

Chapter 1

Introduction and broad strokes

1.1 Introduction and target audience

The aim of this book is to explore the complexities and wonders of how the human body, including our neuroimmune system, adapts to protect us and how this protection process can potentially lead to the experience of pain, discomfort, and distress.

Pain can be conceptualized as an integral part of a bodily protection response, part of how we look after ourselves. The neuroimmune system, as with much of our body, is an incredible learning system that is quite adaptable. Our survival is dependent upon being able to detect signs of threat or harm to maintain homeostasis and our well-being. Thankfully, our bodies have significant capacity to adapt to the perceived and predicted demands required to maintain or regain homeostasis, a process referred to as allostasis. Like many of our biological tissues and processes, our protection mechanisms demonstrate considerable bioplasticity (i.e., adaptability in response to experience, exposure, learning, etc.) (Moseley & Butler, *The Explain Pain Handbook: Protectometer*, 2017).

When it comes to protection, the neuroimmune system pays close attention and does not miss much. The idea that the body looks after itself and has complex mechanisms to monitor our health and safety is not new. What is explored in this book is the potential to reteach this bioplastic, learning neuroimmune system.

We will explore how we can gain insight, knowledge, and understanding about how this *bodily relearning* occurs, how to reteach the system, and how to regain some sense of control over these protection responses. In addition, we will investigate strategies for using movement exploration and reflection to help reset the protection level, to allow more freedom of movement, and to enable engagement in meaningful aspects of our lives, all while our neuroimmune system continues to look after us (Figure 1.1).

The neuroimmune system needs movement to maintain homeostasis and to facilitate robust health of the system. Neuroimmune system movement is a normal part of our everyday function, in fact, it is needed for healing. After injury, introducing an appropriate amount of movement at the ideal time is an essential component to promote healing and recovery. The interplay between knowledge, movement exploration, and behavioral change is essential to recovery and is, thus, a primary focus of this book.

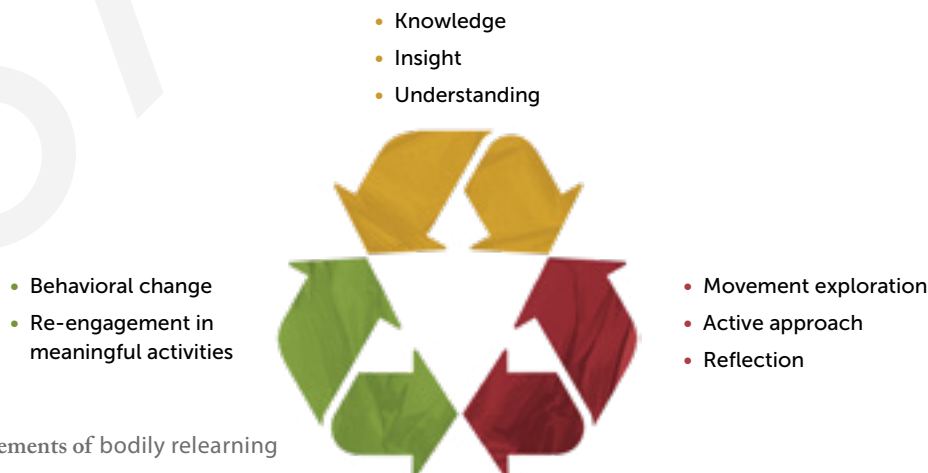


Figure 1.1 Elements of bodily relearning

Who is this book for?

This book may be helpful for any movement specialist within the medical and healthcare communities (such as physiotherapists, occupational therapists, massage therapists, chiropractors, physicians, exercise physiologists) as well as movement-based practitioners (such as Feldenkrais practitioners, yoga instructors, Pilates instructors, mindfulness practitioners, athletic

trainers, coaches, personal trainers) who help people suffering from pain. People in pain who may benefit from the approaches discussed in this book include those with a sensitized neuroimmune system, which can present in many forms. More specifically, people who have conditions within the following general categories may benefit from the concepts covered in this book:




