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*Train Your Brain to Beat Chronic Pain: How to Harness the Power of the Mind-Body Connection.*
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# 1

# Setting the Stage for Healing

## *Understanding Pain and Your Brain*

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Believe it or not the pain experience is tied to psychological, emotional, behavioral, and social processes that you can control. Studies suggest that patients who seek out the latest information on the neurophysiology of pain and combine that knowledge with intentional lifestyle changes like physical activity see a reduction in their pain. Known in scientific literature as *pain neuroscience education*, it works primarily by making pain less threatening and by helping people understand on a deeper level how drug-free treatments, which are reviewed in this book, can reduce or eliminate pain. This understanding will be a key support for you as you embark on the difficult task of making lifestyle changes that promote pain relief.

## What You Read May Surprise You

What you read in this chapter may surprise you for three interconnected reasons:

**1.** *Scientists' understanding of chronic pain has undergone rapid changes in recent decades.* Why? Technological advances have contributed to new discoveries and a more sophisticated understanding of pain. For example, neuroimaging techniques, which allow scientists to "see" the

brain and how it works, transformed how we understand and study pain. Functional magnetic resonance imaging, just one of many brain imaging techniques, wasn't discovered until the 1990s. It allows scientists to look at how the brain operates while we're feeling, thinking, or doing certain things (like feeling pain). And it allows observation of how the brain changes in response to pain treatments, including treatment strategies covered in this book. In this chapter, I'll explain some key findings from this research tradition that you can use to help yourself feel better.

2. *The modern neuroscientific understanding of pain is only slowly reaching the public*. Some scientists have estimated that it takes nearly two decades for a scientific finding to be "translated," or regularly offered to patients seeking health care. The "bench-to-bedside" process is complex, but the point remains that it can take a while for science to actually show up in your doctor's office. It's been argued, in fact, that many pain clinicians even lack a modern understanding of how chronic pain works.

3. *Worldwide, there is a shortage of qualified pain psychologists and interdisciplinary pain clinics, which are best equipped to help people understand pain and pursue a holistic pain recovery plan*. Relatedly, insurance companies tend to restrict access to treatments that offer the latest on pain education, such as pain psychology interventions. Primary care physicians also face challenges in getting the training they need to best support patients with pain. Globally, medical school coursework on pain is limited, and many graduates report feeling underprepared to help patients recover from chronic pain. This is obviously a major problem, and repeated calls have been made for curriculum reform, but change is slow. Further, in the United States, physicians are often pressed for time by the demands of insurance companies and might not be able to educate their patients about the complexity of chronic pain, if they do have a good understanding of it, in the time they're allowed to spend with each patient (sometimes as little as 15 minutes). As you move through the health system, it can feel like the only solution to chronic pain is a pill, which can be prescribed quickly in a brief appointment.

This chapter puts current facts about chronic pain directly into your hands. Every day scientists are discovering more and more about chronic pain and its treatment. In this book all I can hope to offer is what is

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known at the time of this writing. Stay tuned and check the Resources at the back of the book for sources of up-to-date, accurate information on chronic pain treatment.

## Pain and Your Brain 101

Let's dive into the modern neuroscientific understanding of chronic pain. In short, we've learned that hypersensitivity of the nervous system—including the brain, spinal cord, and peripheral nerves—is a key reason, if not *the* reason, in several pain conditions, that pain becomes chronic. In comparison with acute injury (such as stepping on a shard of glass or spraining your ankle), chronic pain is less about underlying tissue damage and more about a sensitized nervous system that produces pain in the absence of any real danger. This phenomenon is often compared to an alarm system: pain alerts us to threats, *but it can become faulty*, alerting us to things that aren't dangerous at all. It can even start going off on its own accord. It's as if a leaf were to fall on your car and set off the blaring alarm.

