chapter 3

# How Pain Develops: The Role of the Brain

Human beings owe a surprisingly large proportion of their cognitive and behavioral capacities to the existence of an "automatic self" of which they have no conscious knowledge and over which they have little voluntary control. — Jonathan Miller

**Why do so many people** have pain and other symptoms caused by Mind Body Syndrome? How do the brain and the body learn the vicious cycle of pain? The key to understanding the answers is to recognize how the brain works and how stress and emotions play a vital role in the initiation and perpetuation of pain.

We live in a stressful world to which we have not fully adapted. Our brains are wired to react to the very different, ancient world of our ancestors. They experienced acute stress—for example, dangerous animals—on an occasional basis. In those situations, the brain activates the powerful fight-or-flight reaction to deal with the acute stress, the body becomes tense, and after that stress is over (assuming the individual survives unharmed), the body relaxes. The brain is well programmed to deal with that kind of acute stress. However, the brain often has trouble dealing with the chronic stress of modern life. That's why, when stress becomes chronic and we feel trapped in situations for which there is no easy way out, we can easily develop a set of neural circuits that are painful.

You already know that stress causes physical reactions. Your face will turn red if you are embarrassed. That's because your emotions cause the autonomic nervous system to increase blood flow to the face. This is a very real bodily response to an emotion. If you have a stressful day at work or at school, you might get a headache; this is also real pain caused by emotions. If you have to give a speech in front of hundreds of people, your stomach may tighten up from nervousness. These are

normal everyday reactions caused by the connections between the brain and the body. Everyone accepts that these are physical reactions to stressful events, that they are not signs of disease, and that the symptoms will disappear when the stress that triggers them subsides.

This is exactly the mechanism of Mind Body Syndrome: Stress triggers emotions that cause our bodies to react by producing physical symptoms. The symptoms are real. Your face really does turn red when you blush from embarrassment. Your head or your stomach really does hurt if you've had a difficult day or face a daunting challenge. The symptoms, including the pain, are not imaginary. They are physical processes. They are real. But they are physiological processes that can be reversed. They are temporary.

If you have these symptoms, you're not crazy. You're normal. Almost everyone has some physical symptoms due to the body's reaction to stress. I have asked hundreds of people during my lectures if they know where they "hold" stress in their bodies, and almost everyone has an answer. It is common knowledge that stress can cause physical reactions.

What is not common knowledge is that stress and emotions can create the neural circuits that can cause chronic and often severe physical symptoms. What is also not commonly known is that it is the brain that actually creates all pain, as we shall see. The cure for such chronic pain or other symptoms is not a drug or a remedy designed to lessen or cover up these symptoms. If you do not find and treat the underlying cause of the pain, you will not get better. For most people, the underlying cause is that neural circuits have been activated that actually create physical pain. There are several methods of training the brain out of that pain that are contained in this book.

## The Emotional Brain

The way our brains work explains how the stresses of life can turn into bodily pain. Though our brains are very complicated and everyone reacts differently to stresses, we share many things in common. We all need to be loved, nurtured, and protected. We all need to grow, develop, and become independent. We all have thoughts and emotions and memories.

Our emotional memories are imprinted in our brains and stored in what are called associative networks (LeDoux, 1996). They are imprinted in a network of the brain that registers and stores emotions, which includes several structures such as the amygdala, hippocampus, insula, anterior cingulate cortex and prefrontal cortex. These areas are closely connected to the hypothalamus, the

center for the autonomic nervous system (ANS) (van der Kolk, 1994; Okifuji and Turk, 2002). The ANS controls our breathing, heart rate, blood pressure, temperature, and many other automatic and involuntary functions—the things our body does without our conscious mind being aware of them.

During times of stress, the emotion-based network sends signals to activate the ANS and produce the hormones cortisol and adrenaline, which turn on the "fight or flight" reaction. That's a system that directs blood flow to muscles to get our body ready to run or do battle, and it causes our bodies to react instantly before we are aware of what is going on. Human beings have this system to protect us from danger and improve our chances for survival.

If we see something squiggly moving across the ground, our brain activates the autonomic nervous system and causes us to immediately jump back to protect ourselves. We do not stop and reach out to see what the squiggly thing is. That conscious action could get us killed. Our protective system kicks in before we have the chance to think. In fact, research shows that when emotions arise quickly, the blood flow in the brain shifts away from the frontal lobes, the conscious thinking part of the brain, to the limbic system, which is the emotional, reacting, and subconscious part of the brain, which includes the amygdala and the autonomic nervous system (Takamatsu, et. al., 2003).

# The Role of the Autonomic Nervous System

The autonomic nervous system controls the nerve fibers that affect every area of your body. Studies have shown that emotions such as anxiety or anger cause increased tension in the back muscles of people with chronic back pain (Burns, et. al., 2006; Quartana and Burns, 2007). This muscle tension, which typically takes place without our conscious awareness, can cause real and severe physical pain. Often we are not even aware of the emotions that are triggering these automatic physical responses, which is why they are referred to as subconscious or unconscious emotions.

