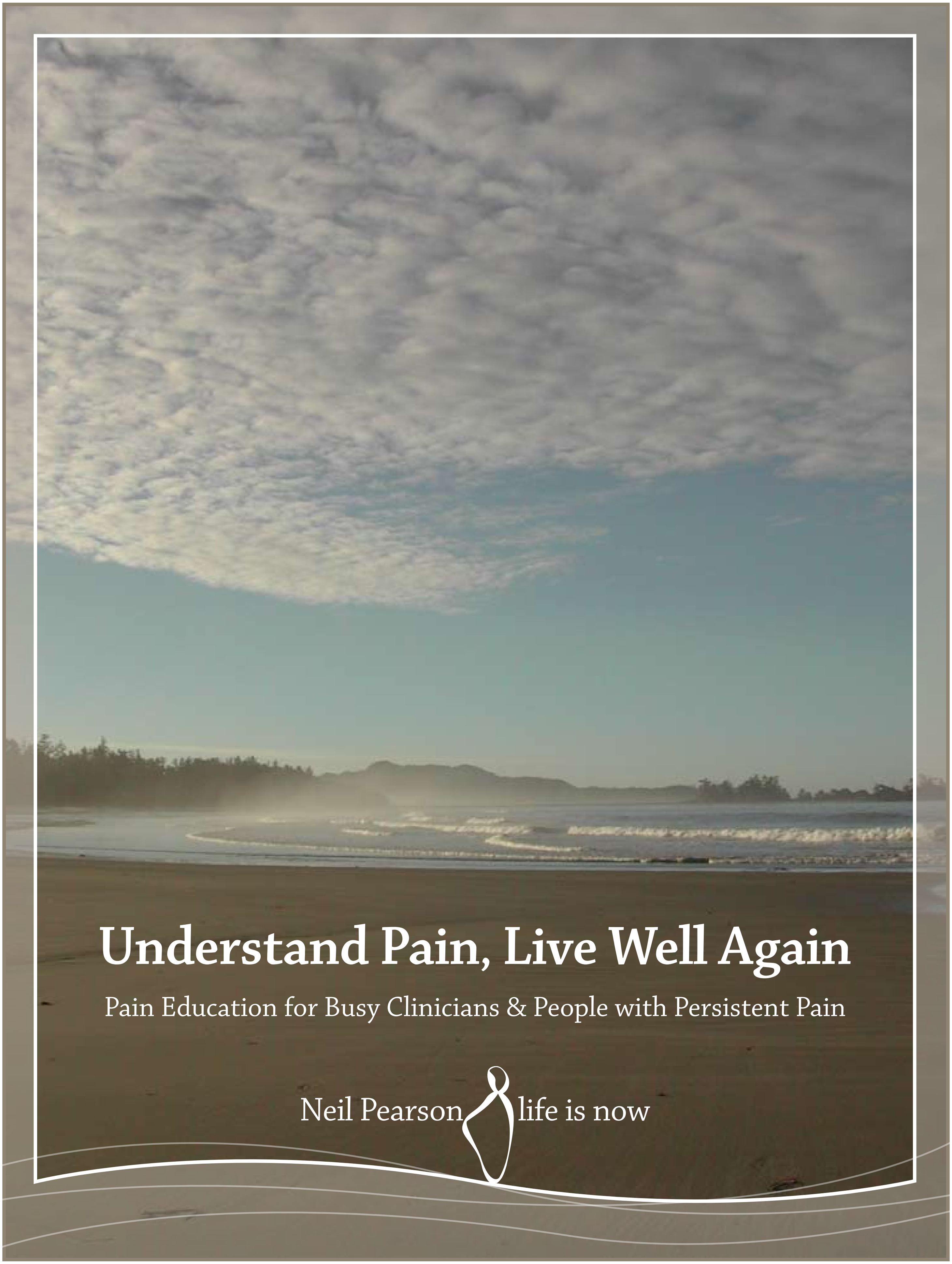

Understand Pain, Live Well Again

Pain Education for Busy Clinicians & People with Persistent Pain

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Table of Contents

Introduction

The information you are about to read was written to assist your health care provider in educating you about pain science and pain management.

Much of the information presented here draws from knowledge I have gained from Lorimer Moseley and David Butler. These two physiotherapists and educators have provided many original concepts about pain neuro-physiology in their excellent book Explain Pain. A number of their ideas are paraphrased here, including the powerful therapeutic question, "Is this really dangerous?", and the concept of discussing input from the 'pain alarm system' as danger signals. Reading their Explain Pain book will provide you with greater depth of knowledge than provided here.

I like to take every opportunity I can to thank Lorimer Moseley for concepts and anecdotes I have learned from him during numerous lectures in Vancouver. Many of these are presented in his book, Painful Yarns. The turning point for many of my clients has come from understanding how pain is like vision, and how pain is like thirst. If you are having difficulty understanding how these concepts are relevant to your recovery, please discuss them with your health care provider. This is critical as you move forward with practicing pain self-management techniques.

Please read one section at a time. Then discuss the information with your health care provider. Do not expect that you will understand it the first time. At the same time, know that knowledge produces powerful changes in your nervous system. Understanding pain neurophysiology is linked with less pain, improved movement, and decreased perception of disability. As difficult as this might be to believe, there are numerous recent studies with people with chronic pain proving this. You don't need to stop learning after reading these ten sections. Explain Pain, Painful Yarns and books such as "The Brain that Changes Itself" by N. Doidge, are all valuable in guiding you in your recovery.

I would be entirely remiss if I did not acknowledge the invaluable lessons I learned from the patients and health care practitioners at OrionHealth Vancouver. This center offered me the chance to practice pain management education, and refine many techniques I learned from the work of Lorimer Moseley and David Butler.

My biggest thanks goes to those people with pain who continue to confirm and disprove our 'knowledge' gained from scientific research. The science of one is as important as gold standard research. I have learned the most from people who come to me for help.

...life is now...

Section 1
The Purpose of Pain

KEY MESSAGES:

- Pain is one of the protective mechanisms of your body.
- The pain alarm system is complex, adaptable and always changing.
- Typically, the system responds when there is damage to the body and when something potentially dangerous is happening to the body.
- The pain alarm system does not work very much like simple alarm systems.

Figure 1.1: Paper cut
Pain is not simple. How can a little paper cut hurt so much? It's not just because your fingers are really sensitive.

How would you answer the question:
"Why do you experience pain?"

It seems really obvious.

"Pain tells you when you are injured!"

"Pain warns you when there is something wrong or something damaging happening in your body!"

It may seem surprising, but these statements do not completely describe why we feel pain. For example, you might remember a time in your life when the pain you were feeling didn't match the severity of your injury. Sometimes big injuries don't hurt much at all, and sometimes little injuries can hurt a lot. Think of a paper cut.

Science tells us that why and how people experience pain is much more complex than we expect. It also tells us that pain is more complex than we have been taught. On the other hand, science tells us that understanding pain and what it's really about will help you in your recovery.

Your body has many ways to protect you. Sneezing, muscle spasms and reflexes are all protective actions of your body. Pain protects you too. Pain is a protective mechanism.

We all have a pain alarm system. It is an extremely complex alarm, so before we discuss how it works, let's consider a simple alarm system. Most of us have seen a motion detector, which people use to help keep their house safe at night or when they are away. These detectors are made up of a sensor that detects movement, wires that send an electrical message to a light switch and a light bulb. In your body there are sensors that detect the things from which you need to be protected. There are nerves that send electrical messages from your sensors and instead of the messages going to a light bulb, you have a brain.

In the 1600's, scientists thought there was a pain centre in the brain in which a type of bell would ring when the pain nerves were tugged by something that was damaging your body. As you might guess, modern science has disproved this belief. However, even until the early 1900's the belief that a pain centre existed in your brain was common. Even today, people have the idea that there is a damage meter in the brain. This would make some sense, but it is not true. Modern science tells us that your brain can do so much more than ring a bell or turn on a light.

One of the jobs of the brain is to analyze information coming in. When danger signals get to the brain, it needs to decide what is going on and how to protect you. It's a little like having a computer attached to your motion detector; your brain can tell the difference between leaves blowing by, you walking out to your car, your neighbours walking up to your house, or armed bandits. If a home motion detector could do that, you could sell it for a lot of money. Not only would it be able to decide whether the light needed to be turned on, it could also decide if the light was the most appropriate response. Maybe you

Figure 1.2: What happens when we twist our ankle?
Pain is one of your body's protective responses. Your body has the ability to choose any way it can to protect you.

need the SWAT team to run out (for the burglar) or the front door to lock and the lights to switch off (for the unwanted neighbours) instead of a light turning on! This sort of decision making is what the brain does for you.

What is great is that your brain, unlike the simple motion detector, has many options for how to respond. When the brain decides that there is danger, it can protect you in many ways.

If there is something dangerous happening to your body, what does your brain do to protect you? If you answered “PAIN” you are correct. Pain would help protect you. Pain usually makes you stop what you are doing, move away from the danger and sometimes even go lie down. All these responses would protect you from a lot of dangerous things. How about muscle tension? If your muscles spasm or stay tight, that would stop you from moving too. Or maybe your nervous system might make your muscles weak. Have you ever banged your knee really hard? Not only does it hurt, but your leg muscles also feel weak. If the muscles are too weak for you to walk, that protects your knee too.

There are other protective systems in your body that work in similar ways. Think about what happens when you eat or drink something dangerous. When your body decides it is dangerous, your protective system responds and you start to feel sick, stop eating or drinking and probably lie down. If your system decides this is really dangerous, your systems will create a bigger response (vomiting) to protect you. Pain responses are similar to this in many ways.

Imagine a time in your life when you twisted your ankle or had your thumb or finger pulled back too far. You may have felt pain. Why? Your pain alarm system was trying to protect you. Either it was warning you that if you kept moving you would cause damage, or trying to get you to stop using that part of your body so that it would have a chance to heal.

What if that same ankle was twisted many times? Your pain alarm system is so smart, it might start to protect you. For example, it might make you tense up as soon as you got near rough ground. On the other hand, if you decided that spraining your ankle wasn’t a big problem, your system might start to protect you less. In other words, you might have less and less pain the more times you sprain your ankle.

If you are getting the idea that your pain alarm system is nowhere near as simple as a motion detector, you are right. Now you have an idea of what it is not. In the next sections you will learn more about how it actually works.

Summary

The purpose of pain, just like muscle spasms, sneezing or vomiting, is to protect you. The pain alarm system – unlike most alarm systems we imagine – is able to adapt and learn. It is a complex and sophisticated system that responds when your brain decides something is really dangerous and that you need to respond.

Section 2

The Nervous System: Major Parts and Functions

KEY MESSAGES:

- The major parts of the nervous system include the brain, the spinal cord, nerves and the automatic nervous system.
- Each part has different functions. They coordinate their activities so you can sense things inside and outside of your body, control your body's organs, think and move.
- Each part can influence the other parts of the nervous system.
- The spinal cord is more complex than a bunch of wires sending information between the body and the brain.
- The autonomic nervous system is a part of the nervous system that allows many things to be monitored and controlled, usually without you being aware that any of it is going on. It is also called the automatic nervous system.

Your nervous system has three main parts: the brain, the spinal cord and the nerves in your body. Each of these three parts works together. They allow you to know what is happening inside and outside your body, to decide how you should act and react, respond, move and make adaptations in your body.

The nervous system has four main jobs:

- Sensing things inside and outside the body
- Sending information to the brain for analysis
- Deciding what actions are needed
- Creating actions, thoughts and reactions.

This may seem to suggest that the nervous system – and you as a human – is easy to understand. You know that is not true. However, let's look at the main functions of each part of the nervous system.

Nerves in your body pick up information and send it through nerves to your spinal cord. The messages then travel up the spinal cord (through nerves) and into the brain (nerves again) so you know that something is happening and your brain can plan how to respond.

Messages can also travel in the opposite direction, from your spinal cord and out into your body through nerves. Many of these messages go to your muscles, telling them to contract or relax in patterns that allow movement. Other messages come out to your body to control automatic body functions, telling the heart to beat faster, the breathing muscles to work harder, the blood vessels to divert blood to your muscles from your stomach, or telling the muscles to stay tense. Signals can even come down from your brain to tell your nerves and sensors to pay more attention to what is happening in your body.

Main Functions of Your Nervous System

1. Brain

- Analyses information coming in
- Decides what needs to be done about the information
- Creates actions
- Thinks

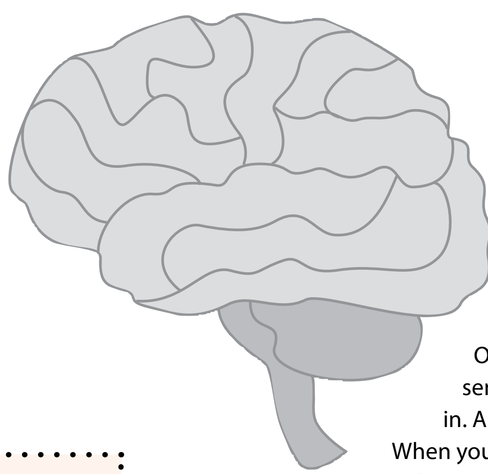


Figure 2.1: The Brain
One of your brain's jobs is to make sense of all the information coming in. Another job is to help protect you. When you feel pain, over 200 areas of your brain can be involved in protecting you.