	Description	Example conditions	Category / mechanism
	Injuries or conditions that directly affect and have sensitized the neuroimmune system	<ul style="list-style-type: none"> • Cervical, thoracic or lumbar radicular pain • Thoracic outlet syndrome • Carpal tunnel syndrome • Cubital tunnel syndrome • Radial nerve irritation at the elbow • Tarsal tunnel syndrome • Superficial fibular nerve injury after an ankle sprain • Common fibular nerve injury due to contact sports 	Neuropathic
	Focal conditions of other types of tissue (e.g., bone, joint, muscle, ligament, tendon) that have a component of a sensitized neuroimmune as part of the bodily protection response	<ul style="list-style-type: none"> • Osteoarthritis • Post fracture • Post immobilization • Glenohumeral instability • Post-operative conditions • Lumbar herniated disc without nerve root compression 	Nociceptive with neurogenic response
	Generalized increased sensitivity of the neuroimmune system due to more systemic conditions or widespread bodily protection responses with or without a known trigger or cause	<ul style="list-style-type: none"> • Fibromyalgia • Chemotherapy induced neuropathy • Diabetic neuropathy • Complex region pain syndrome • Post-traumatic stress disorder • Post breast cancer treatment • Chronic fatigue syndrome • Ehlers-Danlos syndrome or other forms of extreme hypermobility conditions • Autoimmune disorders <p>NOTE: many of these conditions can lead to susceptibility of developing the types of conditions noted in category 1 (such as focal neuropathies)</p>	Nociplastic

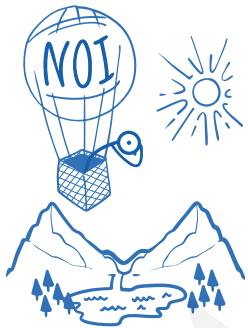
Figure 1.2 Forms of a sensitized neuroimmune system

Throughout this book you will see various “**deeper dives**” down some scientific, philosophical, contextual rabbit holes as well as “**10,000-meter overviews**” where we zoom out to see the bigger picture. These glimpses from various vantage points will parallel the main body of text and are meant to help navigate the content of this book at whatever depth you choose.

10,000 meter overview:

Why Bodily Relearning?
Bodily

The term bodily refers to anything related to or concerning the body. In this book the term body, or bodily, refers to both the physical body including our nonconscious processes but also the parts of us that make up our mind and our conscious processes. Bodily here refers to all of that which make us the person we are, not just in the physical domain, but in the emotional, behavioral, spiritual, psychological, and other domains as well.



Learning

Like the adaptability of our body tissues, our biological and physiological processes are adaptable too. Our processes of ongoing threat assessment and self-monitoring for safety are adaptable. As healthcare providers we seek to facilitate adaptations that improve people’s function and engagement in life... to help their bodies learn to allow for more freedom of movement and activity.

Re

Why Re? Because it’s the hardest part! To change what the body has already “learned” is HARD, particularly when we are talking about learned bodily protection responses. We aim to “re-teach”, “relearn”, “reset”, “retrain” the body’s response to activity. In other words, this book outlines a “re”-habilitation approach aiming to shift from a dysfunctional state to a better state of being, applied to the process of how our bodies look after us.

1.2 Frameworks and definitions

What is meant by the neuroimmune system? There is significant emerging evidence that the immune system and the nervous system work in an intricately coordinated fashion to accomplish many bodily functions.

The term neuroimmune system refers to these two systems working in harmony to accomplish specific bodily functions. The specific focus of this book is on the function of the neuroimmune system to monitor, transmit, process, predict, and respond to information about potential danger or threats (i.e., nociception). There is an important distinction between nociception and a pain experience. Nociception is the monitoring and transmitting of information about (actual or) potential danger or threats (e.g., noxious stimuli) to be processed and scrutinized by other areas of our neuroimmune system. This information is not pain. Rather, this information about noxious stimuli is evaluated in context with other relevant information and may contribute to the experience of pain. This evaluation determines if a pain experience would be a useful response. A key principle in this distinction is that nociception can be present without pain and pain can be present without nociceptive input from the peripheral body. Moreover, the magnitude of tissue damage and the associated danger or threat signals is rarely a one-to-one relationship to the pain experience. A multitude of other factors can dramatically modulate this relationship. We will explore these concepts more in **Chapter 2**.