There is a large variety of processes that can occur with ANS activation. Not only are muscles and blood flow involved, but the nervous system, the heart, the gastrointestinal (GI) system, and the genitourinary (GU) systems can all be altered. And the ANS can produce very specific changes, depending on the specific situation, that will vary from person to person and from moment to moment (Levenson, 1992; Burns, et. al., 2008). A careful understanding of the reactions of animals to stressful situations reveals that they may fight or flee, but they may also freeze (as a rabbit will do) or submit (play dead) (LeDoux, 1996). The ANS can produce a much greater variety of symptoms in response

to stress and emotional reactions in humans. Activation of the muscles can produce pain in almost any part of the body. Nervous system activation can produce tingling, numbness, or burning sensations as well as dizziness, tinnitus, and anxiety. Activation of the GI system can cause abdominal pain or bloating, heartburn, nausea and vomiting, diarrhea or constipation. When the GU system is activated, one can experience pain, itching, burning, and urinary frequency. Cardiovascular (CV) activation can produce palpitations and a rapid heart rate. Alterations in blood flow can produce migraine headaches. And the freeze and submission responses typically cause fatigue and/or depression. It is important to realize that the ANS is not acting on its own. It is controlled by the brain and the danger/alarm mechanism that can turn on or turn off these autonomic physical responses.

Pain caused by ANS activation can occur suddenly with an acute spasm of muscles, or it can develop gradually over time. It can occur in the back, neck, head, abdomen, pelvis, or almost anywhere in the body. This pain can be constant or occasional, it can be mild or severe, and it can feel like an ache, a numbness, or a shooting pain. For people who suffer in these various ways in various places because of Mind Body Syndrome, there is no tissue breakdown or physical disease in the body. Yet, the pain is real. As we shall see, the pain is caused by an activation of a neural circuit..

# Pain in the Brain

The brain has complex mechanisms to handle pain that involves many structures. The neuroscientists commonly refer to this network as a "salience network," meaning that the brain decides what is most salient (or more important) for it to attend to (Barrett and Simmons, 2015). If you are running from a lion and twist your ankle, your brain will likely not activate pain so that you have the best chance of escaping. However, if one of our ancestors was running after a deer and broke his ankle, the brain would want to create severe pain so that he would immediately stop and rest the foot in order to heal. If pain did not occur in that situation, he would continue running and could completely destroy the ankle leading to long-term disability. Our subconscious brains decide when to turn on pain and when to turn it off, by activating this salience network that we commonly call the danger/alarm mechanism.

The subconscious controls not only responses to our environment but also what we perceive. Eyewitness accounts are dramatically altered by the values and experiences of the viewer (Arkowitz and Lilienfeld, 2010; Drew, et. al., 2013; Lum, et. al., 2005). We can see only what our brains expect

us to see. This is known as predictive processing: what we perceive is predicted from past experiences. For visual, auditory and taste perceptions, this is termed exteroception. Over time, we learn to like and dislike certain music and foods. A similar process, interoception, occurs for internal sensations (Barrett and Simmons, 2015): The brain creates the sensations it expects us to feel. When the brain is in an ongoing state of warning or danger, it will continue to produce pain with movement, fatigue with activity, disordered thought processes, and many other sensations designed to enforce rest and inactivity. And the more the accompanying neural circuits are activated, they more they become normalized as default circuits.

I have learned that it's very important to truly understand how the brain creates all of our internal experiences in order to understand pain and other symptoms. Let's review that in detail here.

The term neuroscientists are now using to describe how the brain works is predictive coding or predictive processing. This means that our brain doesn't just react to our environment, but that the brain actively helps us navigate the world by trying to predict what will happen next so that we are prepared for it. It's like a soccer goalie trying to figure out how the opposing player will kick a penalty kick. The goalie has to guess which way the ball will go. Sometimes, they get it right and can make the save, but sometimes they get it wrong, and the ball sails into the net.

How do we see?

Actually, we do not see with our eyes, we see with our brains. Light comes into our eyes, but the actual images that we see are made (or constructed) in a part of the brain called the visual cortex (towards the back of the brain). Most of the nerve fibers that go to our visual cortex do not come from our eyes, but come from within the brain itself. These fibers transmit information from our memories of what people, cars, trees and birds look like.

If I had you wear prism glasses that turned all images upside down, you would see everything upside down. But not for long! In a few hours or a day or two, your brain would convert those images right side up again, even though the light waves are still upside down. If you look straight ahead and close one eye and then the other eye, you will see the same image in front of you. That's because your brain is using both eyes to see at the same time. But if you keep your head straight and look all the way to your right side, you will be looking out of the "corner of your eye." Then close your left eye; you will still see the same image to your right side. But if you close your right eye, you will see an image in front of you, not to the side. This means that your brain has automatically turned off the images coming into your visual cortex from your left eye. It is only using the images from your right eye. Smart brain!