INTERESTING BRAIN FACT:

- The brain works on a priority basis. It will attend to whatever it, or you, decide is most important. This is one reason why you can injure your body and not feel any pain.

2. Spinal Cord

- Sends sensory information up to the brain
- Sends action impulses down from the brain
- Controls reflexes
- Processes, modifies and prioritizes messages

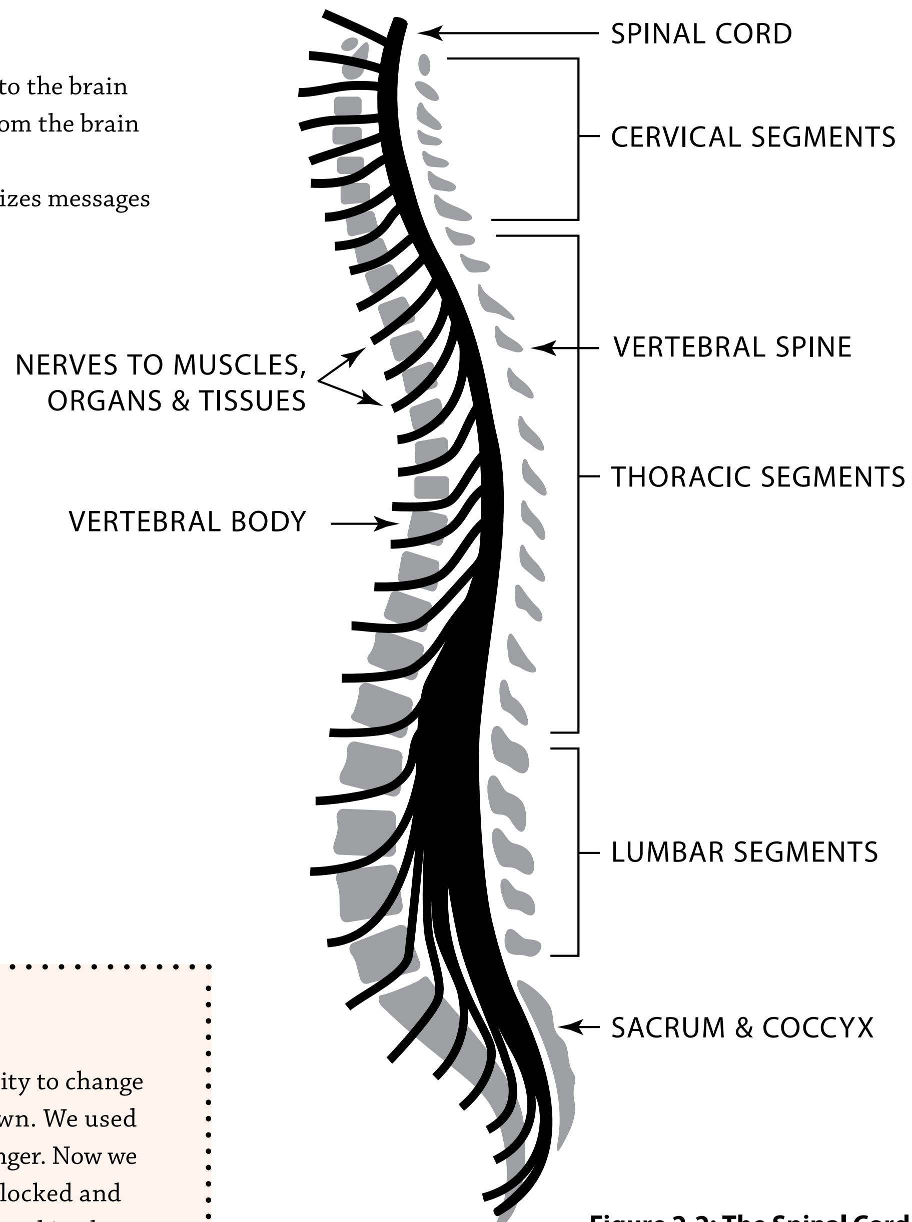


Figure 2.2: The Spinal Cord
The spinal cord does more than carry messages up and down through millions of neurons. It can also amplify or even block signals passing through it.

INTERESTING SPINAL CORD FACTS:

- The spinal cord has the ability to change signals travelling up or down. We used to think it was just a messenger. Now we know that signals can be blocked and their intensity can be adjusted in the spinal cord. It is a little like the brain having an administrative assistant who has some authority to decide which messages will get through and which ones require immediate attention.
- The spinal cord can send messages right back out to the body to tell the body to move, even before the brain knows what is happening. These are called reflexes.

3. Nerves

- Sense what is happening in the body and its surroundings
- Send sensation information to the spinal cord
- Send action impulses to the muscles and other body tissues from the brain and spinal cord

4. Autonomic Nervous System

- Performs the automatic functioning and reactions of the body, i.e., reflexes such as tensing your jaw or neck muscles when you feel pain in your body
- Includes digestion, muscle tension, heart rate, blood flow, breathing rate and depth, pupil size, sweating, etc.

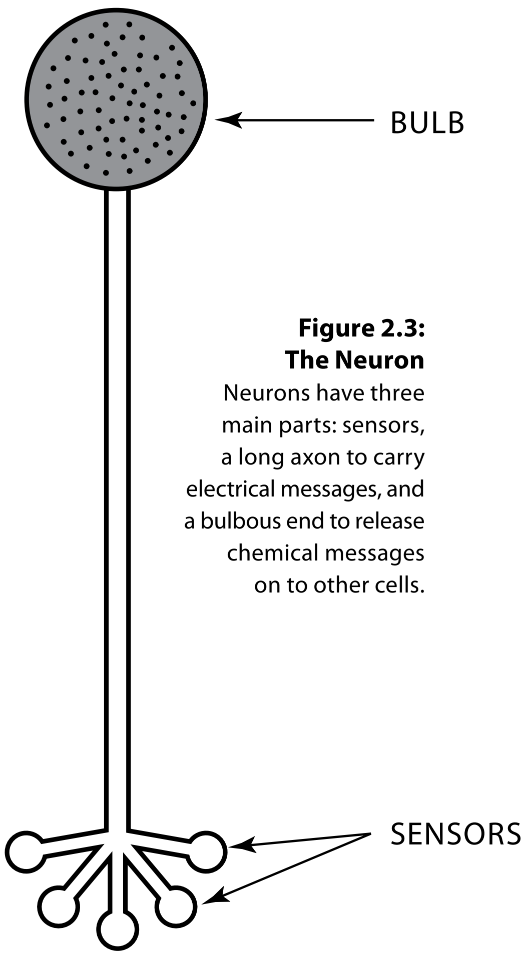


Figure 2.3: The Neuron
Neurons have three main parts: sensors, a long axon to carry electrical messages, and a bulbous end to release chemical messages on to other cells.

INTERESTING NERVE FACT:

- There are many more nerve endings in your skin than other tissues in your body. You get to know much more about what is happening in your skin than in any tissue under the skin – even more than your heart.

INTERESTING AUTONOMIC NERVOUS SYSTEM FACTS:

- The automatic responses of the nervous system usually occur below our awareness.
- Science has shown that people can learn to take some voluntary control over most of their automatic functioning.

When you are injured each of the parts of your nervous system responds. What do you notice happening in your body and nervous system when you feel pain? In your muscles, heart rate, breathing, sweating, in your interest to eat, in your ability to sleep...

Figure 2.4: Thumb meets hammer-1
Signals from your body pass through the spinal cord and then into the brain. The brain sends signals back down to many parts of you as a protective reaction.

Figure 2.5: Thumb meets hammer-2
When your brain is busy with something important, fewer signals make it to your brain and your brain will be less protective. You will feel less pain due to "priorities".

Summary

You have three main parts of your nervous system as well as an autonomic nervous system. Each part of the system works with the others. All of these parts working together allow your body to react automatically. They also allow you to decide how to act and react, to feel things happening inside and outside your body, and to think.

Many of the automatic responses of the nervous system are involved when pain persists. The spinal cord can change the messages heading to the brain, and the brain can decide all by itself what you will feel and how your body will react. The more you understand how this relates to you, the better you will know how to recover.

Chapter 3
How Nerve Cells Work

KEY MESSAGES:

- Nerve cells are called neurons.
- All neurons:
  - Have sensors
  - Send electrical messages
  - Release chemical messages from their ends.
- Each sensor detects things that are specific to the neuron it is attached to.
- When sensors detect something, they open a small gate that changes the electrical charge inside the neuron.
- When enough electrical charge has built up, an electrical signal will move along the neuron to its other end.
- Sensors are replaced every few days.
- Neurons in the pain alarm system respond to three things: pressure on the tissue, chemicals and extremes of hot and cold.
- Neurons in the pain alarm system send danger messages and release danger chemicals.

Just as muscles are made of microscopic muscle cells, nerves are made up of incredibly thin nerve cells. These cells are called neurons and they are shaped sort of like wires. They are so thin you can't see them with your eyes. You can't even see individual neurons on an MRI (Magnetic Resonance Imaging: a diagnostic test that can look at tissues in your body with more precision than an X-ray); scientists need huge electron microscopes to see and study them. Inside a nerve, which is as round as the head of a pin, there are thousands of neurons.

Though they are thin, neurons can be quite long. Nerve cells from your big toe are long enough to reach all the way to your spinal cord. This makes you wonder whether it would take longer to know if you have stubbed your toe than hurt your back. It turns out that the nerves send the signals so fast, that the length doesn't really slow down how quickly the signal gets to your brain and your awareness.

Have a look at figure 3.1 and 3.2 below. Neurons have three main parts. On one end there are sensors. In the middle they look like a simple wire. On the other end there is a bulb that contains chemicals.

All the neurons in your body function in a similar way. They detect some type of information, send an electrical message along to the other end of the neuron, and then release chemicals from that end. These chemicals go on to be detected by other cells in your body – mostly by other neurons.

Consider the neurons in your eyes. Their sensors detect light. On the other hand, the sensors in your taste buds detect chemicals. Just as your motion detector at home will not turn on due to odours or sunlight, the sensors in different neurons in your body only get excited by specific information.

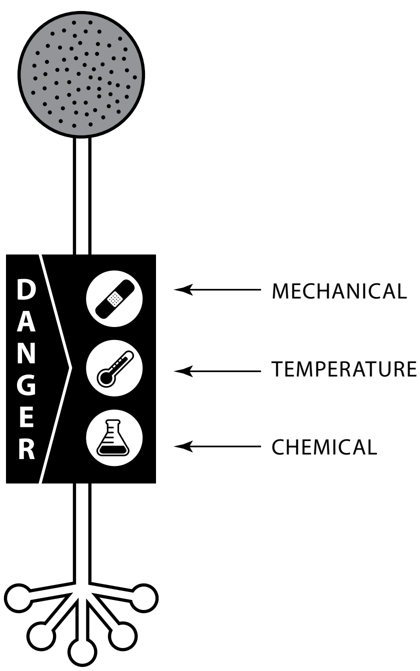


Figure 3.1: Dangerous stimulations
Neurons in your pain alarm system can get excited by three things: forces on your tissues, chemical irritations and extremes of hot and cold. All three can potentially send a danger signal through the neuron towards the spinal cord.

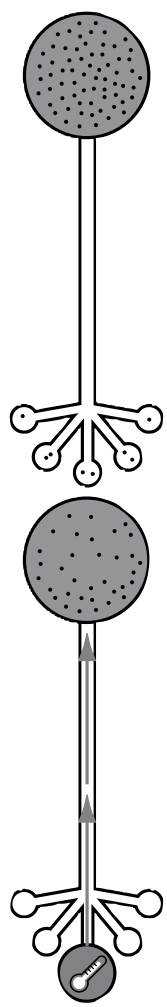


Figure 3.2: Danger messages
When a danger message gets to the end of a neuron, the neuron releases danger chemicals to excite the next neuron. These are called neurotransmitters. Danger neurotransmitters excite the next neurons. Other neurotransmitters inhibit the neuron on the other side of the synapse.

In the pain alarm system there are three kinds of sensors. Each sensor can usually detect just one of these three things:

- Mechanical forces such as pressure and stretch
- Extremes of temperature
- Chemical irritants.

You may realize right off that all three of these sensors in the pain alarm system are detecting things that are potentially dangerous. Because of this, we often call these 'danger' neurons, with danger sensors, and we say that they send danger messages*. You could also say that these neurons send messages that say, "THERE IS SOMETHING WRONG HERE".

Let's give an example of how the sensor and the neuron work. When a sensor on a neuron in your eye detects light, it will open a tiny gate or door in the wall of the neuron. This allows chemicals with an electrical charge to move into the neuron. When the sensors detect a lot of light, many doors will be opened. When the neuron is excited enough by all the electrical charge, it will send a signal through the neuron, along to its other end.