If you're one of the many people whose pain arose seemingly out of nowhere, perhaps during a stressful time in your life, or one whose pain following an injury or surgery persisted long after your tissues healed, nervous system hypersensitivity may be the primary driver of your pain symptoms. A relatively new term has been coined to describe such conditions: *nociplastic* pain. According to some estimates, most chronic low back pain conditions are primarily nociplastic, with no identifiable tissue damage or problem in the back itself. Also thought to be nociplastic (or significantly so) is chronic pain that

- Emerges during stressful life experiences or in the absence of injury;
- Moves, changes, and spreads throughout the body;
- Gets worse with stress; and/or
- Involves fatigue and sensitivity to light, sound, and smells.

In the case of chronic pain conditions with a genetic basis (sickle cell anemia) or an autoimmune component (rheumatoid arthritis), nervous

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system hypersensitivity often contributes to pain symptoms and should be targeted in a biopsychosocial pain treatment plan.

Because pain is so attention grabbing, the brain starts to fixate more and more on pain and less and less on pleasurable, safe aspects of our experience, making the pain even worse and all-consuming. Scientists call this phenomenon *reward system dysfunction.* It works like this: we have a limited capacity for attention, so when pain consumes so much of it, the parts of our brain that allow us to pursue and enjoy pleasures, or rewards, start to become faulty and disengaged. If you find that you've lost interest in things you used to love, or that your favorite activities just aren't fun anymore, that's reward system dysfunction at work.

This is a big problem because *rewarding experiences can lower pain*. Positive feelings help your body release pain-relieving and mood-boosting biochemicals, like opioids and serotonin (your body's natural pharmacy)! And when you're feeling curious or interested in something, grateful, content, or confident, it's hard to feel like you're in danger. When you feel safe, your alarm system (your pain alarm) is less likely to go off.

To make matters worse, when you have chronic pain, your brain might not even notice when your pain level goes down a bit. Ordinarily you'd notice at the dentist when the horrible drilling stopped or the painful needle was pulled out of your gums. Without chronic pain in the picture, the reward system registers pain relief as pleasant. But when your reward system glosses over moments of reduced pain, your alarm system stays stuck in high-alert mode. Maybe you can think of a time when you had a lower-than-usual pain day. Instead of feeling relieved or encouraged, maybe you remained stuck in an anxious state, fixated on trying to predict the moment when your pain would ramp up yet again. You weren't able to savor the pain relief or capitalize on it by doing something healthy or fun. *This book will help you rehabilitate your reward system and learn to savor all sorts of rewards again.*

We'll look at this concept in more detail in Chapter 3 but know that positive feelings do more than help pain momentarily. They shift your attention and behavior in ways that help build resilience over the long term. In contrast with negative emotions like anger and sadness, which generally lead to a *narrowing* of attention toward problems and threats, positive feelings *broaden* attention toward a wider range of possibilities. They help you feel more creative and motivated to build what psychology

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researchers call *resilience resources*, like friendships, new knowledge, hobbies, and habits. These resources, once established, continue to provide you with pain-relieving positive feelings and meaningful experiences.

Here's an example: Maybe you can remember a time when you did something that you used to love before pain started to dominate your life, like when a friend invited you for coffee and your initial reaction was *ugh—I'm really not up for that.* But you went anyway, only to discover that while you were laughing with your friend you didn't even notice your aching back. On your way home, you realized you felt a lot better than when you'd left. And, whether you recognized it at the time or not, this experience deepened your friendship. And so, you nurtured a key ingredient in chronic pain recovery: social support.

Let's tie these concepts back to the car alarm analogy. When your car alarm is going off, you're not appreciating the beautiful blue sky or colorful fall foliage around you. You don't want to stop to enjoy it. You're fixated on the painful sound and frantically search for the button on your fob that silences the noise. The alarm consumes your experience. Although this is completely normal and natural, you miss the opportunity to ease the pain because you can't pay attention to how good it feels to be surrounded by beautiful scenery. You don't experience a positive inspiration to build new healthy habits, like going out in nature each day to enjoy the beauty of autumn. This is reward system dysfunction at work.