It is always working to help you navigate the world.

Look at this image. What do you see?

Do you see one or two women? They are looking in different directions and one is younger and the other more "mature." Vision is constructed in the brain and your brain will be able to see both of these images once you have looked at this long enough. After a bit, it will be easy to see each of the images as your brain has made the neural connections or circuits for seeing those images. And you will probably be able to switch from one image (one neural circuit) to the other image (a different neural circuit) by choosing which image to pay attention to. This is an example of how our brains work, by activating different neural circuits and then paying more attention to one of them than to another.

Police officers have very difficult jobs at times. They are called to uncertain and potentially dangerous situations, and their brain is continually asking this question: "Do I see a gun or not?" And it's stressful, and there is very little time for actual consideration. So, what happens? Sometimes, the officer is accurate about whether the people they meet have a gun or not; and sometimes, their brain will actually see a gun that is not there, or vice versa.

How do we hear? With our ears? Well, not actually. A couple of years ago, a young woman got up to give a presentation at our hospital and she said: "Good morning, America." That seemed odd, but that's what I heard. In reality, she said "Good morning, I'm Erica." But I didn't know her name and my brain was just trying to make sense of the sounds, so it came up with something that was familiar to me from US television.

Have you ever heard someone call your name, yet find out that no one had? This is common and has happened to me.

Our brain is constantly working to predict what we will need and then to create that

experience. The simple act of standing up is actually very complex: your heart rate will increase a bit, the blood vessels going to the brain will dilate to create more blood flow to the brain, many different muscle groups will be activated, the balance center will be put into gear. All of those things happen immediately and effortlessly, all occurring due to actions by the brain. And, most importantly, these actions occur before you actually stand up. Your brain anticipates (predicts) what you will need and creates that experience ahead of time so that it is there, waiting for you to actually stand up. The same kinds of actions occur every time you walk up or down a flight of steps.

If you are thirsty, your brain will start turning off the sensation of thirst before you drink that glass of water. If you have a slight headache due to missing your morning coffee, your brain will turn off the headache as soon as you pick up that warm cup of joe.

Have you ever felt your cell phone vibrating in your pocket when it wasn't? This is also common and has also happened to me.

So, it turns out that all of the sensations that we feel in our bodies are actually created by our brains. There are literally millions of inputs from every spot of our body that are going to the brain each second. Our brain has to decide which ones to ignore and which ones to pay attention to. If our lungs, heart and kidneys are working fine at the moment, no need to pay attention to them and no need for the brain to create a sensation to alert us to some kind of problem there.

A few years ago, my wife woke up early while I was still in bed and got her usual breakfast: sliced apples, yogurt and granola. That day, she had an extra slice and brought it to the bedroom, which was still dark and fed it to me. I didn't see it or touch it before biting on it. As soon as I bit on it, I got a rotten taste in my mouth, as if I was eating a rotten apple. But I wasn't. That day, my wife had a peach, instead of an apple.

My brain was expecting an apple; predicting a certain sensation arriving from the body. When it got the softness of the peach instead of the crunch of an apple, it immediately reacted to protect me, giving me a rotten taste with the message: "Don't eat that, spit it out, it's dangerous/poisonous." My brain ignored the sweet taste of the peach (and I love peaches) and replaced that sweet taste with a rotten one. That is predictive processing in action. All of our sensations are actually created by the brain, whether it's taste, touch, pain, anxiety, what we see and what we hear.

Pain is one of the brain's ways of protecting us. It is a powerful mechanism to give us a strong sign of something being wrong. If you are running across a field and you break an ankle, do you want pain? Of course you do! If you didn't get pain, you would keep running on a broken ankle, which

would even more severely damage that ankle. We know that all pain is basically protective. It protects us from further harm by alerting us to the danger. In fact, children who are born without the ability to feel pain often have severe injuries and may die at a young age.

Amazingly, it is not the broken ankle that causes pain, but rather the brain's danger/alarm signal. It alerts you and forces you to stop running, so that you can rest and heal. The broken ankle will activate nerve signals that go to the brain, but it is the brain that will "decide" whether to actually turn on pain or not!

But what if you were running across a field being chased by a lion and you broke an ankle? Would you want pain then? Probably not, as you would die if you got pain, so in that case, as mentioned, the brain would probably make a decision to not turn on pain so that you could try to escape with your life. Pain is a decision made by the brain on a moment by moment basis.

To repeat, when we cut our finger or touch a hot stove, it is not the finger causing pain. It is the brain. Nerve impulses from the finger are sent to the brain immediately, but it is the brain that turns on pain. Or not. Sometimes, we can get injured and the brain does not turn on pain. There are hundreds of stories about this. In fact, a study of soldiers from World War II found that a majority of those who were injured did not describe any pain once they got into the safety of a medical unit.