Additionally, a “pain experience” represents more than just the sensory aspects (i.e., intensity, location, quality) of the experience. Pain experiences also include the meaning we ascribe to the circumstances, our thoughts and feelings and behaviors associated with the experience, as well as the simultaneous

adaptations by other systems in the body in response to the same threats (such as the cardiovascular, motor, neuroendocrine, neuroimmune, and respiratory responses). A pain experience is influenced by and includes many biopsychosocial components. Perhaps “biopsychosocial” is too restrictive? The domains involved may include bio-psycho-social and -cultural-affective-environmental-spiritual-and beyond. A pain experience is an individual, embodied, biopsychosocial, holistic, humanistic, first-person experience occurring within someone who is embedded within the world, at a particular time, place and social context. A fundamental premise of this book is that nociceptive information about danger or threats can be significantly modulated, transformed, and modified and thus, does not always match the pain experience. This makes the pain no less real. In fact, this book will explore the real physiological mechanisms involved.

The neuroimmune system can also become a dominant “driver” of a pain experience. This neuroimmune system activation can occur, for example, when there is direct insult to the neuroimmune system, when a neuroimmune system adaptation occurs locally as a response to insults to other bodily tissues, or when more central, systemic, and widespread adaptations occur within the neuroimmune system even in the absence of a known injury (**Figure 1.2**). These differing circumstances have unique mechanisms (some understood and others still a mystery). However, they share two important features, namely, heightened bodily protection responses and an increase in the level of alert within the systems responsible for looking after us. The body has adapted to protect us, or part of ourselves, more.

We can determine the level of mechanosensitivity (i.e., the sensitivity of the neuroimmune system to physical stressors) by evaluating the degree and type of bodily protection responses when physical stressors are applied to the body. Neurodynamic tests (discussed in detail in **Chapter 7**) aim to evaluate the mechanosensitivity of the peripheral and central neuroimmune system and its contribution to bodily protection responses. These examination techniques can be translated into movement-based activities as part of treatment, often called neurodynamic mobilization or neurodynamic exercises, part of the movement exploration (**Figure 1.1**). Thoughts on the nervous (neuroimmune) system have dramatically evolved over the decades. This book aims to explore

therapeutic narratives, evaluation, and treatment approaches that match our modern understanding of neurodynamics, the neuroimmune system, enactive/embodied philosophy, and *bodily learning* regarding self-protection.

To avoid the potential stigmatization that can come with the label of “chronic pain”, the term persistent pain or pain that persists is preferred and thus intentionally used in this book. In addition, people-first language, such as “a person who is dealing with persistent pain” compared to a chronic pain patient or a fibromyalgia patient is purposeful. Thus, the label is intentionally phrased as a noun (something that someone experiences or deals with) and not an adjective (something that describes or defines them). The language we use should match the respect the person deserves; to be treated as a person first, someone who may have a pain condition but is not defined by their pain. The hope is to avoid implying pain is part of a person’s identity. The desire with these language choices is to minimize the risk that the label, language, or descriptors negatively impact the person. Words matter!

1.2.1 Let’s meet our clients...

To facilitate a deep understanding of the content covered in this book, illustrative case stories are presented at the back of the book. Periodically, you will see these faces in places that link to elements of their stories. This is an effort to explicitly link the concepts in the book sections with these case stories.

Disclaimer: the names and details of the case stories are purely fictional for illustrative purposes. Any similarities to real people, living or deceased, or to actual events are purely coincidental.



Eleanor (pages 298-303) **Mahlik** (pages 304-308) **Thuy** (pages 309-314)



Figure 1.3 Example of factors influencing bodily protection responses

1.2.2 A learning model for bodily protection responses

Our body evaluates information about what is going on within our tissues and internal environment and within the context of what is happening in our external environment (time, place, location, etc.), including our physical and social world (Figure 1.3). This information is processed, or scrutinized, in conjunction with our “internal resources,” such as our memories, thoughts, knowledge, past experiences, and specific motivations and is influenced by our present affect and current biological state. Based upon past learning, our body makes a best guess estimate or prediction as to what is going on and what to do about the situation. We are trying to make sense of ourselves and the world, including our biological viability in that world (i.e., our safety). Our body performs this threat assessment in real time, non-stop.