If you experience positive feelings only rarely, or struggle to feel motivated to do things that *could* be pleasant, you're in good company. We see evidence of reward system dysfunction across the board in chronic pain. It becomes easy to abandon activities that you once enjoyed, thereby losing access to the internal painkillers (opioids) that we all have, which get released when we experience something as enjoyable. Patients tell me, for example, that things they used to love, like spending time with friends, simply aren't that fun anymore. They describe feeling less and less motivated to see those friends (or do other pleasurable things that might bring relief) because they don't feel like anything helps the pain. They're tired, and nothing feels worthwhile.

I've been there. When my pain was at its worst, I was basically surviving the day in graduate school, taking the bare minimum of classes necessary to stay in my program, and then crashing on the couch in

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misery. I hardly ever saw any of my fellow classmates. I think many of them started to think I simply didn't like them, especially since I wasn't that open about my health problems.

Nervous system hypersensitivity and reward system dysfunction happen outside of your conscious awareness. Obviously, you aren't trying to make your pain alarm supersensitive! It's like learning how to do something new, such as play the guitar or learn a new dance. As you practice repeatedly the movements start to become effortless because the pathways in your brain that underlie your new skills have gotten more and more efficient. Soon you can do it without even thinking about it. That's how it is with persistent pain: it starts happening automatically.

And now get *this*: that automatic process can be changed. You can reduce nervous system hypersensitivity and improve the brain's reward system functioning with your conscious mind, including engaging in the evidence-based practices presented in this book. Looking back, I really wish I knew about this information when I was grappling with my own chronic pain problem. So please join me in a brief exploration of the neuroscience of pain. I anticipate that you'll come away feeling that you have more control over your pain than you realize.

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## Pain Is an Alarm System Governed by the Brain

We hate to feel pain, yet it serves a lifesaving purpose. The whole point of pain is to keep us alive by motivating us to escape bodily harm. As I mentioned, pain is like an alarm system—it notifies you that something is amiss and motivates you to act. Tellingly, people with congenital pain insensitivity—a tragic inability to feel pain—rarely survive to adulthood because once they realize they're in danger, it's too late. So it's wonderful to have an alarm system that alerts you to threats. The alarm system doesn't care about your quality of life, however, only your survival. It's better to warn too much than not enough, since ensuring your survival is pain's goal. The brain governs the alarm system: *100 percent of the time pain is produced by the brain.* If your brain thinks that you might be in danger, somewhere, somehow, it will produce pain, even if you're made miserable in the process. Pain doesn't care if you miss your kid's soccer game because of a pounding headache, only that you keep on living.

If this information comes as a surprise, understand that pain, including chronic pain, was historically conceptualized in the Western medical system as caused by underlying tissue damage and solved by curing that damage. This idea is part of the biomedical model of health, which claims that if you have a physical complaint, it must be because something has physically gone awry that demands correction through medicines or procedures. Dr. Emeran Mayer argues in his book *The Mind-Gut Connection* that traditionally, Western medicine has viewed the body as a mechanical device like a car with complex parts. The physician is like an auto mechanic who fixes a single broken piece of that device with surgery or pills. Although this model supports a lucrative health-care industry with expensive pharmaceuticals and procedures, it fails to help our society achieve good health, and it particularly fails people with chronic pain and illness.

The biomedical model is flawed, but it does apply somewhat to acute pain. The pain you feel after spraining your ankle motivates you to rest; after your tissues have healed, the pain vanishes. But the model fails to explain chronic pain; for many people pain persists long after injuries have healed. And even with acute pain it's the brain that makes the final decision on the extent to which you experience pain.

