomes less well defined. It's why it is common for people with a painful shoulder to view the shoulder as something different from them or something that "just doesn't feel right". The perception of your body has changed.

Backfiring nerves: nerves become more sensitive and can yell their danger signals up to the brain as well as in the other direction. This is why you can feel pain spread or in different areas

A bigger amplification of danger signals from the body can occur in the spinal cord.

Emotional Changes

We don't know how depression, anxiety or catastrophizing (i.e. believing the worst about a situation) are related to pain. We just know that they are related. Whether they cause pain or are result of pain is debatable. Regardless, there is a link and it is a common occurrence to have changes in our emotional state with pain.



Pain changes the brain's body MAPS and other Neurotags

A map of our body is stored in our brain (a type of neurotag). There are sensory maps (for feeling the body) and motor maps (for controlling how the body moves). The map is a representation of your physical self. Just like the map you see on your GPS is a representation of the actual earth and where you are on earth. But like some GPS units the maps can be wrong. They don't actually match reality.

Pain can **change** the brain's map of the body. Sounds weird, eh? With painful body parts the map of those parts in the brain become poorly defined. It's hard for the brain to draw the borders of where that body part ends. This is again called smudging. Fortunately, the brain is very plastic and malleable. It can change. In Braille users the area of the brain dedicated to the fingers becomes larger. The opposite happens with pain but treatment can change these maps back to normal.

Understanding body map smudging helps us understand some of the symptoms that can be felt with pain.

Smudging can lead to:

- decreases in a sense of balance
- a decrease in the ability to "feel" where a limb is in space (aka Proprioception)
- spreading pain that diffuses to other adjacent body parts
- changes in muscle strength and muscle timing

Why should you care about **smudging**?

A lot of treatment probably helps treat the brain and helps change those maps in the brain. Activities where you focus on your movement, move very slowly and with attention to how things feel (e.g. yoga), manual therapy and massage that gives tonnes of feedback to the brain about your body parts and visualization or mindful exercises all probably help sharpen-up those maps in the brain. Why do you think athletes visualize their activities? What do you think they are training if not their brain? They train the brain to help make the body move better!

Graded Motor Imagery

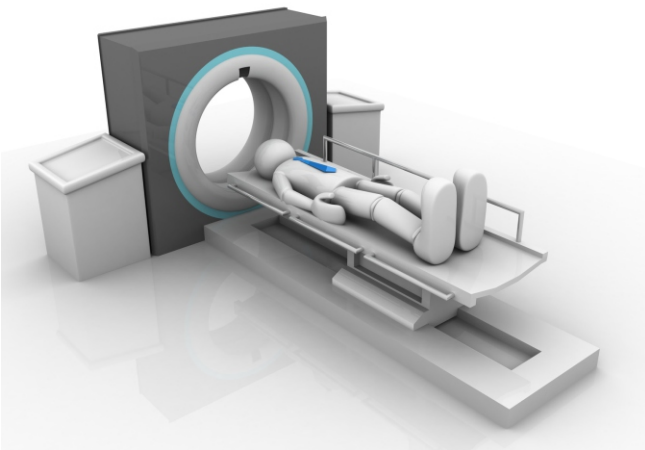
A well researched technique in specifically training the brain is called Graded Motor Imagery. It is a three step process that involves training the brain to make decisions about the position of limbs or spines, visualization of difficult movements and finally mirror therapy to help de-threaten movements. Please see noigroup.com or gradedmotorimagery.com for more information. NOI is the leader in education in this area.

Pain is poorly correlated with MRIs, X-rays and Imaging

- ⦿ the majority of people over the age of 50 will have tears in their rotator cuff muscles and feel know pain
- ⦿ disc degeneration begins in our twenties and peaks with age. Yet the prevalence and severity of low back pain occurs in our 40s. The correlation between degeneration on imaging is very poor with pain
- ⦿ degeneration is like “wrinkles on the inside”. Our face wrinkles with age - does it hurt?
- ⦿ a broken bone might initially hurt when you break it but there is often no pain when it is put in a cast. The bone is still broken but no pain exists



How imaging can hurt!



- ⦿ we are lead to believe that changes on our imaging is the cause of pain yet this is often false
- ⦿ since most people without pain have “damage” on imaging we know that we often should not worry about the findings
- ⦿ however, if we are told that the imaging is significant (and many healthcare providers do this as a means of generating patients) then it creates a sense or feeling that we need protection and fixing
- ⦿ imaging and its interpretation becomes the cause of the problem

Big take home point...you are not your MRI or x-ray.

- ⦿ we need to change how we think about x-rays, ultrasounds and MRIs
- ⦿ changes seen on x-rays that we were once taught as problematic are normal changes associated with age.
- ⦿ many of those changes are even helpful (osteophytes form in the spine which helps transfer load)

Painful questions

If you were given imaging what did the reports tell you?

If there were findings on the report was it ever explained how common those findings were in people without pain

How much do you think the findings on the report are contributing to your pain?

Painfree Questions kind of a test. Good luck!

Why do Flare Ups occur?

Will I hurt myself if I exercise?

Why does the pain spread?

How can you help with your pain?

Are you saying the pain is in my head?

Things that Help with **Pain**

Part Two of this series is a treatment guidebook. It is designed for you and your therapist to create a treatment plan specific to your needs. It helps you control your pain and find ways to treat your own pain.

Again, it is meant to be completed with your therapist and will help you get started on techniques that can help solve your pain puzzle. It will include topics on:

- activity goal setting to promote tolerance
- specific exercises to uncouple pain from movements
- specific exercises to desensitize your ecosystem
- general exercise recommendations to turn down your pain alarm and build you back up
- manual therapy to desensitize your system
- an introduction to graded motor imagery
- tips on exercise “confrontation” therapy: how you can “poke the bear” with pain to help resolve your sensitivity and build tolerance to difficult movements

I hope this book has helped. It is a first step.

Be confident, things do change. We are built to adapt, we just need to find the right stimulus that causes your adaptation to getting out of pain.

Greg Lehman