A friend of mine was alone at a construction site when he accidentally shot a nail into his hand. Shockingly, he had no pain at all! No pain with a nail sticking into his hand. For some reason, his brain "decided" not to turn on pain at that moment, despite the obvious injury. Why? Well, we don't know since the brain just acts and reacts to situations as best as it can. We can guess that a millisecond decision by his brain factored in two options: 1) Be in severe pain, all alone at a construction site, or 2) Create no pain and let him drive himself to the hospital for help. It chose #2.

It's important to understand that we have absolutely no control (or very little control) over these critical, rapid decisions made by the brain. The brain works primarily on a subconscious basis, i.e., we are unaware of all of these decisions and actions. We just know that they occur, after they occur!

Now you know that not all injuries cause pain. Pain is a decision made by the brain. What about the opposite situation? Can the brain create pain when there is no injury at all? Not only can it do that, but this is an extremely common occurrence, even though few people are aware of it.

To see some amazing demonstrations of neural circuits in the brain, go to unlearnyourpain.com, click on the Media tab at the top of the home page, select videos and watch the Rubber Arm and the Backwards Bicycle videos.

# How the Brain Creates Pain

The fact that pain can be felt in an area that is not diseased has been illustrated in phantom limb syndrome, where an amputee experiences pain that feels like it is coming from the part of the body that's been amputated. Phantom limb syndrome is a perfect example of Mind Body Syndrome—pain is felt in an area that is clearly not diseased. The pain is caused by nerve sensitization and brain reorganization producing pain, which is felt in the missing limb (Flor, et. al., 1995).

Going one step further, a group of researchers tried to determine if the brain could actually create pain (Derbyshire, et. al., 2004). They took a group of people and exposed them to three distinct conditions; thermal pain in one hand, the hypnotic suggestion that they were feeling thermal hand pain, and simply imagining feeling thermal hand pain while not under hypnosis. Their brains were imaged to see if there were differences between these three conditions. The brain images showed that similar areas were activated in the thermal pain and the hypnotic pain situations (including the ACC and a few other areas), while fewer and different brain areas were activated during imagined pain. This was the first evidence that the brain can create pain that is indistinguishable from pain caused by stimulation of nerves in tissues. This research helps confirm that real pain can be caused by either physical disease states or by neuroplastic processes that create learned neural circuits, as with a psychophysiologic disorder. The fact is that all pain is experienced in the brain. We cannot have pain without activation of the pain pathways in the brain. As we shall see, the brain can turn off pain even when the body is injured or has some degree of tissue damage. And, as just mentioned, pain can occur when there is no physical injury or tissue damage. This type of pain is very common. When I was explaining this to one of my patients, she smiled and said, "Oh, I get it. The pain isn't in my head; it's in my brain!" With that understanding, she took a huge step in the process of unlearning her pain.

The brain can cause a wide variety of mild to severe symptoms in virtually any area of the body. Cutting edge neuroscience research has given us a better understanding of how this happens. Timothy Noakes, an exercise physiologist, has studied how an athlete's brain reacts to running a marathon (Noakes, 2003). Dr. Noakes discovered why well-trained athletes "hit the wall" in endurance events: the pain and fatigue is due to their subconscious brain sounding an alarm warning them that they will run out of energy soon. Noakes explains that athletes must ignore these warning signals in order to finish the race, recognizing that there is no actual danger of physical harm. "Hitting the wall" is similar to the light on your car's gas gauge turning on to alert you that your gas is getting low; however, your car can still run fine for a while.

The subconscious brain is the driving force behind psychophysiologic reactions. The subconscious controls our bodily functions to protect us and help us adapt to our environment. Our reactions to our environment depend on both the innate and learned coding of our brain. Over our lifetime, our brains learn to respond to potentially dangerous situations. And, as Hebb famously noted, "when neurons fire together, they become wired together," and those neural pathways become more likely to fire the more they are activated (Hebb, 1949).

When I had low back pain several years ago, my back hurt every time I bent over. However, it turned out that my back was not actually damaged. It was my brain turning on pain because it predicted that I should have pain when I bent over. This new understanding led me to stop worrying about my back and remind myself that I was fine every time I bent over. In a few weeks, my back pain decreased and eventually went away. For more information on predictive coding, interoception, and how the brain constructs what we feel, see *How Emotions are Made* by Lisa Feldman Barrett (2017).