A few striking examples illustrate that it's not tissue damage or dysfunction that produces pain, but rather the brain. The first is phantom limb pain in amputees, where pain is felt in limbs that aren't there at all. Another is an often-cited case described in *The British Medical Journal* involving a construction worker who stepped on a nail that pierced through his boot through to the other side. In excruciating pain he headed for the emergency department of a nearby hospital, where he was given opioids for pain control. His doctors then removed the boot only to see that the nail had passed between his toes, his foot unscathed. This man's brain made a calculation that it was beneficial to his survival to produce pain based on visual input that suggested potential bodily harm. *Obviously no one-to-one relationship between tissue damage and pain exists.*

The lack of direct association between tissue abnormalities and chronic pain has been known for quite a while. For instance, a group of pain researchers in the 1990s scanned the backs of people with and without chronic low back pain with magnetic resonance imaging and found a similar frequency of disc abnormalities in both groups. So often patients

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with chronic low back pain are told that their pain is caused by "slipped discs," "herniated discs," and the like. Yet we all demonstrate degeneration in the spine as we age, and only some of us have chronic low back pain. Similarly, in knee osteoarthritis, the extent of joint degeneration is only moderately associated with how much pain people report, and in up to a third of patients, knee replacement surgery doesn't cure their knee pain. These findings suggest that a key mechanism of chronic pain is a hypersensitive nervous system, with the brain at the helm.

Remarkable cases of people reporting little to no pain despite real danger also show us that the brain produces pain. For example, as reported by anesthesiologist Dr. Henry Beecher, during World War II soldiers undergoing surgery following battle wounds said they had significantly less pain than civilians undergoing the same kinds of procedures. The meaning assigned to the situation might have been paramount in determining the pain experience: the soldiers viewed their injury and associated surgery as a ticket to safety (being shipped home), whereas civilians felt that surgery was an interruption of normal life, rife with uncertainty, potential complications, and a lengthy recovery. Again, the brain's calculus ultimately hinges on whether it thinks life and limb are at stake. Multiple studies now show that our thoughts (such as the meaning we give to our state of health) are one input that the brain uses to make this calculation. We'll talk more about the brain's decision-making process and how we can influence it through our conscious thoughts and behaviors in the next section.

You might wonder, what about the nerves in our arms, legs, and organs? Don't they communicate pain? In fact, we don't have nerves in our body that definitively signal "pain." We have nerves known as *nociceptors* that pain neuroscience educators aptly call "danger receptors" because they notify us that something's weighing on us too heavily, something's too hot, or we're in contact with a dangerous substance, for instance. But impulses traveling from these nerves to the brain are not necessary for us to experience pain, as the construction worker example shows. Nor are they sufficient for pain, as shown by the injured soldiers example. The brain ultimately decides whether pain is appropriate.

You may not feel the need right now to take an even deeper dive into pain neurophysiology, but to get the most out of recent advances in our understanding of chronic pain it's useful to know something about

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the brain's decision-making process. First, how does it decide to trigger the alarm?

### *How the Brain Sets Off the Alarm*

Let's go back to the construction worker who was in agony after stepping on a nail that he thought had gone all the way through his foot. The man's visual experiences and beliefs were key messages that the brain incorporated into its decision to send the danger signal we call pain. But, as this example shows, the brain does not have access to an "objective" picture of reality. Rather, the brain must constantly sort through a staggering amount of ambiguous sensory and perceptual information, coming from inside and outside the body, and make guesses about our state of health and safety based on that information. It also draws heavily on prior experiences about health and safety in its guesswork. For example, adverse childhood experiences like trauma or growing up with affectionless, overprotective parents are associated with a greater risk of developing a chronic pain condition later on in life.

After the brain makes its best guess, it orchestrates pain and related physiological responses (inflammation, stress hormones, and so forth) accordingly in an effort to keep us alive and well. So for the construction worker, all it may have taken for the brain to flip on the pain switch was the shocking visual picture of a big nail sticking up out of his boot—of course it must have gone through his foot, an understandable but inaccurate assumption. On the other hand this worker may also have had a history of stepping on sharp objects lodged firmly in his memory. Or he may have had parents who curtailed his childhood adventures based on exaggerated risks to their son.