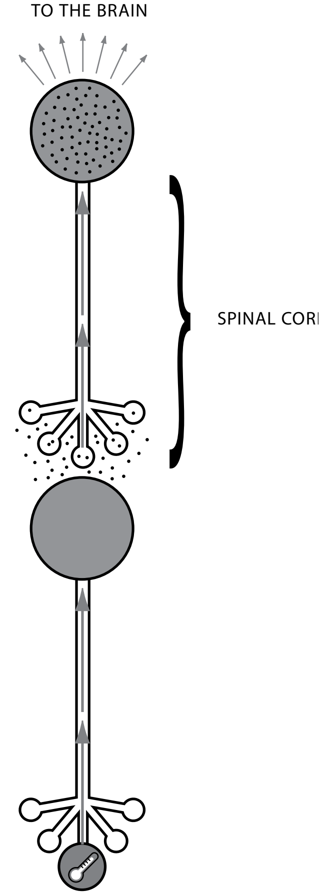


Figure 3.3: Danger messages from body to brain
A single danger message travels through at least three neurons before it gets to your brain and it crosses two synapses. The danger messages can be changed on the way to the brain. Once in the brain, the messages try to excite over 200 areas.

Lucky for us, our danger neurons* normally have a high threshold. This means that they do not respond to small amounts of force, small temperature changes or to small amounts of chemicals. Pull your finger a little bit and some of the sensor will detect this, but the neuron will not be excited enough to send a danger signal. Pull it back really far though, or stick your hand in the snow, and the neurons will become excited enough to send a danger signal. The same thing happens when you damage your body. Pull your finger back far enough to damage the tissues and chemicals will be released from the broken cells. The sensors will detect this. When enough of these sensors open, the danger neuron will send an electrical message to the other end of the neuron, on its way towards the brain.

Neurons in your spinal cord and brain work the same way. When they are excited enough they send messages.

You may wonder what happens at the other end of the neuron. Well, each neuron has chemicals in this end. When an electrical signal gets to that end of a neuron, these chemicals are released out of the neuron. They then cross a very small space and look for sensors on the next neurons in the spinal cord to pass the messages on to. See Figure 3.4.

The danger chemicals are called neurotransmitters and there are many different kinds in the nervous system. Some excite other neurons, some inhibit other neurons and some are more powerful than others.

When the danger neurons* release neurotransmitters into the spinal cord, some of the spinal cord neurons get excited. Once any one of these neurons in the spinal cord is excited enough, it will send messages towards the brain. All the neurons send messages using their own neurotransmitters in this same way.

* Referring to these as 'danger' messages and 'danger' neurons has been popularized by David Butler and Lorimer Moseley.

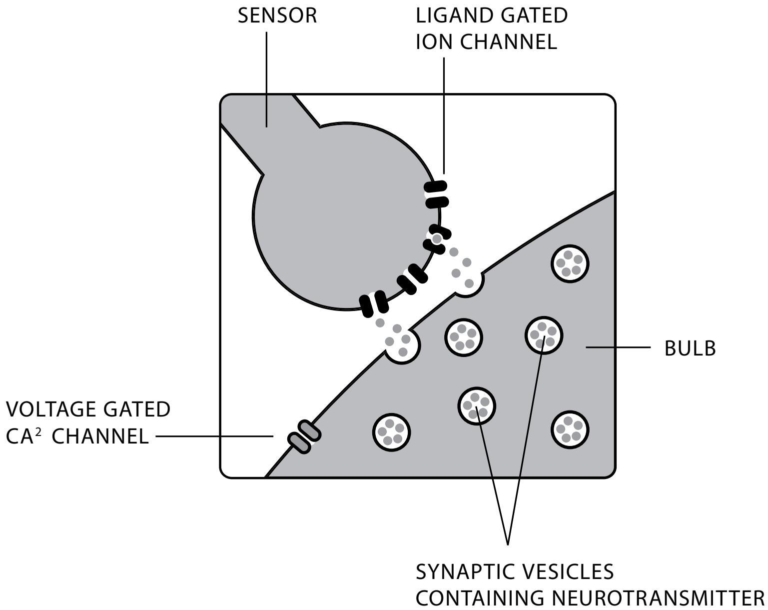


Figure 3.4: The Synapse
The tiny gap between neurons that neuro-transmitters cross is called a synapse. The next neuron has sensors for the neuro-transmitters and tiny gates/channels to let in electrical charges.

Summary

Nerve cells are tiny and they are called neurons. Their sensors allow an electrical charge to build up inside the neuron when they detect something exciting. Neurons in the pain alarm system are excited by three things: pressure, chemicals and extremes of temperature. These neurons usually require a lot of excitement before they will send a message towards the spinal cord; they typically have a high threshold. When a message gets to the end of a neuron, it will release a chemical called a neurotransmitter to either excite or inhibit the next neuron. When pain persists, the neurons in the pain alarm system change in many ways, including how easy it is to excite them and how the neuro-transmitter system works. You will learn much more about this in Section 7.

Section 4
How Signals are Interpreted in the Spinal Cord and Brain

KEY MESSAGES:

- Danger messages are modified in the spinal cord as they travel towards the brain.
- Not all danger messages excite the neurons in the spinal cord or in the brain.
- Other messages from your body can increase or decrease the intensity of danger messages.
- Messages from the neurons in your brain can increase or decrease the intensity of the danger messages in the spinal cord.

From what you have learned so far, it seems that danger signals are passed along from the body, to the spinal cord, to the brain in a simple manner. However, it turns out danger signals can be modified by many things on their way to the brain. As mentioned in Section 1, we usually imagine the spinal cord as a huge wire system, carrying messages between the brain and body. However, a more accurate image would be of many little computer processors in the spinal cord influencing whether messages will pass through, be blocked or even amplified. So the spinal cord has a chance to stop some signals from passing through to the brain, as well as make sure the brain gets a message that has been identified as really important.

Think back to the motion detector. The spinal cord is like the wire that runs from the sensor to the light, but this time in the wire there are computer chips that can make their own decisions about whether the light needs to be turned on, how bright it will be and how long it will stay on. To make these decisions, the chips require more information. It could get this information if it had other sensors besides just motion sensors, and if it had a way of storing old information about the activity of the motion detector. Previous information might tell the computer chip that this type of motion is really important. Maybe this same burglar tried to break in before. As such, it would let all these signals through and even turn up their intensity so the light would not only turn on, it would also be really bright. In another example, the different sensors might be able to hear the sounds made by your guard dog's collar as it walks by the sensors. When the chip analyses this new information, it knows that this particular motion isn't important. So the chip would block most of the motion signals and the light either doesn't turn on, is dull, or doesn't stay on long.

The neurons in your spinal cord work in a way similar to these examples. As signals go from your body to your brain, the intensity of the signals can be turned up or turned down depending on many factors.

Have you noticed that rubbing your skin over a painful area can make it feel less painful? Danger signals coming from your body are trying to excite neurons in your spinal cord so that danger signals will pass upwards to your brain. At the same time, touch/rubbing signals are trying to decrease how excited these same spinal cord neurons are becoming. The danger signals are exciting the spinal cord neurons, and the touch signals are inhibiting them. In this sort of competition, if there are enough pleasurable signals the danger will be overpowered, or decreased.

Figure 4.1: Converging signals
Your pain experience can be changed temporarily by other pleasant sensations that come from your body tissues. One can override the other.

Have you ever hurt yourself and thought, "that really hurts, I must have really injured myself a lot", but then you look at where you expected to see a mess, and it isn't so bad? You probably found that the pain became less bothersome right away. Ever wondered why that happens? Danger signals from your body are always modified by signals from your brain. The brain sends messages into your spinal cord that either increase or decrease the intensity of the danger signals passing up towards the brain. Once you've looked at the injury and have decided that the problem isn't so bad, your brain can tell your nervous system that it doesn't need to pay attention anymore. On the other hand, if your brain sent messages into your spinal cord telling neurons there to release more of the very same danger chemicals that were coming up from the body, you would experience more pain. Why would your brain do this though? Maybe you know that what is happening in your body is really dangerous. If it is really dangerous, you will need more protection, so your nervous system will want to send more danger signals to the brain. This way your brain can produce even more responses to protect you.

Imagine that chopping wood is how you make a living. Getting a splinter in your hand would be a common experience. If you felt a big splinter going into your hand, and you knew it would be fine to wait until later to fix it and that it would not cause any problems with your work or life, then your brain could send signals down your spinal cord that would release powerful chemicals into your spinal cord neurons telling them to be less excited. This would mean that fewer or none of the danger signals from the area of your body with the splinter would excite your spinal cord neurons or get to the brain. You need less protection, so your nervous system lets fewer of the signals get from your body to your brain.

It is a complex system.

The other thing that affects whether danger signals excite the neurons in your spinal cord and brain is how excited the neurons are before they receive new signals. All neurons in your body have a base level of excitement. Or stated another way, all neurons require a certain amount of excitement to send a message through to their other end. The neurons in the pain alarm system typically are difficult to excite. They have a high threshold for getting excited. So while they are sitting around, resting, not doing much, their level of excitement is low. At these times, some signals from your body may not be enough to make the neuron fire off a signal. On the other hand, when a neuron is already active and excited, it can have a high resting level of excitement. This will make it easier to fire and send a signal to the other end. Think of how excited the nervous system in your skin is when you have a sunburn. Now even warm water feels like it is burning your skin. Even worse, the system is so excited that normal sensations like a gentle touch or your shirt on your back can get the pain system excited.

The resting level of excitement in your neurons is changing all the time. When the nervous system wants signals to travel easily to the brain, it will make the neurons more excitable. If the nervous system believes that you need to be protected, it will make it easier for danger signals to travel to the brain. Maybe think of it a little like how difficult it can be to get some people to laugh. If they are already happy and laughing, it takes less to get them to laugh more. It's the same thing when you are angry. It will take less to get you angrier, and it would be almost intolerable if someone came along and poked you in the chest. Neurons, though they don't have emotions as far as we know, are like that.

Figure 4.2: Up-regulating messages from your spinal cord
Your brain has the ability to send messages down the spinal cord to increase signals coming up. If it is really important to you or really dangerous, your nervous system will let more of the signals through.

Figure 4.3: Down-regulating messages from your spinal cord
Your brain has the ability to send messages down your spinal cord to block or decrease the signals coming up. If you know it is not a big problem, your nervous system will produce less pain.

Summary

The neurons in the pain alarm system can be rather insensitive at times and extremely sensitive at others. Sometimes signals from your body are not able to excite neurons in your spinal cord, and sometimes signals from your spinal cord are not able to excite the next neurons in your brain. At other times, only a few signals are needed to excite the spinal cord or brain neurons. With these abilities to respond differently, the nervous system can adapt when it thinks you need to be protected more or when you don't need to attend to the signals from your body.

With persisting pain, your system is usually protecting you well. You can imagine the type of adaptations that have occurred. Once again, you will find more details of that in Section 7. But first, it will help if you know more about how this system acts when you feel pain under more normal circumstances.

Section 5

What Happens in the Brain and the Body When You Experience Pain?

KEY MESSAGES:

- Before you feel pain, the brain needs to decide: "*How dangerous is this?*"
- 200 to 400 parts of your brain get excited when you experience pain.
- Every system of your body changes when you need to be protected.
- The fight/flight mechanisms turn on when you feel pain.
- Automatic processes in your body can increase your pain experience.

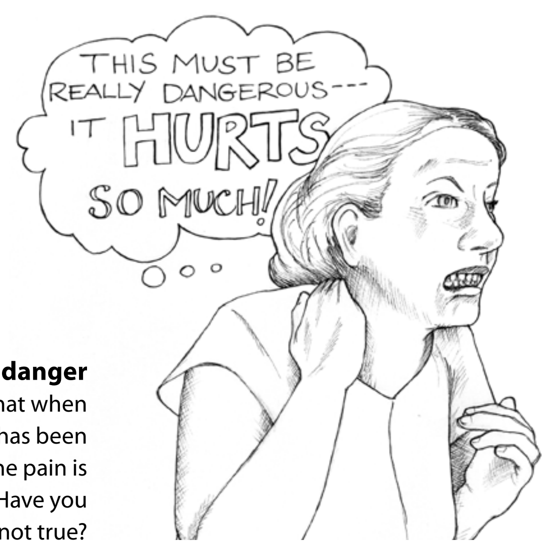


Figure 5.1: Pain and danger
Most of the time we believe that when there is intense pain the body has been damaged a lot, and when the pain is small there is little damage. Have you experienced that this is not true?

When the danger signals get to your brain you feel pain, right? Not exactly. Even before you know that anything is going on in your body, your brain needs to make a decision. Your brain decides, "How dangerous is this really?" Scientists do not know where this decision is made, or how, but we know that you will not feel pain when your nervous system decides that the information coming in to the brain is not really dangerous. And we know that the more danger the brain decides exists, the more pain you will feel.

Stated another way, the brain's job is to come up with a sensible decision about what is happening in your body. How it decides this is both simple and complicated. The brain analyses all the information coming to it, and combines this with everything you already know and have experienced. From all this information, it decides what is going on and whether you need to know about it.

To understand this better, consider for a moment that many things happen in your body automatically: digestion, breathing, changing sugar to fat, the cleaning actions of the liver and kidneys, blood flow… These are all things you normally need to make few decisions about. The automatic nervous system does this all for you, usually without your awareness. The pain system also works automatically.

You may have noticed, however, that you can have some influence over these automatic reactions. It is the same for pain. Maybe you have cut your finger and didn't feel much pain. If so, your nervous system decided that what happened was not really dangerous and you didn't need to know about it. Then you looked at the injury and decided it really was dangerous. Now the pain intensifies. The brain has taken in the visual information as well as your conclusion that this is a bad injury. Now you need to protect it, so now you will feel pain.