# The Role of Stress in Childhood

It is not only current stress that can trigger painful reactions. Emotional experiences in childhood are imprinted in the brain. Several studies show that animals exposed in infancy to very stressful environments (such as separation from their mother or being exposed to painful stimuli) grow up to have overly active autonomic nervous system responses (McEwen, 1998; Arborelius and Eklund, 2007). Human infants who are exposed to repeated blood drawing within the first few weeks of life have increased pain when they have medical procedures several months later (Taddio, et. al., 2002). Adults who are exposed to traumatic events in childhood such as emotional, physical, or sexual abuse have a much greater chance of developing chronic pain (as well as anxiety and other psychological disturbances) (Anda, et. al., 2006). The emotional imprinting from early experiences is stored in the brain, and when a similar experience occurs later in life, the ANS reaction can start a painful process.

Researchers can measure markers of chronic stress, such as abnormalities in an ANS hormone, cortisol. One study found that adults who have abnormalities in cortisol production are more likely to develop chronic pain than those who do not have these abnormalities (McBeth, et. al., 2007). This further cements the powerful relationship between chronic stress and chronic pain.

# How an Injury Can Start a Cycle of Pain

Sometimes the pain cycle is started by an injury, such as a strain, a sprain, or a fracture. When the injury occurs, the danger signals in the body and brain get fired. Usually these signals will decrease, and the pain will go away when the injury heals. Most acute injuries will heal within a few weeks. That is how long it usually takes for the body to repair any tissue breakdown that has occurred. After that, if the pain does not go away, there is something else going on. Many people are suffering from chronic pain that they believe is caused by an injury that occurred several months or years ago. That doesn't make sense, because fractures of even our biggest bones will heal in several weeks. The injury itself—whether from a sprain or a strain such as a whiplash injury—is not *causing* the pain. But an injury can trigger a series of events that lead to chronic pain. This point is quite often misunderstood, since many people have been told by doctors, physical therapists, or chiropractors that their injury never healed or set off misalignments that continue to cause pain. While I must avoid judging every single situation, I can say that in general, this concept is not supported by the research. Injuries to our body do heal. Even if there is scar tissue present, scar tissue doesn't cause pain. People with retained bullets or shrapnel or those who must walk with a limp due to an injury don't necessarily have pain.

Physical injuries are more likely to create chronic pain if there are stressful life circumstances occurring around the same time as the injury. If so, the pain signals set in motion by the injury can become learned, and a vicious cycle of pain may develop. The brain is always learning from the experiences that we have. When pain is triggered by a physical injury, the brain will need to "decide" whether to turn that pain off or continue to create it. That decision by the brain is made moment by moment depending on the inputs the brain is given. These inputs come from our past experiences as we have seen, our thoughts and emotions, and our reactions to the pain itself. As we shall see, the way that we react to the pain is a powerful determinant of whether the pain will resolve or become chronic. While we can't change our pasts, we can change how we respond to the pain itself and this is one way that we can train the brain to de-activate the neural circuits of pain.

# Thoughts and Pain

A great deal of research has demonstrated how the brain actually controls pain. All pain has sensory, cognitive, and affective components (Wager, et. al., 2004). The **sensory** component includes descriptions of how pain is felt, such as aching, burning, sharpness, or numbing. The **cognitive**

component is what you think about the pain: what the cause is, whether you believe it is temporary or permanent, controllable or curable. The **affective** component consists of your feelings and emotions about the pain, such as fear, worry, anger, and resentment. There are distinct areas of the nervous system that process these three components of pain (Melzack and Casey, 1968; Ploner et. al., 1999; Vogt and Sikes, 2000; Ochsner et. al., 2008). In order to eliminate chronic pain, all of the components need to be addressed. The ways in which people think about their pain and the feelings that are connected to it have great impact on the severity of the pain.

M.D. Lieberman and colleagues (2004) conducted a study in which people with irritable bowel syndrome were treated with a placebo pill. In those who responded with fewer symptoms (less pain, diarrhea, or constipation), they found that certain areas of the brain were activated while other areas were de-activated. In those whose symptoms did not decrease, they found opposite effects in the brain. This study demonstrates that what we think about our condition—the cognitive components of our pain—affects how our brain controls pain and other Mind Body Syndrome symptoms.

In a study published in the *Journal of the American Medical Association* (Waber, et. al., 2008), a group of researchers tested the pain responses of volunteers to a bracelet that gave gradated levels of electric shocks. All participants were first given a pill that they were told was a new medication similar to codeine, but faster acting. Half of the subjects were told that it cost about $2.50 per pill, while the others were told that each pill cost ten cents. Though all the pills were placebos, those who received the more "expensive" pills felt significantly less pain from the bracelet shocks than did those who were given the supposedly cheaper pills.

In a research study of people with chronic hand pain due to an ANS dysfunction condition known as complex regional pain syndrome (or reflex sympathetic dystrophy), subjects were shown pictures of hands in different positions. They were asked to imagine moving their hand into those positions. Results showed that they had increased pain and swelling of their hands just from imagining moving them (Moseley, et. al., 2008).