The factors that play a role in the brain's decision to create a painful danger warning are complicated. Let's say you're at the beach with friends, enjoying a bonfire and barbecue. Suddenly, you step on a shard of glass. To decide whether producing pain will benefit your survival, the brain will process signals coming from the nerves in your foot along with many other inputs: psychological factors (maybe you're worried about how deeply you've been cut or your risk of infection), social processes (the fact that friends are there to support you), emotions (such as fear), prior learning (such as that sharp glass tends to be dangerous), and

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environmental features (how far are you from the nearest hospital?). If the answer is yes, *whammo*, you experience pain and become motivated to remove the shard of glass, get help from others, and stay off your foot until your tissues have healed.

### *Pain Involves More than Biology*

This is the contemporary, neuroscientific understanding of pain. Rather than a biomedical phenomenon (a direct relationship between tissue damage and pain), it's a biopsychosocial one, with the brain making a final decision on whether pain is appropriate by considering social, psychological, biological, environmental, and emotional information. This biopsychosocial model of pain is the prevailing model guiding chronic pain research at present.

Because Western medicine has been so firmly rooted in the biomedical model, it may seem hard to believe that psychological and social factors can substantially exacerbate pain. It may be even more incredible to think these factors can also *relieve* pain! Yet we've all had experiences that illustrate how powerfully our thoughts, attention, and context impact the level of pain we do (or don't) experience. Think about sports. Say you're playing soccer with friends, and the competition is fierce. You're so focused on winning and enjoying the match that it's only afterward that you notice your calf is bleeding. In the heat of competition, you felt no pain at all!

As you can probably sense already, we can impact the brain's guesswork through our own conscious thoughts and behaviors. It's not as if pain is some objective reality over which we have no control. Our feelings, thoughts, actions, and environments are all different types of inputs to the brain that we can consciously alter for our brain's benefit. In essence there are thoughts, behaviors, and environments that communicate safety and well-being to the brain, which are liable to reduce pain. On the other hand, there are thoughts, behaviors, and environments that communicate threat and danger to our nervous system, which promote pain. Furthermore, we can retrain the brain away from a narrowed, fixated attention to pain and toward a broadened perspective with the ability to notice, savor, and enjoy natural rewards. We can "rehabilitate" our brain's reward system, in turn reducing pain.

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*Neuroplasticity: Getting Good at Sounding the Alarm at the Expense of Joy and Well-Being*

As noted earlier the more the nervous system produces pain, the better it gets at producing it. This capacity is known as *neuroplasticity*, or the brain's ability to change in structure and function. Neuroplasticity can be a great thing. For instance, the more we play a sport, the better we get at it and the more automatic it becomes—we can perform skilled motor movements without even thinking about them. The more people practice meditation the better they get at being in the present, and we see corresponding changes in brain circuits that underlie attention and concentration.

In the case of chronic pain, unfortunately, neuroplasticity is unhelpful. Pain physiologists Lorimer Moseley and David Butler compare the brain to an orchestra that's been practicing a "pain tune" so much that it knows how to play it loud, fast, and constantly and now can't remember how to play anything else. Neuroplasticity can lead to all kinds of hypersensitivity common in chronic pain conditions: feeling more pain in response to things that used to cause less pain; feeling discomfort in response to harmless stimuli, like a tag on your shirt; and feeling pain that spreads beyond the site of the initial injury. The brain gets so good at alerting us to threats that it even becomes concerned about sensations from our own bodies that are completely harmless. Everyone experiences natural fluctuations in bodily sensations: feelings of pressure, warmth, etc. People living with chronic pain are much more likely to interpret these sensations as threatening or painful because their brain is on high alert to identify dangers.