You may have noticed this same sort of reaction in other people. For instance, many people have watched a young child fall and scrape their knee. Many times the child will show no reaction until they see they are bleeding – then the tears come.

Once the brain decides that the information coming in is important, and that you need some sort of protection, then you feel pain. Not only do you feel pain, but many other things happen in your brain and your body.

What have you noticed happening in your body when you feel pain?

You may notice:

- Changes in breathing
- Changes in heart rate
- Skin gets pale or flushed
- Skin gets sweaty
- Muscle tenses
- Muscle gets weak
- Other senses become heightened
- Light-headedness or dizziness
- You move away from what caused the pain
- You look to see what caused the pain
- You vocalize an emotional reaction to the pain, or to the injury
- You think about how this will affect the rest of your day
- You think about the last time this happened
- You imagine how this will impact your work or leisure
- You plan how to make sure this doesn't happen again

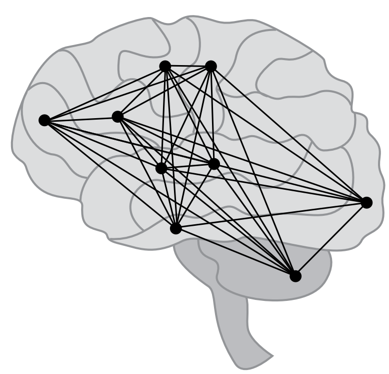


Figure 5.2: Brain pathways
When the brain decides that there is something really dangerous happening, many parts of the brain become excited. No two people have the same nervous system response to the same pain, though there are 12 or so areas of the brain that usually become more active in everyone.

It turns out that hundreds of areas of your brain will get excited when you feel pain. These reactions of the brain all focus on one goal – to protect you.

Every system in your body will respond when you feel pain. Self-preservation is that important. Even so, you may have noticed that when you feel the same pain a number of times, the pain will change. Most times, the more times you feel the same pain, the less intense it will feel. When this happens, the nervous system is adapting. The system is becoming less responsive so the pain decreases. However, it is also possible that the opposite occurs. When your nervous system automatically responds over and over as if the problem is really dangerous, then all the systems will become more and more responsive and protect you more and more. This worsens the pain.

Both of these changes – the nervous system responding less and the nervous system responding more – illustrate a very important point: your pain alarm system is not a static thing. It can learn to ignore old injuries, but sometimes it learns to pay more and more attention. In the later case, the system will continue to find new ways to protect you more.

One of the parts of your nervous system that you have probably heard about is the fight/flight mechanism. When you are in pain, or there is any threat, this will turn on. Fight/flight refers to your reactions, your body's reactions and all the changes in all your body's systems when you are in a threatening situation. Your body gets ready to either fight what is threatening you, or it does what it needs to help you get out of the situation (flight).

Sometimes, when the threat seems really huge, the system does something a little different. In order to protect you, the system can shut things down. Your body might feel weak, you might not be able to talk, you may find it difficult to breathe and you may freeze. As such, the system is sometimes referred to as the fight/flight/freeze system.

Generally, fight/flight responses include:

- Blood going to your muscles, muscle tone increasing and sugar being released into your blood stream so that you are ready to physically react
- Blood diverting from the digestive system to the heart and muscles
- Increased breathing rate
- Pupils dilating and senses heightening
- Lack of interest in sleep, eating and procreating.

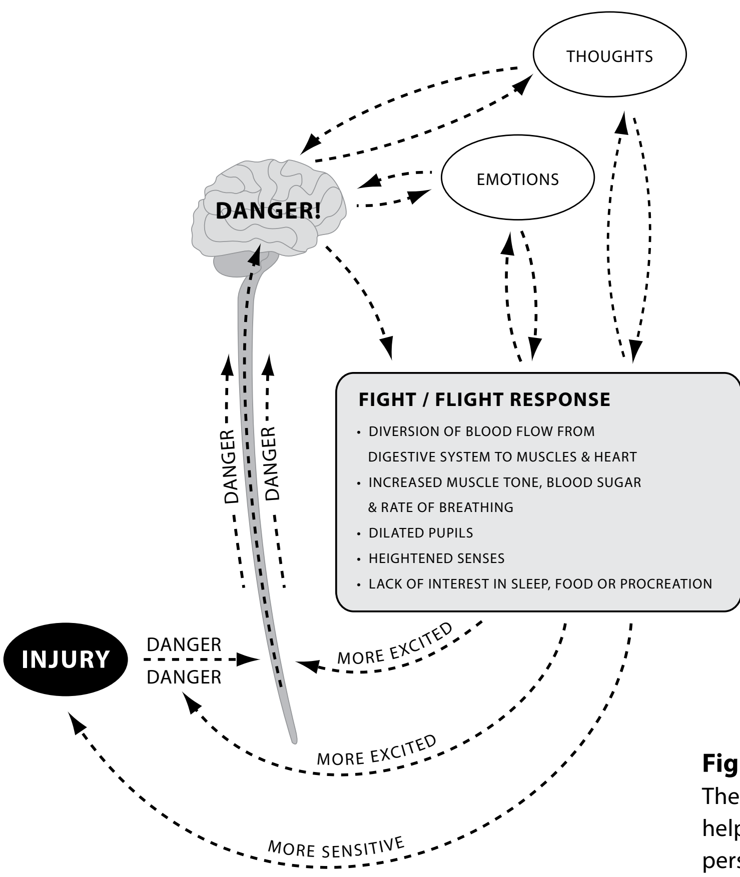


Figure 5.3: Fight/flight responses
These reactions are part of the protective mechanism. They help make you safe in the short term. When these reactions persist, the vicious cycle of worsening pain can occur.

It is important to know that although these reactions are typically automatic, you can learn to have some control over them. It is also important to know that if fight/flight reactions persist, this will increase your pain experience. Research shows us that when these reactions remain turned on, the pain alarm system stays wound-up. Fewer danger signals from your body will be required for you to feel pain and if you are feeling pain, its intensity will increase.

Unfortunately, the flight/flight mechanisms can lead to a vicious cycle. The more pain you have, the more the fight/flight system turns on and then the more sensitive the pain alarm system gets -> more pain -> more flight/flight reactions -> more pain...

Figure 5.4: How dangerous is this really?*
When your pain increases your nervous system has decided that something is really dangerous.

Summary

When you feel pain your brain and body are changing in many ways. The changes are all part of your automatic protective mechanisms. When pain persists, these automatic reactions can become more reactive, and by themselves they can start to make your pain worsen. With practice, you can learn to gain some control over these automatic reactions, such as fight/flight reactions. This will help break the vicious cycle of pain and lead to less pain, better movement and better quality of life.

" How dangerous is this really?" is an important concept I first learned from Lorimer Moseley, and which is described in both Explain Pain and Painful Yarns.

Section 6

Pain is Not an Accurate Indication of What is Occurring in the Body

KEY MESSAGES:

- The severity of pain is influenced by many things other than the severity of the tissue injury.
- Chronic pain happens just as often when the tissue injury is small as when it is large.
- We can feel pain in parts of the body where there is nothing wrong.
- Pain is like vision and thirst, but not like touch.
- The nervous system provides us with experiences, not with the facts.
- Pain is not an accurate guide to tissue health or tissue healing.

One of the beliefs that most of us have about pain is that we feel more pain when we damage the body more. It is a little strange that we hold this belief. Most of us can recall many situations in our life when a small injury has hurt a lot or a bigger injury didn't hurt much at all.

Another common belief is that chronic pain only happens when the tissue damage is large. "If a person has chronic pain, but their injury was small, they must be making it up, or it must be in their head." Right? Not at all! Science and experience do not support such statements.

Chronic pain can occur as often from a small injury as a large one. Chronic pain is not limited to any specific tissue injuries. We will talk more about the development of chronic pain in Section 7. For now, let's further discuss how the pain alarm system works.

Have you ever felt pain in a part of your body where there is nothing wrong? This can happen for many reasons. Here are two common ones: referred pain and empathy pain.

Figure 6.1: Brain freeze
We have all felt this. The nervous systemis making a mistake. There is nothing dangerous happening in your forehead.

Referred pain is pain that is felt in an area where there is no tissue problem. Often this happens when signals come from one part of the body, but the nervous system can't correctly identify where they came from. Sounds odd, but have you ever had brain freeze from drinking or eating something really cold? Where did you feel the pain? Was there really something wrong in between your eyes? It turns out that when the soft palate at the back of the roof of your mouth detected that there was something really cold there, it sent messages to your brain. The brain decided you needed to be protected – swallowing really cold things may not be the best thing for you. But you didn't feel pain much in the roof of your mouth. The problem is that the brain doesn't have a good map of the inside of your body. It has a great map of your skin, with incredible detail in areas such as your hands and face. Just like signals coming from muscles and joints, signals from your soft palate get to your brain, but it can only tell you the general vicinity of where the signals came from. So even though there is nothing wrong with your forehead, you feel pain there.

Referred pain is important to understand because it shows you that the pain alarm system does not work the same way as the part of the nervous system that tells you about touch. You have learned to rely on the fact that touch sensations tend to be an accurate indication of what and where things are happening on your skin. You usually know exactly where touch sensations are coming from. Pain is not like touch in this way. People often find that where they feel pain does not accurately indicate where the tissue problem has occurred inside their body.

Empathy pain is another good example showing that pain is not an accurate indication of what is happening in your body. Empathy pain is pain we feel when we see someone else getting hurt or expressing pain. Some people feel it when they see someone they love in pain. Others feel it when they see someone else get injured in a manner in which they have experienced. Most men know exactly how it feels when they see another man hit between their legs by a ball.

Scientists suggest that the neurons behind this experience are called mirror neurons. These neurons allow your nervous system to react as if what you are seeing, hearing or thinking is really happening to you. When you see someone fall and hit their head, these neurons set off activity in your nervous system as if this just happened to you. When you hear a word you have not heard before, these neurons set off activity to plan how you would say this word. This experience is one of many that scientists have studied showing that pain is not an accurate indication of what is happening in the body.

Pain is like vision*
Have a look at this image. Which side of the cube looked closer to you when you first looked at it?

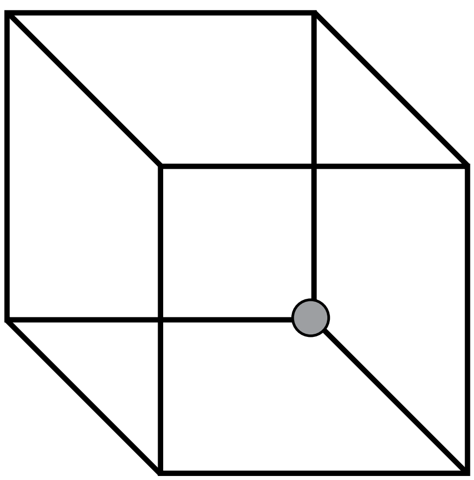


Figure 6.2: The Cube
This visual 'illusion' shows us important information about how the nervous system works. Follow the description to learn more.

It doesn't matter which it was. Did you decide which way to see it, or did it just pop out at you by itself? Consider whether the following seems accurate. You looked at the image, this excited neurons in your eyes, which sent information back to your brain, and then your brain decided for you, in an instant, without any input from your conscious thinking brain, which way you would see it.

Right. This is one of those automatic things going on in the nervous system.

Okay, try something new. Can you see the cube the other way?

What did you do so that you could see it the other way? Consider this. You looked at the same image as before, this excited the same neurons as before and sent the same information back to your brain. Your brain decided to see the cube one way and you decided to see it the other.

This shows you two things: the nervous system can respond on its own to signals coming in and, even when the nervous system responds in a certain way, you have the power to change it.

Here is another important question. If you can change how you experience visual information coming into your nervous system, can you also change how you experience the danger signals coming in?

Keep in mind though that danger signals are a higher priority than visual information about a cube. This means that it will likely be more difficult to change how your nervous system perceives danger signals – not impossible, just harder.

Pain is like thirst*
We feel thirsty when we don't have the optimal amount of fluid in our body. Scientists believe that the system works in the following way. When you are dehydrated, signals start from your body that send a message to your brain telling it that your blood volume is low. When the brain detects these messages, which have a relatively high priority/importance, it creates the feeling of thirst. It is as if the brain knows that if you feel thirsty, you will drink.

The system works in two unexpected ways though.

1. If you feel thirsty and then drink a big glass of water, you will likely stop feeling thirsty right away. The strange thing is that it will take 10 to 15 minutes for the water that is now in your stomach to get to your blood system. So

* See Painful Yarns for informative and hilarious stories explaining these concepts further.

your body is still sending 'blood volume is low' signals to the brain, but you do not feel thirsty anymore. Your brain is not paying attention to these signals anymore. It turns out that your brain will stop paying attention to any signals, including danger signals, if you have done what is necessary to take care of the problem. So if you take a pain pill that you believe will work, the pain starts to decrease even before it gets into your blood stream. On the other hand, if you do not receive the treatment you believe you need, the system may pay more attention to the danger signals. That would increase your pain.

2. The second unexpected thing about the thirst phenomenon is even odder. Although thirst is a high priority signal, we often pay little attention to it, we misinterpret the need to drink for the need to eat, or we drink things that dehydrate us more. You might expect that for such an apparently simple and such an important process as thirst your nervous system would interpret the signals correctly. You might also expect that the nervous system should give you accurate information about what you should and should not do to correct the problem. You probably know people who drink coffee or cola when they are thirsty. You might not have known that one of the leading causes of headaches is dehydration. Do you think of drinking some water when you have a headache? Usually not. This shows that an important alarm system in your body does not always provide accurate information about your body. Pain is like that too.