The scrutinizing process is ongoing, iterative, and cyclical, whereby past experience informs how we deal with current circumstances. Additionally, we learn from the present experience, setting a new foundation for expectation, predictions, and responses in the future. While this process might seem like a complex computational model (inputs → processing → outputs), in the view of this author, choice and free will are an important part of this process. A concept attributed to Viktor Frankl, a psychologist, philosopher, author, and Holocaust survivor, is that “between stimulus and response there is a space... in that space is our power to choose our response.” This latter point is important because having some sense of control, that we are more than the sum of our complex computational processes, that our experience is not pre-destined or pre-determined by the circumstances of the moment, is a much needed and powerful message to those suffering with persistent pain. Our available choice may initially be solely within the conscious realm; however, we can use conscious approaches to help retrain the nonconscious responses over time, at least to a degree. More on this in Chapter 5.

Additionally, the body is not reactive, but rather proactive in this process. We actively predict or anticipate what will happen when we move within the world. We predict what is likely to be safe and what is risky or potentially pain provoking. These predictions are weighted based upon probabilities

of a particular outcome or experience that are informed by past experiences, knowledge, reason, and evaluation of circumstances. Depending upon how we then engage in movement and activity, we compare this prediction to sensory feedback that may either confirm or negate the prediction. Ideally, we learn from this movement exploration either way. This evaluative process can lead to updating our “models” that form our future predictions (i.e., experiential learning).

We are inseparable from our world and it from us, including our physical and social environment. Our cognitions are formed from and within ourselves and our world. Mind/body dualism is a false dichotomy. In this book, the terms “body” and “bodily” are used frequently to reference a more holistic concept of the body that includes our conscious and nonconscious processes that adapt to look after us. This includes, but is not limited to, our brain and other parts of our central neuroimmune system and should be understood to also include all the other components of our physical body and mental self. The learning model presented in this book of a body looking after itself (Figure 1.3) is based upon multiple theoretical models such as the Mature Organism Model (Moseley & Butler, 2017, Explain Pain Supercharged; Gifford, 1998; Gifford, 2013), the Neuromatrix model (Melzack, 1999; Melzack, 2001; Iannetti & Mouraux, 2010), predictive processing models (Clark, 2013; Wiesch, 2016; Solms, 2019; Solms, 2021; Barrett, 2018; Kelly et al, 2019), and embodied cognition perspectives (Clark, 2007; Stilwell, 2019; Varela, 1991; Solms, 2021; Thompson, 2005). In addition, the language chosen within this book to describe this learning model comes from years of clinical discussions with people suffering from pain.

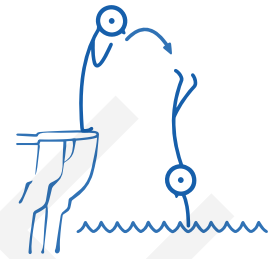
In summary, pain is a real, first-person experience related to bodily protection that relies upon a biopsychosocial (and beyond) context of a learning organism capable of looking after itself within the world. Pain can be considered a universal human experience that is part of how we survive. However, pain that persists can become problematic and get in the way of our thriving.

For often unknown reasons, pain can become debilitating, seem to serve no valuable purpose, and get in the way of living well or thriving. We may technically be surviving, but often in these pain states the suffering is profound and the quality of life is significantly diminished. The prevalence of persistent pain in the US population was estimated at over 20% of adults with nearly half of those people (about 8% of entire adult population) having “high impact” persistent pain, defined as pain that frequently limits daily life activities and/or work (Dahlhamer et al, 2018 CDC). Similarly, around the world the prevalence of persistent pain has been established at 18.4% in Germany (Hensler et al, 2009), 18.9% in Canada (Schopflocher et al, 2011), 19% in Denmark (Erikson, 2003), 21.5% in Hong Kong (Wong et al, 2011), 24.4% in Norway (Rustøen et al, 2004), 27% in the European Union (Leadley et al, 2012), and 39% in Japan (Inoue et al, 2015). In comparison, estimates of persistent pain prevalence in adults (here defined as 15 years or older) in developing countries (Brazil, China, India, Iran, South Africa, Libya, Nepal and the Philippines) has been reported as 18% (Sá et al, 2019).