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### *More Pain and Less Pleasure*

Let's come back to the pain tune. Beyond upping your pain, it can disrupt the brain's reward system, making it difficult to look forward to and enjoy pleasurable, rewarding, and meaningful aspects of your life. A critical overture that the brain forgets how to play is the one about joy, pleasure, and meaning. We need that overture not only for happiness but, critically, for pain management. Research resoundingly shows that positive feelings and activities have natural pain-relieving effects. Yet under chronic pain conditions, thanks to neuroplasticity, we can't access them

as easily. The brain has finite attentional resources, and much of them are being sapped by pain—how it feels, what it means, how to fix it. Resources are becoming less available to seek out and notice pleasurable, rewarding experiences, or even neutral, nonthreatening experiences. This is not your fault, of course. Pain is attention grabbing by its nature. And the distressing thoughts (how long will it last?) and feelings (fear, sadness, anger) that surround it start to win out. However, it's possible to retrain the brain to experience more joy and pleasure and seek out environments that promote positive feelings of safety, joy, and well-being.

## Turning Neuroplasticity into an Ally

Importantly, you can retrain the brain while the alarm bell is going off. It's easy to feel like you need to wait for pain to get better to be able to experience joy and pleasure again. Commonly (and understandably), people feel they need pain-relieving medication or intervention (surgery, injection) before feeling safe enough to go out and do things like hiking, walking, having dinner out with friends, or taking an art class. It's easy to postpone your life and let pain take center stage. This way of responding is natural. Remember that acute pain is designed to get us to move out of harm's way and then rest until our damaged tissues have healed. But resting and avoiding activities after pain has become chronic while waiting around for an effective drug or surgery isn't what's needed. Although your pain seems to scream at you to rest, withdraw, become afraid or angry, and shove fun things to the side until the pain sensation itself is lowered, you must consciously override these impulses and find ways to engage in and savor activities that you like and value. This in and of itself *is* a treatment. It will help your brain learn that it doesn't need to continue to keep creating a pain experience as well as release the body's natural painkillers (opioids).

Because of neuroplasticity, you can retrain your brain to notice rewards and pleasures once again. In upcoming chapters you'll learn strategies to get your brain and body out of high-alert mode and into a state of greater balance, ease, happiness, and well-being. Please know that it will likely take time and dedicated practice for your brain to unlearn what it has learned, but you might also notice an immediate benefit from using

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the strategies in this book. And you're not embarking on an exhausting, max-intensity, lifelong mental training program. Retraining your brain and changing behaviors is like weight training or learning to ride a bike: it's hard to build initial muscle mass, but less effort is required to maintain the muscle that you've built. Bike riding takes all your attention at first but then becomes automatic. As you start experiencing pain relief from the strategies you'll learn, you'll likely settle on a combination of practices that work best for you, and that will help maintain the gains you've made.

## The Role of Inflammation

Inflammation, the body's natural response to harmful stimuli, is a vital part of its alarm system. After injury your body releases various chemicals and molecules that fight infection and promote tissue healing. So in acute pain situations inflammation is a good thing because it's needed for tissue repair. When you see redness and swelling after spraining your ankle or having your wisdom teeth pulled, that's inflammation. The swollen area becomes tender to the touch because inflammatory chemicals stimulate danger receptors (nociceptors) both at the site of the injury and near it. Your alarm system *really* wants you to notice the injury as well as protect an area as large as possible from further damage. The brain is very responsive to inflammatory chemicals, and when it detects them, it is quick to construct a pain experience. Scientifically, the causal link between inflammation and pain is robust (they don't simply correlate or happen at the same time). To demonstrate this, scientists have experimented by injecting people with inflammation-inducing bacteria (with their consent of course!) to observe its effects. They found that increased inflammation, heightened bodily pain, and increased negative mood tended to result more than when something benign, like a saline injection, was given.

Unlike acute injury situations, chronically elevated inflammation is not a good thing and contributes directly to ongoing pain. It's another way in which your alarm system can get stuck in crisis mode. Like chronic versus acute pain, chronic inflammation loses its protective function. Rheumatoid arthritis, complex regional pain syndrome, diabetic neuropathic pain, chronic widespread pain, fibromyalgia, chronic

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low back pain, and temporomandibular disorder are just a few examples of chronic pain conditions with elevated systemic inflammation relative to healthy conditions. Interestingly, whole-body, systemic inflammation has been documented in conditions where pain is felt only in one area of the body (like the lower back or jaw). Systemic inflammation also contributes to fatigue and cognitive issues, which often accompany chronic pain, as well as mental health conditions like anxiety and depression that worsen pain.