How do we make sense of all this? Why would the nervous system not give us accurate information? No one knows the answer to these questions. Sometimes I joke, "every time I ask a neuron, it just ignores me."

What we know about the nervous system is that it provides you with experiences, not with facts. This may seem odd at first. The experiences we have and the sensations we feel are influenced by everything, just like pain is. For example, the cube you looked at is really just a bunch of lines on a page, but you saw a cube. The same sort of thing occurs when people are trying to match paint on their walls. The shades and hues we see on the little paint chips look very different in the store than in your home. They even look different in different rooms in your house. The surrounding colours and lights can make the same colour look very different in two different places. Pain is like vision. The system provides you with an experience based on all the information going into the nervous system.

Unfortunately, the nervous system does not give you the facts. Simply stated, if you had the identical tissue injury on separate days your pain experience

Figure 6.3: Beliefs and medical closure
If you believe you are not getting the right care, or that there is something really dangerous going on, you will have more pain.

would be different, unless every other input to your nervous system was also somehow identical.

This same situation occurs with all your senses. Foods and wines often taste different at home compared to in a particular restaurant. A rapid heart beat will provide you with a different experience if you just finished a race you trained for, or if you are worried about a heart attack. If you have a rapid heart rate and are worried that you are having a heart attack, your experience will be different if you are in a hospital with a competent health care team or far away from medical assistance. A paper cut will usually feel worse at work than at home – according to one scientific report.

Many optical illusions rely on the fact that your eyes do not see the facts. All the information your eyes detect gets meshed together. This means that your experience is not an accurate indication of what you are really looking at. Remember Inspector Friday on Dragnet, always asking for "just the facts"? Little did he know that this was impossible. Our nervous systems perceive and we remember experiences, not facts. This is one of the reasons ten different people with the same injury would describe how it felt in a completely unique way.

Figure 6.4: Pain: fact or experience?
Pain is not an accurate indication of tissue health or tissue damage.

Summary

Pain is not an accurate indication of tissue health or tissue damage. Even though we would expect our alarm systems to provide accurate information they do not tell us accurately where the problem is, what the problem is, or how dangerous the problem really is. Even though we have all experienced that pain does not give us accurate information about tissue health and tissue damage, we go through life with this belief. Coming to a new understanding of pain is one of the most important things for people to accomplish as they work at moving and living well again.

Section 7
How the Pain System Changes When Pain Persists

KEY MESSAGES:

- Anything the nervous system practices it can learn.
- When pain persists the nerves in your body learn to detect smaller problems and they send more signals about these problems.
- When pain persists the nerves in your spinal cord learn to respond more to signals from your body.
- When pain persists the nerves in your spinal cord start to act as if normal body sensations are danger signals.
- When pain persists more nerves in your brain pay attention to the area of injury.
- When pain persists nerves in the brain start to produce hormones that increase your body's stress reactions and fight/flight/freeze responses.
- All these changes can change back to normal.

It is usually surprising when we learn how quickly and how much the nervous system can adapt and change. Look at how quickly we can learn new things. Under the right circumstances we can adapt to driving a car on the 'wrong' side of the road with the steering wheel on the 'wrong' side of the car relatively quickly, even after many years of driving with everything on the 'right' side. At other times, especially when under considerable stress, it might be very difficult to adapt to something new like this. Some things and even some people can be harder to adapt to. We can adapt to less sleep, more caffeine and hotter or colder climates. How long it takes depends on many factors, both individual and environmental. Practice makes adaptation possible.

The information you are about to read may seem like bad news. With persistent pain your nervous system has become better at sending danger signals and better at paying attention to danger signals. It did this automatically – the nerves learned what they were practicing. Remember though, it is possible to change anything the nervous system learns no matter how much time has passed.

As you continue to read, you will learn how the system becomes hypersensitive when pain persists. Then, you will learn how to make it less sensitive.

Some of the changes you make in your nervous system will be quick and easy. Others will require learning new skills, combined with considerable effort, repetitive practice and determination.

How the nervous system changes when pain persists
Each part of the nervous system changes when pain persists. You have likely noticed how other systems have changed. Your muscles may be tighter or weaker. Your circulation, sleep patterns, appetite or digestion, and sexual drive may or may not be different now. Once again, the exact changes in most of your systems are individual. However, it appears that in all of us with ongoing pain, the neurons change in specific ways. Here are a few of them.

Figure 7.1: Distorted body image
When pain persists and the nervous system attends too much or too little to an area of your body, it can feel as if it has changed size.

In the neurons in your body

1. Through most of your life the sensors in your danger neurons have a high threshold. This means that it takes a lot to excite them enough to send a danger signal up the neuron towards the spinal cord. When these neurons send the signals over and over, the threshold starts to go down. It is as if the neuron starts to believe that you require more protection, so it wants to send more danger signals to the brain.

2. The more a danger neuron fires, the more excited it acts. Usually, these neurons will send a signal and then there will be a delay before they can send another signal. When pain persists the delay time decreases, allowing each danger neuron to send more signals. Sometimes this mechanism becomes so changed that the neuron will continue to send signals long after the sensor detects something dangerous.

3. The danger neurons may start to release chemicals out of the 'sensor' end of the neuron – the end that is in the tissues. These chemicals produce inflammation and are probably released because your nervous system thinks that if there is this much pain, there must be a need for lots of protection. Inflammation is a part of the body's protective systems. These chemicals can produce swelling in the tissues even long after the tissue has healed.

In the spinal cord

1. The neurons in the spinal cord become more easily excited the longer pain persists. They do this by increasing what we call their 'resting level of excitement'. Even after these neurons fire a signal off towards the brain, they remain a little excited. It's a little like an experience you might have noticed when we get angry. If we are happy, it takes more to get us angry. When we are already angry about something else, it takes less to get us to the same point of anger. Now obviously the neurons can't be happy or mad, but the more excited they are the easier it will be to excite them to send messages along. With persistent pain, danger signals will travel to your brain more easily. It will require fewer signals from your body for you to feel pain.

2. The neurons in the spinal cord start to build more sensors when pain persists. If there are more sensors, they can detect more of the danger chemicals and thereby send more danger signals to the brain. Once again, it is as if the nervous system starts to change so that the alarms get louder, as if you need more protection. And once again, it will require fewer signals from your body for you to feel pain.

3. The neurons in the spinal cord that send danger signals can misinterpret normal sensations of touch, stretch and movement as danger signals. This means that you can feel pain just because you touched the skin in the area of the injury or because you stretched an uninjured tissue in the area of the injury.

In the brain

1. The map of the part of your body that was injured becomes bigger when pain persists. This is sort of like what we see in old cartoons when someone stubs their toe or gets hit on the head. The cartoon shows the area of the body getting bigger, sometimes even pulsing. When pain persists more of the neurons in your brain will pay attention to the painful area.

2. When this map changes it will impact your ability to contract and relax your muscles as well. For instance, if the pain is from your shoulder you might notice that you can't lift your arm smoothly. Moving your shoulder requires coordination of activity between the deeper stability muscles and the bigger stronger muscles near the surface of your body. The deeper muscles generally keep your joints in the proper position while the outer muscles move your heavy limb. Often when pain persists the deeper muscles do not turn on enough or at the right time and the outer muscles turn on too much. The muscles have learned a new and unhelpful pattern of responding thanks to the changes in the nervous system. When you try to move it feels like the joint is stuck, the muscles spasm, or it just plain hurts. The brain is sending the wrong signals. This will feel like there is something terribly wrong inside – there is, but this added problem is in your nervous system, not so much in the tissues.

3. When pain persists, the brain starts to change the chemicals it produces and releases. Some of these chemicals are hormones and they can stimulate your body's fight/flight/freeze reactions. Not only can this lead to feelings of anxiety, fear, anger and depression, these reactions all tend to feed back into the pain system increasing its sensitivity even more. One of the oddest things is that when pain persists the sensors on your danger neurons can change so that they become sensitive to adrenaline. So each time something stresses you and your body releases adrenaline, this will excite danger neurons and send more danger signals towards your brain.

4. Have you ever woken in the morning with a song playing in your head? Wondered why? Given that there is not an actual band or MP3 player in there, we would have to guess that your nervous system learned the song, something reminded you of it and triggered it to play. This sounds less strange when you consider the people who drive trucks through residential areas in the summer selling ice cream to children. If you have not experienced this, it is important to understand that they always have music playing from their truck. Who knows why, but they often play the theme song from the movie "The Sting". Of course, the children start to recognize this tune and pester their parents for money for ice cream whenever they hear it. So the parents come to dislike the tune, maybe even more than Barney songs (Barney is a pretend dinosaur on a children's TV show whose "I love you" song can be hard to shake). Imagine the driver though. Day after day of hearing the same song, his nervous system getting better and better at being able to remember every single note in the tunes. He starts to notice that even when he is out for a pint with his buddies the song keeps turning on in his head. After a while, the smell of vanilla or the sight of a young child pulling on his mother's arm triggers that tune.

Figure 7.2: Pain tunes
Persistent pain tunes, just like songs we hear over and over or thoughts we repeat, can become difficult to stop, even when the body is healing itself.

Pain is like this. The longer you feel pain, the more the nervous system can start to play the tune even when there are no new signals coming from your body. The longer you experience pain, the more things trigger the pain. This explains why a client who was hit by a car feels more pain whenever he sees that particular type of car, or why a client who has experienced more pain every time he bends forward starts to have increased pain when his physiotherapist tells him he is going to re-measure that movement. Just like the unfortunate ice cream driver, who would stop having this song playing incessantly in his head if he were to listen to another song even more, so too can a person with persistent pain change this pain tune.

Remember, all these things that the nervous system has learned can be changed back. Neurons can becomes less sensitive; they can stop paying attention to and stop misinterpreting normal sensation as dangerous. Sensors can change back to the way they were, the map of your body on your brain can go back to its normal state and your muscles can regain their normal coordinated action. All it took was the wrong circumstances and lots of practice to get them to act the way they are. Now you need to practice new things. With patience, persistence, compassion and practice you will find ways to change them back, instead of just covering up the pain.

Summary

When pain persists, you now have two problems: the original one that caused the initial pain and a hyper-sensitive nervous system. This can lead to more intense pain, pain that spreads to new areas and even a distorted image of the painful body area. A hypersensitive nervous system can make it so that normal movements and even normal touch on your skin – things that are not at all dangerous to your body – are experienced as extremely painful/dangerous.

Anything your nervous system has learned can be changed. Finding the right things to do, and practicing them over and over, is the key to making your nervous system less sensitive and turning down the protective reactions. Even if we can not change your original tissue problem, we can most definitely decrease the hypersensitivity of your nervous system.

Section 8
The Power You Have to Change Your Nervous System and Pain

KEY MESSAGES:

- The sensors/detectors on your nerves are replaced every three to four days. This is one of the many ways your nervous system adapts and changes. You have some influence on the sensitivity of the new sensors.
- Your nervous system produces pain-killing chemicals. These chemicals are much more powerful than the danger chemicals coming from your body. They are also more powerful than any pain medications – without the unpleasant side effects. You can stimulate your nervous system to release these chemicals.
- You can influence what your brain pays attention to. The more it attends to healthy, non pain-focused activities, the less it will attend to the pain.
- You have the ability to change how your nervous system interprets information coming from your senses. When pain persists, the nervous system mistakenly tells you the problem is really dangerous. By convincing your nervous system that "it is not so dangerous", you can have less pain.

Now that you know some of the ways that your nervous system and body can change when pain persists, you need to know that **it is possible for you to make the changes in your nervous system that you want.** You probably know that you can strengthen muscles and make your body more flexible. When you get stronger or more flexible, you are changing the structure of the cells in your muscles and tendons, and you are changing how these cells function. It is the same idea with nerves. For some reason we have the idea that nerves never change. We tend to agree, "once there is something wrong with a nerve, that's the way it is going to be." However, nerves are incredibly adaptable cells. They can change how they function much more quickly than muscle cells change. Not only do nerves have the ability to learn new ways of acting quite quickly, we can change the way a neuron works in many ways. If you want a bigger muscle, you need to exercise it by making it contract. Other than illegal drugs we do not know of any other way. Neurons, however, can be changed by almost anything – how we move, by input through our skin, how we stretch, what we think, what we see, our environment, what we believe, our emotions, etc. We have the ability to change each of these things, so we have considerable power to change how our neurons work.

You may have noticed that it is not easy to change the nervous system. This it true. The point to understand though is that it is possible to change the nervous system. With practice and the right approach, you will be able to learn specific techniques to change your neurons, change your nervous system and change your body. These changes will lead to less pain, better movement and improved quality of life.

Changing the sensors

Remember that there are sensors on the danger neurons? Some sensors detect physical things like stretch, some detect extremes of temperature and others detect chemicals. When pain persists, your body starts to produce more sensors that are sensitive to chemicals. For example, you have many more sensors now that detect chemicals such as adrenaline. Maybe think of it this way: as pain persisted, your body thought you needed more protection so it built new, highly sensitive sensors to protect you. Adrenaline usually means there is something threatening happening or something stressing you. So your body built more adrenaline sensors to make sure you knew when you needed more protection. The pain alarm system can now make sure you are well protected (by responding to the adrenaline, as well as to force on the tissues in the injury site).