These studies demonstrate that what we think about pain can have a great impact on how we actually feel pain. Many studies also show how emotions affect how we experience pain.

# Emotions and Pain

Several studies demonstrate the connection between emotions and pain. Mark Lumley and colleagues have published an excellent review of this topic (Lumley, et. al., 2011). There is a large overlap between Mind Body Syndrome and different types of anxiety disorders. More than a third of

people with fibromyalgia or irritable bowel syndrome have high rates of post-traumatic stress disorder (PTSD) (Amir, et. al., 1997; Sherman, et. al., 2000). One study of a group of military veterans with PTSD showed 80 percent of them had chronic pain (Beckham, 1997). In a study of people with obsessive-compulsive disorder (OCD), situations that triggered their OCD symptoms were associated with an activated ACC in the brain (Fitzgerald, et. al., 2005).

John Burns (2008) studied pain thresholds in people with chronic low back pain. He found that when they recalled a time that had made them angry, they had increased activation of the lower back muscles and experienced more pain. They did not show increases in heart rate or blood pressure and did not have activation of muscle groups unrelated to the areas of pain, which shows that their bodies reacted to anger in a very specific area. In another study, volunteers were put in a situation that created either anxiety or anger and then instructed to either express their feelings normally, try to inhibit their feelings, or try not to show any feelings. After this they placed one hand in ice water. Those who were instructed not to feel or show anxiety or anger had less tolerance for the pain (Quartana and Burns, 2007). Finally, patients with low back pain were instructed to either suppress or not suppress anger during a stressful laboratory experiment. Those instructed to suppress their emotions reported more pain, both during and after the experiment (Burns, et. al., 2008). Together these studies show that both anxiety and anger can cause a lower pain threshold and can increase muscle tension. Suppression of emotions leads to even higher pain levels.

Brain imaging studies have also revealed the strong relationship between emotions and pain. For example, Eisenberger and her colleagues (2003 and 2006) have shown that when people are put in a laboratory situation where they are excluded or rejected by others, the brain's danger/alarm mechanism is activated and pain sensitivity is increased. The brain's danger signals are also activated by fear and worry (Fitzgerald, et. al., 2005; Das, et. al., 2005). Ethan Kross and colleagues performed separate brain scans in young adults who were given a mild physical pain and also shown a picture of an ex-lover who had broken up with them within the past six months (Kross, et. al., 2011). Not surprisingly, the same areas of the brain were activated by a physical injury and an emotional injury. Both physical pain and emotional pain are handled the same way in the brain and can cause real pain.

When pain develops, if we are unsure why it's there and our doctors are unable to explain it or make it go away, most people begin to worry about the pain and to fear that it will become a constant problem. These emotions then trigger pain circuits in the brain to become more pronounced, which, of course, tends to exacerbate the pain (Bailey, et. al., 2009; Asmundson and Katz, 2009). A

vicious cycle of pain, fear of pain, decreased activity, and worry often ensues. When this happens, chronic pain becomes a way of life, and there is no way out of it until the thoughts and feelings which are driving the pain are addressed. As we shall see, this vicious cycle of pain leading to fear that leads to increases in pain is often the most important mechanism of the persistence of pain. The program in this book will teach you how to reverse this cycle in the brain to eliminate your pain or other MBS symptoms. For an excellent description of this phenomenon as seen in chronic back pain, see *Back Sense* (Siegel, et. al., 2001).

A unique study was conducted with a group of healthy volunteers and a group of people who had recovered from significant depression (Hooley, et. al., 2005). Both groups had brain MRIs taken while they listened to a tape recording of their own mothers, who had recorded thirty seconds of praise and also thirty seconds of criticism. Both groups had increases in activation of the "safety" mechanisms (an area of the brain known as the dorsolateral prefrontal cortext, DLPFC) when listening to the praise. When the healthy volunteers listened to the criticism, they also had increases in the DLPFC (demonstrating their resiliency to stress), but those with a history of depression had decreases in DLPFC activation, putting them at risk for developing pain. To summarize, when we experience difficult or stressful situations, especially if we have had significant stresses earlier in life and if we are unable to express or show how we feel, we will be at risk for our bodies to experience pain.

# The Triggers of Pain

Once a pain cycle is initiated between the brain and the body, certain "triggers" will usually begin to develop and add to the painful responses. Most people have heard of the experiments of Ivan Pavlov, the Russian scientist, who rang a buzzer when he fed his dogs (Cunningham, 2001). He soon noticed the dogs would salivate when the buzzer rang, even if there was no food in sight. Their brains had learned that a buzzer meant food, so their bodies reacted accordingly. Several years ago, Robert Ader gave some mice cyclophosphamide, a powerful immune-suppressing medication, in a bowl with saccharine, which has a peculiar taste. Predictably, their immune systems became significantly suppressed. A few weeks later, after their immune systems recovered, he gave them a bowl with just saccharine. Their immune systems again became suppressed, demonstrating the power of triggers (Cohen, et. al., 1979). This study has been replicated in people as well (Goebel, et. al., 2002).