If you've been living with chronic pain, even if it's isolated, it's very possible that elevated inflammation is playing a role in your symptoms. Again, your body's alarm system, which includes inflammation, is overreacting. It's faulty. But I have some fantastic news: you can lower your level of inflammation, which will in turn lower your pain. Science shows that an anti-inflammatory diet, physical activity, and improved sleep can have especially positive effects on inflammation and therefore pain. We'll dive into that in greater depth in Part Four.

I bet you've heard it a million times before, but I promise you, science has given us new and exciting insights into how and why these lifestyle habits lower pain and that their effects can be extraordinary. I experienced some of the biggest reductions in my pain by strictly following an anti-inflammatory diet for 90 days on the advice of one of my physicians. It was tough, but I was desperate, and in the end the results were phenomenal. To this day I maintain that diet as best I can to help keep migraines, shoulder pain, and neck pain at bay. It's also worth noting that pain self-management strategies (think anything that you can control and don't rely on a doctor for, like meditation, relaxation training, or getting social support) have the potential to reduce inflammation by lessening the fight-or-flight response. Studies have shown that pain management strategies like mindfulness-based practices, stress reduction techniques, and behavioral activation (increasing engagement in valued pursuits) can lower inflammation.

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## Expectations Matter

Because the brain lacks a complete picture of reality, it has to fill in the gaps. Fascinating new research indicates that the brain wants our

experiences to match its predictions. For example, if the brain expects the body to heal (if we enter a healing environment with medical rituals, or we develop a mindset that we are on a path toward healing, for example), it will begin to interpret bodily sensations in accord with that prediction, nudging us toward health. Research illustrates this quite dramatically: chronic pain patients who take placebo (sugar) pills over a period of weeks and are openly told by the research staff that they don't contain active ingredients, report significant improvements in symptoms!

Researchers conducting these trials theorize that subconsciously the brain is getting health and safety signals from the simple act of taking a pill, and it then interprets what's happening in the body in a manner consistent with those signals. Laboratory studies have shown that people perceive more pain in response to a potentially harmful stimulus (like heat) when they are simultaneously exposed to a danger signal (such as a red light) versus a safety signal (like a blue light). Our world has conditioned us to associate the color red with heat and danger and the color blue with coolness and safety. Findings like these illustrate that prior expectations and beliefs are part of the brain's process of guessing how threatened or safe we are. Worldwide, studies confirm that expectations and beliefs shape our pain experience. Conversely, if the brain forms a prediction that we are sick and only getting worse, it will interpret bodily sensations as threatening, making pain more likely.

As we close this chapter, take a moment to consider what conscious expectations you hold about your pain journey. Do you expect, even in a small way, that your pain can be reduced or eliminated? If so, take a moment to notice and appreciate this positive expectation. On the other hand, do you have expectations that you'll never improve? Can you question or challenge these expectations?

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**FOR MORE INFORMATION ON PAIN NEUROSCIENCE EDUCATION**

When you're ready to take a deeper dive into pain neurophysiology, you can seek out the many volumes that have been written for the public explaining how and why the brain makes the final decision on whether we experience pain. Notable among these is pain physiologists Dr.

David Butler and Lorimer Moseley's *Explain Pain* (*www.noigroup.com/product/explain-pain-second-edition*) series. Further, there is a relatively new evidence-based smartphone app called Curable (*www.curablehealth.com*) that can help you deepen your understanding of pain neuroscience and apply it to your own situation. Lin Health (*https://lin.health*) is another online program grounded in modern pain neuroscience. The most exciting thing about pain neuroscience education is that it shows us that we have more control over pain than was once believed.

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