It turns out that every three to four days every sensor is your body will be replaced. Not all at once of course. Thousands are replaced every second. This makes sense given the highly adaptable nature of the nervous system. When the body is in a wound-up state, for instance when there are a lot of stress reactions, the new replacement sensors will be highly sensitive. Whenever the body and nervous system are calm, your neurons have a chance to replace the sensors with less sensitive ones. Given that there are trillions of sensors in your body, every second your nervous system is calmer your body can replace the highly sensitive ones with the more normal (low sensitivity, high threshold) sensors.

More time in a calmer state, more opportunity for positive change.

Imagine that all of your sensors will be new four days from now. So you really only need four days of absolute calm – no stress, no fight/flight, no stressful thoughts, no worsening pain with movement and none of the normal automatic processes that help sustain a wound-up nervous system. This would make a tremendous change in your pain. Unfortunately, this is not very realistic for someone with persistent pain. Since we are all living our lives and it is impossible to turn off the nervous system, it takes much longer than four days for most people to significantly change their pain. Regardless though, by practicing the right techniques you can influence the types and the sensitivity of sensors that are replaced in your nervous system. This will change your pain.

Brain chemistry

One of the most powerful chemicals to change pain is a chemical you have the power to create – endorphin. Endorphin is a pain-killing chemical produced mostly by neurons, but also by other cells in your body. When you are happy, enjoying yourself, laughing, or exercising in a way that doesn't make the alarms scream, your neurons produce more of this chemical. In the brain and the spinal cord endorphin chemicals work to stop or block danger signals. Fewer danger signals getting to your brain means you feel less pain.

One endorphin molecule may be able to block as many as 50 danger signals. This makes endorphin even more powerful than morphine, and without all the side effects. The side effects of endorphins in your body are pleasant things like a generally elevated and pleasant mood, greater ease of movement and more enjoyment in life.

More pain leads to more adrenaline release, which leads to more pain. More endorphin release leads to less pain and better mood, which leads to more endorphin and less pain. Additionally, more laughing leads to more endorphin, which leads to more laughter. All of this will mean you have less pain.

Can you remember a time when you were actually laughing and having fun? Did you notice that your pain was not only less while you were happy, but it felt better through the whole time you remained happy? It can be difficult to be happy when you are in pain. Yet finding a way to be happier is an extremely powerful technique for changing pain and improving the quality of your life. Practicing techniques to release endorphins will not just produce temporary changes. With enough practice the nervous system will start to remain in a happier state 24 hours a day.

You can learn to have more control over your emotions, you can laugh and smile more and exercise more on purpose. So you can change your pain.

Attention to pain

Scientific literature tells us that as pain persists, the nervous system pays more attention to the danger signals and to the pain. More brain cells are 'listening' to signals from that part of the body right now. Normal signals are being misinterpreted by your nervous system as dangerous. This brings even more attention to your protection systems.

Science tells us that some people can learn to have less pain by learning to pay attention to the 'painful' body part on purpose, without having an emotional reaction to it. We often try to avoid thinking about the pain. Sometimes we suppress the pain. Avoiding, suppressing

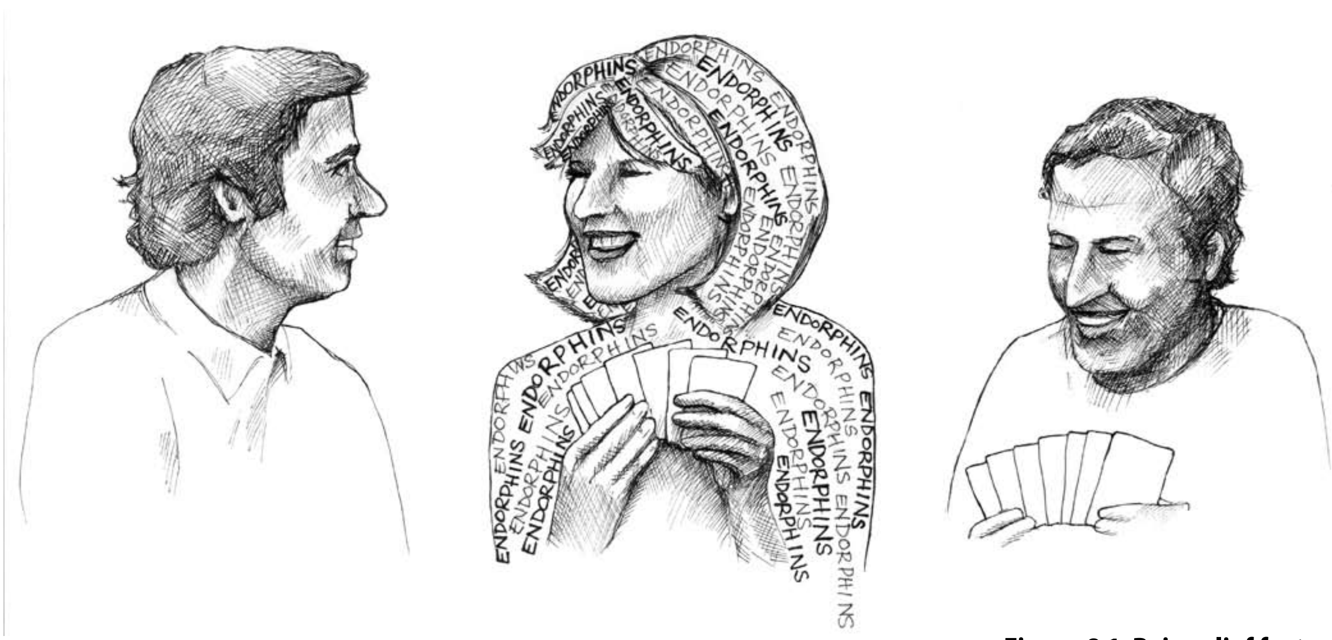


Figure 8.1: Pain relief factory
The chemicals your nervous system produces, such as endorphins, are more powerful than morphine and do not have the unpleasant side effects.

and ignoring pain often causes the nervous system to pay even more attention to it. As an example, what happens if I tell you not ro think about a green Martian sitting in the room beside you? It's difficult not to think about it.

Science shows that suppressing pain and avoiding thinking about it are not as useful for pain relief as being mindful of the pain or paying attention to it without the need to respond.

It is not only modifying your attention that will help change the nervous system. Modifying how the body reacts to what you feel is also important. Remember that when you feel pain, hundreds of areas of the brain react. That is all part of the protective reaction and all these other parts can feed back and lead to increased attention to the pain, leading to increased pain. What if you could learn to change how your body reacted?

Figure 8.2: Breathing
Breathing is a bigger priority than danger. Repeating calm breathing frequently engages the nervous system in healthy activity and can lead to lasting improvements.

You can do this! Have you ever seen a person speaking publicly and their neck became red and blotchy? The person was anxious and their body was reacting. We can learn how to control this physical reaction, and when we do, there will be less anxiety. Could you learn to stop your body from jumping or your muscles from contracting when someone puts a cold pack on your back? Yes, you could! Could you learn to stop squirming when someone tickles you? Of course you can. It might not be easy and it might take some time, yet it is possible. With practice you can even learn to experience the pain while you control the other reactions and protective responses of the nervous system. If fewer areas of your brain react to the pain, there will be less positive feedback into the system. Then you will experience less pain.

You can also learn to have less pain by changing how much your nervous system pays attention to the 'painful' body area when you move. Close your eyes and choose to listen to the sound of your breath. Take a few breaths, listening to what your breath sounds like. Now change your focus and listen to the sounds of birds chirping outside your window, or the other sounds in the room around you. Now, stay in touch with the sound of your breath AND the other sounds around you. You can do this. You can do the same with the pain. Decrease how much your brain attends to the painful area by paying less attention to it and more attention to something else, on purpose.

It will take some practice.

Changing how your nervous system interprets danger signals

Were you able to change how your nervous system interpreted the visual information about the cube in Section 6? If so, you can also change how your nervous system interprets danger signals. It's more difficult to change how the brain interprets danger signals because they are a higher priority. So it will take more time and more practice to make this change.

Think about something you can do right now that would increase your pain. Pick a movement of your body that is so small or applies such little pressure to your body that you are surprised it actually hurts. Maybe you just touch skin lightly over the injury area and it hurts. Maybe when you start to have a migraine touching your scalp produces pain. Maybe lifting your arm makes your low back hurt, or making a gentle fist with your hand makes your neck pain increase. The idea here is to find something that increases your pain that you know can't be truly dangerous to your body.

Whatever movement or activity you picked, when it hurts, your nervous system is acting as if it is really dangerous. Your job is to teach the nervous system that it is not dangerous. So when the pain increases, ask yourself the question, "Is this really dangerous?" Every time you decide it is not really dangerous, you are teaching your nervous system that it is not. With enough practice, the nervous system will learn that this activity is not truly dangerous. Sometimes this requires weeks of practice, and people whose pain has been present for years have found that by itself this technique has not been terribly beneficial. On the other hand, even people with intense burning pain for over four years and with a lifetime of migraines have reported benefits from this simple technique.

With practice and even a little success, you will become more confident that your new knowledge and these unusual techniques are really beneficial for you. Talk to your clinician about how you can practice this. Expect that you will need to practice this frequently, maybe even hourly for days or weeks before the changes will start to occur.

This can be a powerful technique for changing pain and improving function.

Summary

The nervous system is highly adaptable: sensors are always changing, brain chemistry can be changed, you can change how much your brain attends to the pain, you can influence the type of attention it is given, and you can change how dangerous your brain decides your activities are. The automatic reactions of your nervous system have been producing changes in your nervous system – adapting it so that you remain protected, or become even more and more protected as time passes.

You can take advantage of how adaptable your nervous system is. Use these techniques, and others to make positive changes in the nervous system and live well again.

Section 9
What Sorts of Things Worsen Your Pain Now?

KEY MESSAGES:

- The longer a person feels pain, the more things can trigger the pain and keep it going.
- Becoming aware of the things that trigger your pain is one of the first steps to recovery.
- The second step is to develop new coping strategies when the pain is triggered.
- The third step is to practice these new strategies over and over to train the nervous system in a new way.

One of the first things to consider as you move forward with learning how to decrease your pain and move well again is whether you can change the things that are triggering your pain. When pain persists, and the nervous system becomes more sensitive, people often experience that many things cause the pain to worsen, sometimes without following a specific pattern.

In previous sections you learned two key things that help explain how the pain can be triggered by more factors now: the danger neurons are excited by physical forces, by chemicals and by extremes of temperature; and when the neurons continue to send danger signals, they become excited more easily. This means that your pain can worsen from even small movements, from other movements, from changes in temperature and from changes in your body chemistry.

- New physical things might worsen the pain, including smaller movements, gentle stretches, movements of joints and tissues close to the injury and even gentle stimulation of the skin over the painful area.
- You might become more sensitive to heat and cold. Although this does not occur in everyone, you may notice your pain worsening or your muscles spasming when you become cold.
- When something stressful occurs, the chemical changes in your body will excite the danger neurons leaving you with more pain as long as your fight/flight system is engaged.
- Even changes in your breathing can change your body chemistry. If you breathe out forcefully as many do when stressed, you will blow off more carbon dioxide, making your blood more acidic. Besides making you feel even more stressed, this change in chemistry can excite your danger neurons, leading to worsening pain just from altering your breath pattern.

It is up to you, hopefully with the assistance of your therapists, to identify what factors trigger your pain. Starting with the physical triggers is often the easiest. However, do not disregard the other influences on the pain alarm system. They are equally important.

Make a list of the movements or positions that decrease your pain.

Then make a list of the movements and positions that consistently worsen your pain.

Then make a list of things that decrease your pain. This might include distractions, laughter, being with friends, doing hobbies, watching certain types of movies or listening to certain types of music.

Now make a list of the other things that consistently lead to increased pain. This could include things like being close to the place where you were injured or sometimes even thinking about it; it could be talking to someone who upsets you, getting stuck in traffic, having to wait for someone who is late, conversations with health care providers, etc.

Finally, make a list of the changes you have noticed in yourself that are difficult to control. This might include changes in muscle tension, posture, breathing pattern, sleep, mood, confidence, positive outlook, etc.

Now consider this diagram:
Endless hypersensitivity.

This diagram is meant to represent the manner in which many things can begin to negatively influence your pain. A vicious cycle can begin in which many different factors make your nervous system more and more hypersensitive, and worsen your pain. Sometimes the intensity increases over time even though a person is not increasing their activity. Sometimes the pain spreads to new areas even though the doctor is saying there is nothing wrong in the body to explain this. Sometimes the pain just stays as it always was, even though the tissues are healing and the neurons in the body are trying to do what they normally do over time – ignore old injuries.

Many factors can aggravate the pain when it persists. As you can see, these factors include things other than physical forces. Each of them can feed back into the pain alarm system. This feedback can then wind up the pain alarm system even more, or keep the alarms ringing.