It is easy to see how certain triggers can develop in people with Mind Body Syndrome. Once

a painful neural circuit (say, a headache) has started, if it occurs during a stressful situation that also happens to coincide with eating a certain food, or drinking red wine, or seeing a certain kind of light, or meeting a certain person, the brain will learn that association. Then the next time you are exposed to that chemical or situation, the headache can recur. This is the process of conditioning.

Foods are common triggers in abdominal and urinary tract conditions, such as irritable bowel syndrome, heartburn, bloating, as well as irritable bladder syndrome (interstitial cystitis), urinary frequency and pelvic pain. People with these conditions often find that certain foods aggravate their condition and many are told to avoid specific foods. Over time, more and more foods start to become triggers for these symptoms, leading to situations where people can eat only a limited range of foods and fear that they will be exposed to foods that will make them sick. The vast majority of the time, these are simply learned and conditioned responses, rather than actual allergies or direct effects of the foods themselves. The same process occurs to a more significant degree in the condition known as multiple chemical sensitivities. Physical activities can also be triggers. For example, someone with back pain will notice that walking, driving, sitting, or bending over will cause pain, and these actions will be associated with pain and become triggers for the pain. Over time, the pathways connecting these triggers to the pain will become stronger, and the pain cycle will become very well learned by the brain and the body.

Fortunately, these triggers can be overcome or, in psychological terms, extinguished, by unlearning this connection. The program in this book will teach you how to break these triggers that perpetuate pain and other Mind Body Syndrome symptoms.

# Priming of Pain

Another important concept to understand is that of "priming." When we learn how to ride a bicycle or throw a ball, those neural circuits become engrained. Even if we haven't been on a bike or thrown a ball in several years, when we need to, those circuits will be activated, and we will perform that skill. Nerve impulses that are caused by a physical injury, such as a car accident or a fall, create a painful neural circuit between the brain and the body, which will typically diminish over a few days or weeks as the damaged body tissues heal. However, these neural circuits can lie dormant, and at some time in the future, if situations occur that create significant stress and emotional reactions, these pain pathways can re-emerge to create the same type of pain.

I evaluated a young woman with severe back pain. As a teenager, she had sustained a mild

back injury from a fall during an athletic competition. Her injury healed, and she was fine for several years. However, when her fiancé broke off their engagement just prior to the wedding date, she developed back pain in the same area, although no new injury occurred. Her brain was primed to have back pain in that specific area, and it created pain in a place that was convenient since it had already been learned.

Dr. Lorimer Moseley is a leading pain researcher whose work is dedicated to understanding and explaining pain (see Butler and Moseley, *Explain Pain*, 2003 and Moseley, *Painful Yarns,* 2007). In *Painful Yarns*, he tells a story from his own life that helps us understand important mechanisms of pain. As a young boy, Lorimer took hikes in the country and frequently came home with lots of nicks and scrapes on his legs. Although his mother was often alarmed, they never bothered him or hurt him. While on a hike at age twenty-five, he got nicked on the leg and kept walking not thinking anything of it. When he got home, he saw the fang marks of the very poisonous Eastern Brown snake and found his left leg to be very swollen and painful. He spent several days in the hospital recovering from the bite and the left leg pain subsided. Five years later, he was walking in a park and noted a nick on his leg. He immediately fell to the ground experiencing a great deal of pain that was all the way up and down his left leg. He was rushed to the hospital only to find that he simply had a scrape, not a snake bite. Why all the pain? When he was a boy, his brain disregarded the mild pain from nicks and scrapes because they were interpreted as "not dangerous" and simply part of the enjoyment of walking in the country. However, after the life-threatening situation with the snakebite, his brain now interpreted a small scrape as "very dangerous" and activated the same pain pathways that were learned five years earlier.

What is amazing is that the pain after a small scrape on Lorimer's leg lasted for two weeks. He's a pain researcher; he understands pain; he knew that nerve pathways rather than tissue damage caused his whole leg to feel real pain; yet the pain persisted for two weeks! The nerve patterns were activated and took a while to calm down and reverse, which they eventually did. But what might have happened if he didn't understand pain, and after one week he went to his doctor and asked, 'Why am I still having so much pain from a small scrape? The doctor might say, "Oh, I'm afraid that you might have "post-snake bite venom" syndrome. It's a chronic disorder. We don't know what causes it and we have no effective treatment for it." This is exactly the situation that occurs to people with fibromyalgia, whiplash, and chronic fatigue syndrome. The labeling of these disorders as being chronic and incurable leads to more fear, more resentment, and more pain. Another factor can greatly activate pain pathways. What if, during those two weeks after the scrape, something was happening in Lorimer's life: maybe his son got arrested, his mother passed away, or his wife had an affair. Emotions associated with those events trigger

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the same brain pathways that activate pain thus turning what would have been a self-limited disorder into a chronic one with little hope of cure.