Thankfully, adaptations of the neuroimmune system towards increased protection, potentially including a pain experience, are also modifiable. The remainder of this book will explore a framework to “re-teach” the neuroimmune system (i.e., *bodily relearning*) by creating a new response pattern that balances ongoing bodily protection, allowing freedom of movement, and re-engaging in meaningful aspects of life.

Deeper dive:

Perhaps focusing only on survival is a low bar for considering a pain experience. Maybe it is also about how a person thrives as well.



Do pain experiences become powerful teachers that serve us in the future?

We expect our bodies to learn from past experiences when it comes to other forms of protection, such as the development of anti-bodies and receptors after an infection which recognize a pathogen in case we are exposed again. Pain experiences are drivers for us to act and can dramatically influence our interactions with others. Perhaps pain is not just about clearing the low bar of survival, but also about aiming towards thriving. Compared to surviving (continuing to exist and live), thriving involves flourishing, prospering, continuing to grow. It benefits us as individuals, society, and as a species to not only just barely survive, but to thrive. Evolutionarily, it would be unlikely that we would be able to pass on our genetic code if pain only supported us just barely being alive. Our bodily protection responses, including the experience of pain, can serve to steer us towards a greater chance of reproducing and creating viable offspring. Thus, pain may be about more than an individual just scraping by and surviving. Expanded beyond evolutionary principles of mere survival, pain can be a means of facilitating the opportunity to express our values, motivations and meaning, as well as to contribute to society in a meaningful way. It is quite plausible that the physiological, behavioral, and knowledge-based learning that comes from a pain experience can be extremely useful in not only surviving, but thriving, as an individual, as a society, and as a species.

Behaviorally, pain experiences can be a powerful resource to call others to our aid when we are in distress or need help. It is a signal to our community to act as well, hopefully in a manner that helps.

1.3 Plan of care development – broad strokes

The framework presented below includes both top-down and bottom-up approaches (Figure 1.4). Top-down approaches involve more explicit, conscious processes of seeking understanding or making sense of one’s pain. One major category of the top-down approach is seeking healthy narratives, beliefs, and thoughts that both help a person to understand what is going on and help the person and their healthcare providers know what to do about the situation. For the top-down approach, we will explore healthy notions of pain including understanding what factors are enhancing bodily protection responses and how to facilitate change to dampen said protection responses. This top-down approach can also include building resilience, self-efficacy, and coping skills.

In addition, these narratives will be paired with elements from the bottom-up approach, which encompasses experiential, movement-based learning enhanced by explicit, intentional reflection. Pairing both approaches, we can develop an understanding (that is codeveloped by the person and their healthcare provider) of how to safely become more active and re-engage in meaningful life activities. Reflection will play a big role in how to bridge the two approaches. Additional elements of the bottom-up approach will include determining when it may be appropriate to remove or reduce non-essential physical stressors (permanently or temporarily) and how to gradually, progressively restore tolerance to the essential physical stressors required for full function. A main theorem of the bottom-up approach is to use movement exploration or “experiments,” enhanced by self-reflection, to reteach bodily systems to be less protective. With this bottom-up approach, we are trying to facilitate movement-based learning of the neuroimmune system. We are using conscious strategies to change what are often nonconscious processes of threat assessment and bodily protection responses. This often includes gradual, progressive exposure to threatening movements or activities in a manner that promotes neuroimmune system adaptation to allow for more freedom of movement with less protection. Both the top-down and bottom-up approaches aim to retrain the bodily protection responses and thus promote *bodily relearning*.