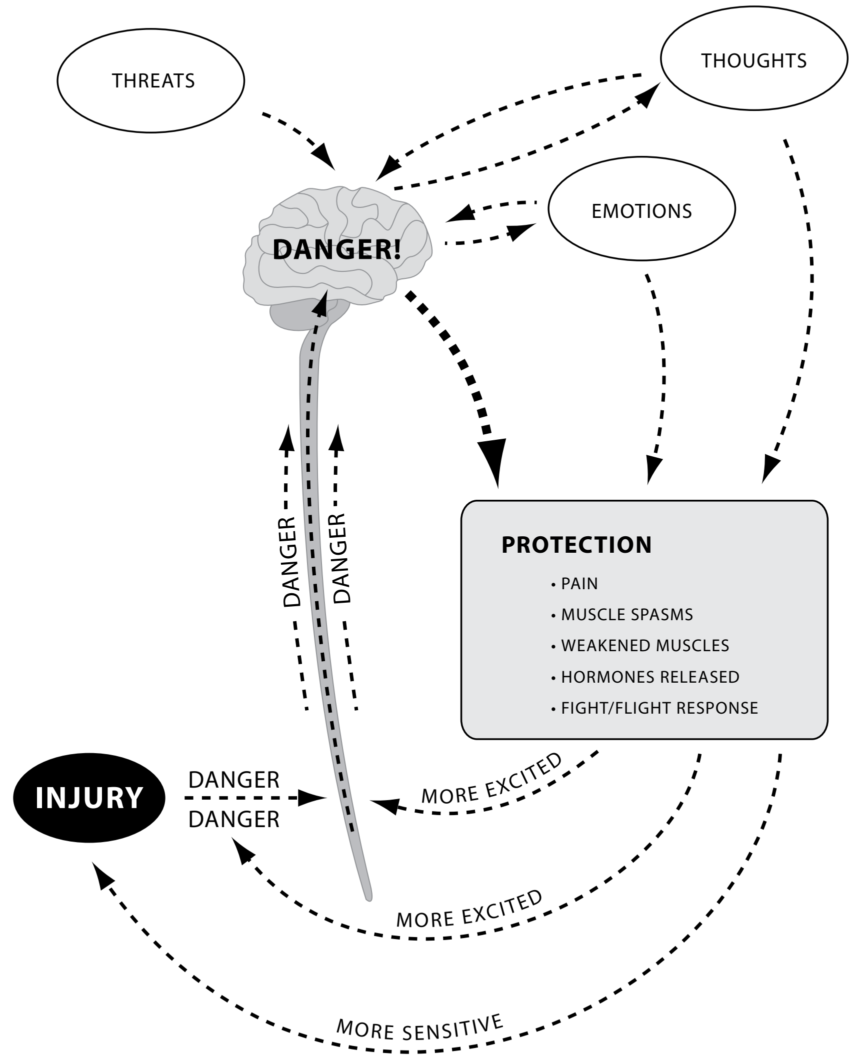


Figure 9.1: Endless hypersensitivity
Discovering which inputs trigger your pain, and knowing that the problem is no longer all about your injured tissue, is important for recovery. (Adapted from Butler 2006)

Once you start identifying the triggers, you can begin to work towards making changes that will lead to less pain and improved movement. For instance, you may notice that each time you become tense and start holding your breath that your pain increases. So breath holding is a trigger for your pain. You can practice awareness and then regulation of this. Or maybe you notice that whenever you are driving the pain worsens. Maybe the trigger here is the physical forces of driving on your body, or maybe it is your thoughts, your emotions, or even the amount of traffic that is triggering the pain. You will need to identify the triggers and then do what you can to influence each of them.

This second diagram, Endless regulation, shows how positive changes in any one area will lead to positive changes in other areas. Even small changes in regulation of body, breath, thoughts and emotions can lead to ongoing decreases in the reactions of your protective systems.

One very important thing to consider here: the things that worsen your pain the most may also be the most difficult things to change. You may need to start with more easily manageable and attainable goals at first, and once you learn how to manage the less troublesome triggers, take your new skills on to manage the more difficult ones.

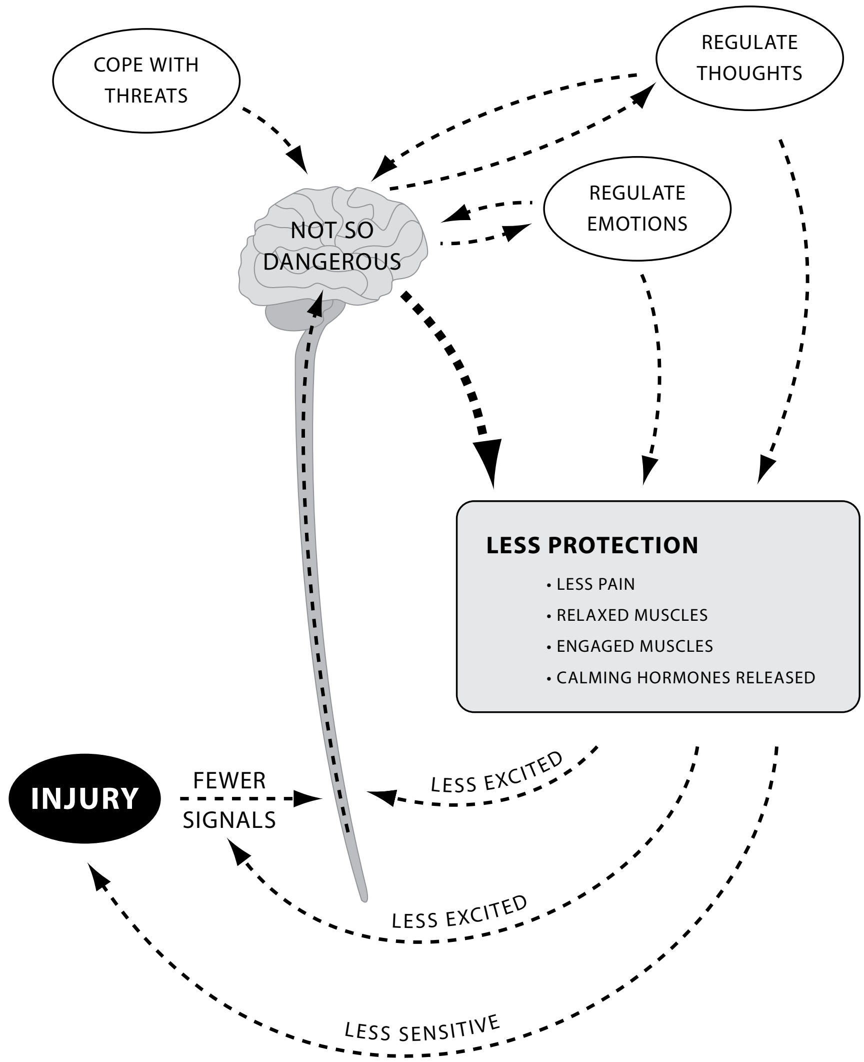


Figure 9.2: Endless regulation
Since everything affects pain, there are many ways to decrease it. (Adapted from Butler 2006)

Summary

Identifying and working with the triggers for your pain is extremely important and powerful. This puts more control of your pain and your life back into your hands. Work with your health care professionals to get you started and then start implementing your own plans to turn your situation from endless hypersensitivity to endless regulation.

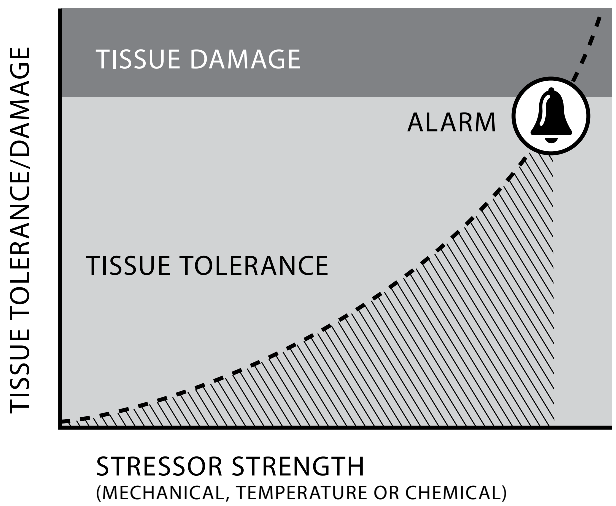
Section 10

Resetting Your Body: How to Move in a New Way

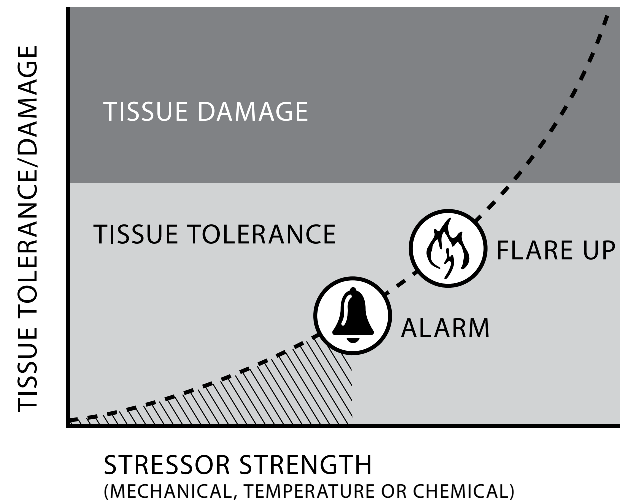
KEY MESSAGES:

- When you move, and the alarm increases, your nervous system is telling you the movement is dangerous. For many movements, they are not dangerous.
- You need to start increasing your activity from your baseline. This is typically difficult to find.
- When movement increases your pain, ask yourself, "*Is this really dangerous?*"
- Forcing yourself to move so much that your alarms scream will not make the alarm system less sensitive. You can not ignore pain.
- Avoiding the alarm completely when you move will not change the alarm system.

These two diagrams are intended to help explain how you will regain function and how you will approach exercise in order to overcome pain and move well again.



PRE-INJURY



CHRONIC PAIN

Figure 10.1: Challenging your body
Regaining movement requires a different approach to exercise. You need to challenge your alarm and make it less sensitive before you can strengthen your body.

Consider these two graphs. Notice the following:

- Under normal/pre-persistent pain circumstances your pain alarm will sound when you are close to damaging your tissue. The alarm is higher up in the graph.
- Under normal/pre-persistent pain circumstances it takes a lot of stimulation for the alarm to go off. The alarm is much further to the right in the graph.
- The shaded area under the graph is the amount of activity you can do before the alarm will go off. This is much smaller in the second/persistent pain graph.
- The second graph shows that if you push through the pain, you will have a pain flare-up, even without injuring the tissues more.

Before your pain worsened, you could do so much more before your tissue would have been damaged and before your alarm would have sounded. Now, your tissues are not as healthy because you have been less active. And now your alarms have become so sensitive that they sound long before you move enough to cause damage to your tissues.

Does it make sense that with a hypersensitive nervous system you will feel pain long before you damage the tissues? Remember that for most of your life you have equated pain and damage. So if you have difficulty with this idea, don't feel alone. Talk to your health care provider for more clarification, or read on to see if it makes more sense.

Experience tells us that many people with persistent pain have at one or many times become frustrated with the pain and decided to 'grit their teeth and push through it'. As a result, the pain flared up and put them back where they started again. Of course, you can understand what would happen if you continued to flare up the nervous system over and over – the more times you teach it to scream at you, the better it gets at screaming. This would move the alarm on the second graph even further down and to the left.

Getting tough and pushing through the pain will not work. When you do that, the pain will flare up for hours or days and you will either be right back where you started, or your alarm will become even more sensitive than it was before.

Experience also tells us that some people look at the second graph and make the wrong decision. Their thinking goes a little like this: "since more pain doesn't mean more damage, it should be perfectly fine for me to ignore the pain and push through it. Right? If I am not damaging myself when I feel more pain, this should work, right?" Most, if not all, of these people though will tell us that this strategy did not work when they tried it. Pushing like this isn't going to injure the tissue, but it will wind up the nervous system more and, consequently, teach the nervous system that you need to be protected from movements.

It is absolutely necessary that you understand that ignoring the pain will not lead to your recovery. If you keep crashing through the alarms, what you will get is a more and more sensitive alarm system. Your alarm system will learn that you do not listen, so it will scream louder at you!

The correct way to approach recovery of movement is to 'challenge your alarm'. You need to find the baseline of movement you can perform so that the alarm gets a little louder, and then when you stop moving it calms back down within a short period of time. By moving and exercising this way, you will be teaching your nervous system to stop reacting to movements as if they are dangerous. Over time the alarm will become less sensitive, allowing you to move more and more without the pain worsening.

The baseline is typically difficult to find. This is partially because the baseline of activity is often a much smaller movement than you want to do. The baseline is the edge, the right spot, the spot where you are moving enough but not too much. The baseline is the spot on the second graph where the alarm sounds. Every time you move in a way that challenges the alarm but does not make it scream, it will move a little up and to the right. Little by the little the area under the graph will get bigger, and it will take more and more movement to increase your pain.

You will know you are at the baseline when you feel the pain increase AND you know the movement is not dangerous to your tissues AND you can breathe in a calm relaxed manner.

Figure 10:2: A powerful pain control strategy
When your pain increases but you know your nervous system is giving you inaccurate information, tell yourself, "I hurt and I am OK". It might take many many repetitions to make this effective.

Once you find the baseline for different activities that you want to start changing, you then need to practice this activity by repeating the baseline frequently. The more times you challenge the alarms without flaring them up, the more the nervous system will change, becoming less sensitive.