It is very easy to think of pain as an enemy. It can hurt so much that it may be impossible to imagine how the mind could be powerful enough to produce it, or why the mind would do that to its own body! Pain can feel like our mind is betraying us for no good reason. But consider how the brain responds to inputs. When you touch a hot stove, the signals from the fingers go up to the brain and the brain sends a "danger" message. The brain determines how much pain is produced in response to how much danger it perceives. The more perceived danger, the more pain. Larger injuries and those that are in sensitive areas (such as the fingers, face, eyes and head) tend to produce more pain. Even in the case of physical injury, the brain determines how much pain will be manufactured, or even if pain will occur at all!

Pain is a protective mechanism. We need pain! In fact, children who are born without the ability to feel pain due to a genetic disorder often have severe problems as they frequently get injuries without knowing it.

A friend of mine told me about a man he saw diving in the ocean for conch shells. When he emerged with the conch shell, he showed it to his wife on the beach and was beaming. He had no pain until he noticed that his legs were bleeding due to cuts from the coral reef. A construction worker in Britain jumped off scaffolding and landed on a large exposed nail, which pierced his work boot. He immediately began screaming in pain and was rushed to the hospital. Pain and sedation medications given through an IV were necessary to try to lessen his pain. When doctors removed the boot, they found that the nail was lodged between two toes and had not injured him at all (Fisher, et. al., 1995). In both of these cases, the brain controlled if and how much pain occurred, while the amount of physical injury was a secondary factor.

Our brains were designed to alert us to danger. When the pain circuits in the brain are activated, we feel pain; when we have a sudden scare, we feel afraid. In both situations, our brain is trying to alert us to physical or emotional danger to protect us from threats to our health and well being. It is telling us to get help, pay attention, or wake up. In the case of mind body pain, anxiety, or depression, your brain is letting you know you are in some kind of danger, and so it activates very powerful neural circuits. It is not really known why the brain would create physical pain due to stressful life situations. As I have mentioned, we know that a physical injury and an emotional injury activate the very same painful neural circuits in the brain, so that the pain due to an emotional injury is exactly the same as the

pain from a physical injury, i.e., real pain! All pain is real and all pain is actually generated by the brain.

Why would the brain create physical pain due to stressful situations? One theory that I find compelling is that the human species survived and thrived due to banding together in clans and groups. Since survival depended on being in the group, getting kicked out of the group or being ostracized could be a kind of a death sentence. Therefore, doing something against the group, such as beating up someone or challenging someone of authority, could result in being shamed or ridiculed or expelled. This process may have linked emotional injuries to severe consequences and therefore the brain adapted to this situation by sending out powerful warning messages of danger. This is a just a theory, of course. We don't really know why physical pain and many other symptoms can occur in the absence of a physical injury, but we do know that it does happen on a regular basis in all of us. Our brain is just trying to help us by alerting us to some kind of danger. It is our task to figure out what the danger is, or if there is really any danger at all!

Another fascinating topic that comes up is why does the brain choose to create pain in a specific area versus another area in the body. The short answer is that we don't know. The subconscious brain has the capacity to produce a wide variety of pain and other symptoms as we have seen. However, there are times when the location of the pain seems to make some sense. Here are some examples of "reasons" why certain pains may occur.

1. **Symbolic** — pain in the neck can mean someone is a pain in your neck; stomach upset can mean there is something in your life that "makes you sick," or foot pain can mean there is something that "you can't stand."
2. **Contagious** — symptoms are often contagious from person to person or on a society level. This is probably what is happening, at least to some degree, with so-called "long COVID" syndrome. There is widespread awareness of this syndrome in society at large and the brain can easily pick up on those symptoms.
3. **Injury** — pain can occur at the spot of an old injury that has already healed as the brain has easily built in neural circuits for that pain.
4. **Familial** — certain symptoms run in families, so the brain might simply choose one of those, such as headaches, back pain, etc.
5. **Mechanical** — the brain may choose an area where the person is using that part of the body quite a bit, such as hands with typing, back with manual labor, or eyes with computer use.

I treated a man who had a recurrence of MBS symptoms of pain and anxiety as he was

buying a new home. I explained to him that his brain was interpreting this act as if he were running into a burning building. Our job is to learn how to recognize these symptoms as primitive warning signals. As with a fire alarm, we are thankful that it alerted us. However, if it's a false alarm and there is no fire, we simply turn the alarm off and reset it. That is exactly what we need to do for Mind Body Syndrome: understand that there is no real physical danger, thank the brain for alerting us, investigate our lives for the source of the message our brain is sending, and turn off the alarm. The program in this book is designed to teach you to do all of that.