10,000 meter overview:

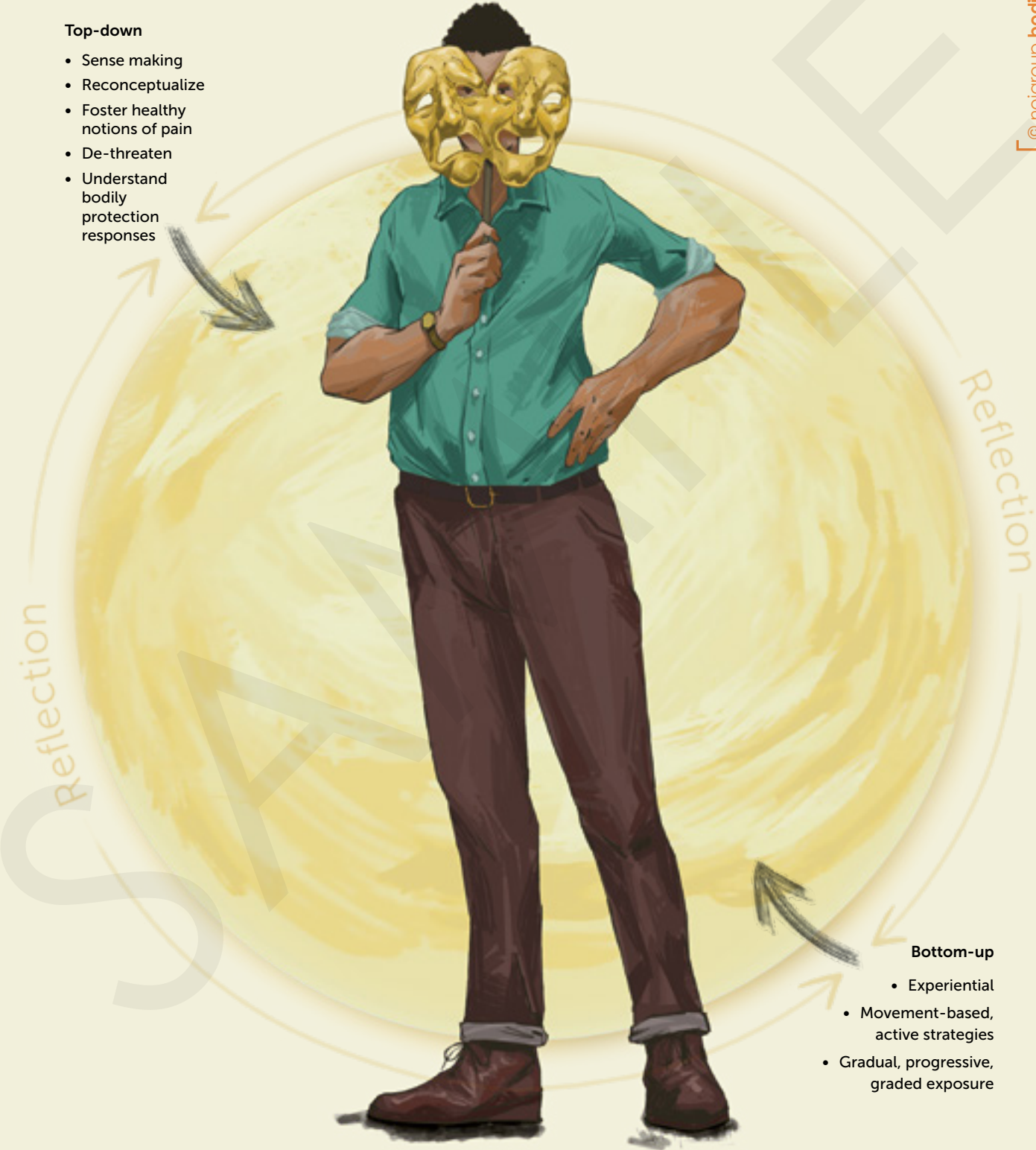
We aim to create adaptation within our bodily protection responses (i.e., create *bodily relearning*) by top-down approaches (such as explicit learning, gaining knowledge, and insight) paired with bottom-up approaches (such as movement exploration, safe re-engagement in meaningful life activities, and mindfulness practices). Reflection helps to integrate the two approaches.



Goals

- Bodily Relearning
- Appropriately diminish protection responses

- Top-down**
- Sense making
 - Reconceptualize
 - Foster healthy notions of pain
 - De-threaten
 - Understand bodily protection responses



- Bottom-up**
- Experiential
 - Movement-based, active strategies
 - Gradual, progressive, graded exposure

Figure 1.4 A framework for approaches to bodily relearning

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