One other important technique to use to recover movement is to remember the simple question, "is this really dangerous?" Remember that when your alarm increases, your nervous system is telling you that the movement you are doing is dangerous. However, you now know that this is not accurate information. When your nervous system tells you this small movement is dangerous, you can ask yourself, "is this really dangerous?" If you know it is not, then teach your nervous system that it is not. Every time your nervous system automatically tells you it is dangerous and you know it is not, you can tell yourself, "I hurt and I'm okay". Remember that we are talking about nerves. They learn whatever they practice. So, teach them.

Don't tell yourself it doesn't hurt. That is ignoring or suppressing the pain. Research is clear that suppression does not allow for more permanent changes. There may be powerful temporary changes, but these do not last and there is usually a strong rebound effect of more pain after the activity is completed. When the pain starts to increase, and when you know you are still safe, tell your alarm system that you hear it, but you know it is not providing you with accurate information.

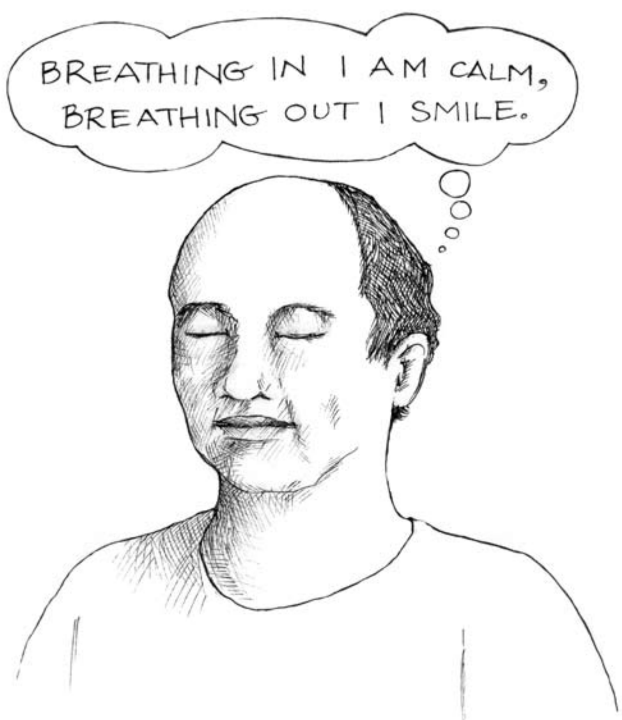


Figure 10.3: Using your breath and thoughts
Experience the power of repeating this to yourself as you breathe in and out a few times.

These same techniques are helpful when you are stretching, strengthening, trying to walk further, sit longer, recover coordination or muscle control or returning to work. You can incorporate them into yoga, pilates, Tai Chi, water exercises or any other physical rehabilitation.

Once you begin exercise to increase your function, don't forget about the other factors that can trigger your pain.

Practice is a huge key to success. Be persistent, be patient and be compassionate to yourself. You can overcome pain and live well again.

Tips for finding the right exercises

- Start by doing a little, frequently.
- Exercise in a new way, instead of the same way you have for years or months.
- Pick exercise that you find fun or that brings you some joy.
- Only do as much as you can while breathing in a relaxed and calm way.
- Practice relaxed breathing in a quiet calm place before trying to do so while you are challenging your pain alarms.
- Imagine doing the exercise with no pain before you try it. The opposite will usually guarantee that the exercise will hurt.
- Practice exercising with a relaxed face, relaxed posture, relaxed tongue and calm mind.
- Consider taking some time for relaxation or calm breathing before you exercise and after you exercise.

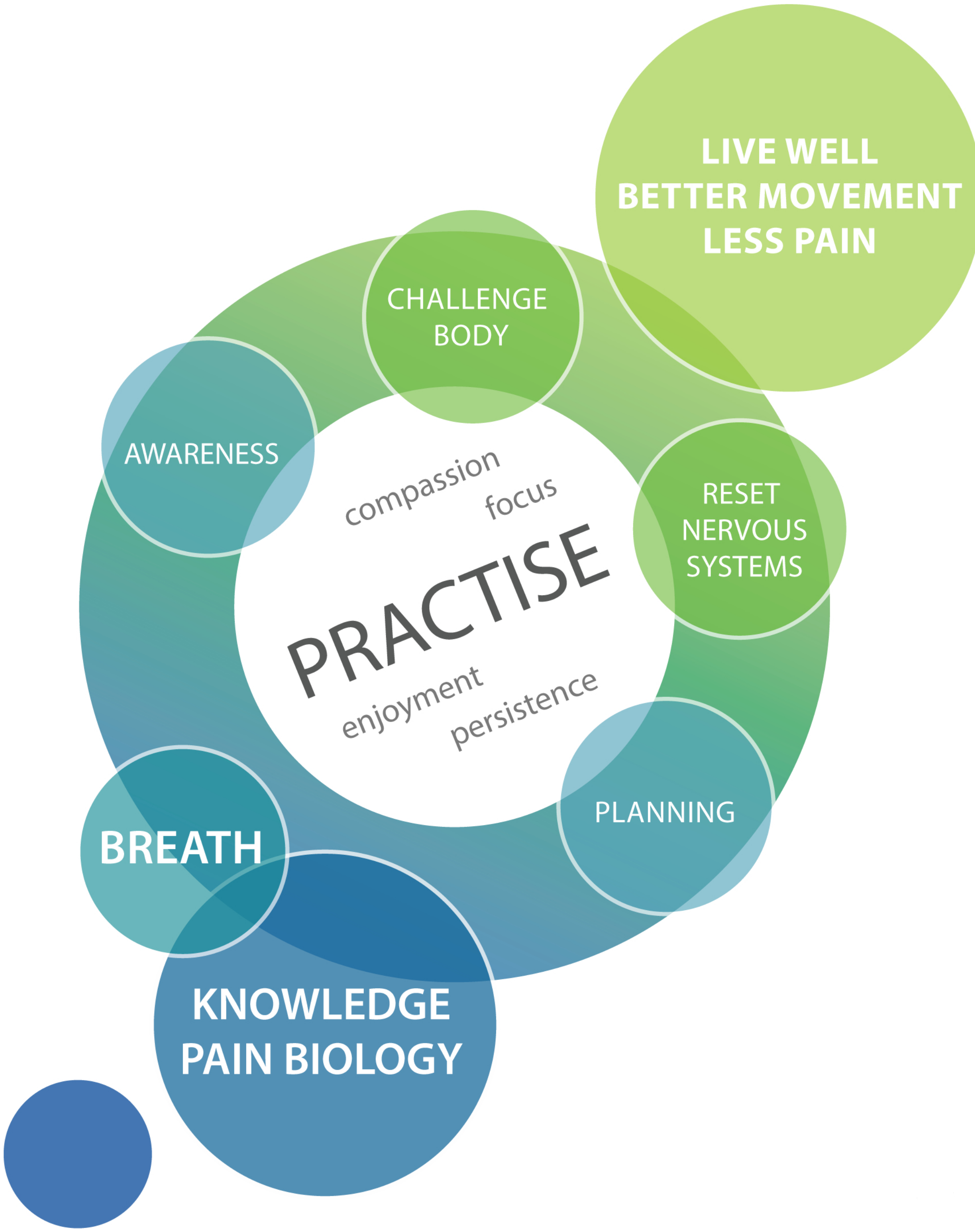


Figure 10.4: An Optimistic Scientific Model of Recovery
This model will help guide you and your health care professionals with recovery activities, allowing you to have less pain, move well and enjoy life again.

Clinician's Questions for Client Sections 1 to 10

The following are sample questions to ask your client after they have read the appropriate section. Feel free to come up with your own questions. These are really just to get you started.

Asking questions is extremely important.

- You need to know if the client understood the information AND you need to know if they found it relevant to their situation.
- Your discussion with your client will help to reinforce and consolidate their learning.
- Listening to the answers, and the person's subsequent questions, is as important as asking the questions. This will assist you in how to guide the person in recovery techniques.

It is common for people to express that they do not know what all this has to do with them, until they have progressed further through the sections. No matter how difficult it is, patience is important.

Section 1

- What is the purpose of pain?
- When your body detects a threat, how might it respond?
- If an injury is really threatening to a person, how do you think this will affect the pain?

Section 2

- What is the function of the spinal cord?
- What does the brain do when it receives signals from the body?
- What is the function of your automatic nervous system?
- Name a few normally automatic things occurring in your body that you can change.

Section 3

- What needs to happen for a neuron to send a signal?
- When a signal gets to the end of a neuron, what happens?
- What could change how sensitive a neuron is?
- What message does a 'pain neuron' send to the brain?
- What would happen when a 'pain neuron' is stimulated by both pressure and temperature?
- What chemicals do these neurons pay the most attention to?
- Why do these neurons detect temperature extremes, intense pressure and chemical irritation?

Section 4

- When danger signals get to the spinal cord, what are three things that can happen to the signal?
- How does rubbing a painful area change the amount of pain you experience?
- How does the brain change the signals passing up the spinal cord?

Section 5

- How many parts of the brain get excited when you feel pain?
- What do you notice happening in your body when you experience pain?
- How do the other protective changes in your body impact your pain experience?

Section 6

- Give an example of intense pain from a small injury or no tissue damage.
- Give an example of when a person could injure their tissues a lot but not have much pain, excluding drugs and shock.
- How is pain like vision?
- How is pain like thirst?
- How is pain different than touch?

Section 7

- Why do nerves become more sensitive?
- What are some of the changes that occur in neurons in your body when pain persists?
- What is a pain tune and what can make it play?
- Describe two changes in the brain that might have occurred because of your pain.

Section 8

- What parts of your nervous system can you change?
- Name two techniques that you can practice to make changes in your nervous system.
- What are three things that increase your pain AND you know are not really dangerous for you? What do you plan to do about this?
- How fast does the nervous system change?

Section 9

- What are things that trigger your pain the most?
- Can you think of ways to avoid triggering the pain tune?
- What techniques from Section 8 would help you to prevent the triggers or control the pain once it is triggered?
- What turns off your pain tune?
- When you notice your pain being triggered, what do you do?

Section 10

- How do you know when you are exercising at the right intensity?
- Why should you not 'grit your teeth and push through the pain', or ignore it all together?
- Why is it important to challenge the alarms when you exercise?

List of Diagrams and Illustrations

References, Books and Websites

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International Association for the Study of Pain **www.iasp-pain.org**
Health care practitioners will find excellent resources and conferences here, including the Core Curriculum which is accessible via their website. The Pain and Movement SIG is of interest.

Canadian Pain Society **www.canadianpainsociety.ca**

Canadian Physiotherapy Pain Sciences Group **www.cppsg.squarespace.com**
Bi-monthly newsletters disseminating current scientific and clinical findings about pain science and pain management. Primarily targeting information for physical therapists, though of interest to other health care providers and people with pain.

Canadian Pain Coalition **www.cpc.com**
A partnership of patient pain groups, health professionals who care for people in pain and scientists studying better ways of treating pain. Purpose is to promote sustained improvement in the treatment of all types of pain through: developing educational programs for the public, informing government about the needs of the pain community and increasing media coverage of pain.

About the Author

Neil Pearson, MSc, BScPT, BA-BPHE, Cert MDT, CYT

Neil graduated from Queen's University, in Kingston, Canada in 1985 from the physical therapy program and also, in the same year, from the physical and health education program. He completed a Masters in Rehabilitation Sciences degree in 1993 at Queen's. In 1997 he moved to Vancouver, British Columbia and he has been a Clinical Faculty member at UBC ever since.

From 2000 to 2007, Neil worked as a physical therapist at OrionHealth Vancouver Pain Clinic. There he developed the role of pain education expert. His success with clients led him to begin teaching pain sciences and pain management courses to health care professionals and the public. Neil currently resides in Penticton, where he works as a physical therapist and a yoga therapist, primarily working with people with persistent pain. Since moving from Vancouver in 2007, he continues working with OrionHealth Pain Clinics in western Canada as a consultant and in continuing education.

Neil is passionate about sharing pain sciences and pain management information. He provides workshops to health care providers, insurance agencies and yoga therapists in Canada and the USA.

Neil is currently a lead investigator for research into the effectiveness of large-group pain neurophysiology and pain management education. He hopes to find ways to enhance his public seminars, titled "Overcome Pain, Live Well Again", making them more effective for changing attitudes to recovery and pain, decreasing fear of pain and improving self-efficacy.

Neil is extremely proud to be a co-founder and co-chair of the Canadian Physiotherapy Pain Sciences Group. Through this non-profit group he is attaining his goals of disseminating pain science knowledge and of promoting an optimistic scientific model of pain management.

About the Illustrator

Jan Little is a graduate of Emily Carr Institute of Art & Design and lives and works in the Okanagan Valley. When not at the drawing board, she can be found immersed in a novel or exploring the local hillsides for neat lichens and barred owls.

About the Graphic Designer

After practising as a physiotherapist for seven years, **Kirsten McFarlane** took the plunge to follow her passion and go back to school. Since graduating from Emily Carr Institute of Art & Design and BCIT, she founded **nimble creative**, a boutique graphic design firm. Her specialty is working with health care providers, helping them build strong brand identities and to effectively communicate with their clients. To learn more, please visit www.nimblecreative.com.