CHAPTER 1

Biopsychosocial Perspective on Chronic Pain

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The past several decades have given rise to advances in knowledge of the neurophysiological mechanisms involved with nociception and pain, advances in sophisticated diagnostic imaging procedures, and the development of innovative treatments. Yet there are still no treatments available that consistently and permanently alleviate pain for all those afflicted (Turk, Wilson, & Cahana, 2011). In this chapter we review the biomedical model and several alternative biopsychosocial models that incorporate psychological and social factors. When these factors are integrated with neurophysiological factors, a broader biopsychosocial framework can be used to help us better understand individuals with chronic pain and their disability, as well as guide treatment planning. We review research focusing specifically on psychological, behavioral, and social factors, how these may directly interact with neurophysiological and hormonal factors, and we also discuss the implications of these contributors for treatment and rehabilitation. The set of factors discussed here underlie many of the treatment approaches described in other chapters in this volume.

The Need for an Alternative to the Disease Model

The conventional biomedical model of pain, which dates back to the ancient Greeks and was inculcated into medical thinking by Descartes in the 17th century, assumes that people's reports of pain result from a specific disease state or pathology associated with disordered anatomy or physiology. From this model, efforts are made to confirm the diagnosis from data obtained from objective tests (e.g., imaging, laboratory assays of fluids) validating physical damage or disease, and impairment. Based on these data, medical interventions are specifically directed toward eliminating either the source of pathology or remediating the identified organic dysfunction—the putative causes of the symptoms described.

From the perspective of the biomedical model, accompanying features of chronic conditions, such as sleep disturbance, depression, psychosocial disability, and pain, are not viewed as pathognomonic of a particular disease or syndrome. Rather, they are viewed as mere reactions to the malady, and are thus of secondary importance. It is assumed that once the disease is "cured," or pathology resolves or is corrected, these secondary reactions will abate. If the symptoms persist, speculations arise as to possible psychological causation for their maintenance. Thus, traditional medicine has adopted a dichotomous, Cartesian mind–body dualistic view in which symptoms are *either* somatogenic *or* psychogenic. Although evidence to support this dichotomy is lacking and often contrary, the view remains pervasive in health care, in patients and patients' significant others, and the general population.

Decidedly diverse responses to objectively similar physical perturbations and identical

treatments have been noted clinically and documented in numerous empirical investigations. For example, although they are related, the associations between physical impairments on the one hand, and pain report and disability on the other, are modest at best (see, e.g., Brinjikji et al., 2015; Finan et al., 2013). Identified physical pathology by itself is not highly predictive of the severity of pain or level of disability. Moreover, pain severity does not adequately explain emotional distress or extent of disability observed. Many of the most prevalent chronic pain conditions (e.g., back pain, fibromyalgia [FM], migraine) do not reveal any definitive pathology that would adequately explain the presence, extent, and persistence of pain and associated disability (e.g., Baranto, Hellstrom, Cederlund, Nyman, & Sward, 2009; Blankenbaker et al., 2008; Jarvik et al., 2005).

Several prospective longitudinal studies indicated that the evolution of persistent pain is unrelated to the number of pathological discs revealed in magnetic resonance imaging (MRI) findings. For example, Jarvik and colleagues (2005) reported that psychological factors were significantly better predictors of back pain 3 years after initial assessment than were MRI scans. In an even longer duration follow-up, Baranto and colleagues (2009) tracked groups of elite male athletes and nonathletes for 15 years, and found that the evolution of persistent pain was unrelated to the number of pathological discs the MRI revealed. These authors found that the presence of pain failed to predict pathology; moreover, the presence of pathology did not predict pain. These data do not obviate the important contribution of physical pathology to the experience of pain; rather, they suggest that other variables, as well as biomedical ones, are important and worthy of attention. The question that remains to be answered, then, is: What set of factors account for the highly varied experience of, and behavioral responses to, pain observed? This question has led to a search for broader models that can account for the lack of any isomorphic relationship between defined pathology and pain reports.

It is apparent that chronic pain involves much more than a physical symptom. Its continuous presence creates widespread manifestations of distress, including preoccupation with pain; limitation of personal, social, and work activities; demoralization and affective disturbance; and increased use of medications and of health care services for those affected. It comes to consume the entire life of the individual, and it evolves overtime. Although the importance of such factors has been acknowledged for some time (e.g., Engel, 1977), only within the past half-century have there been systematic attempts to incorporate these factors within comprehensive models of pain (e.g., Flor & Turk, 2011; Gatchel, Peng, Peters, Fuchs, & Turk, 2007). Dissatisfaction with the inadequacies of the biomedical model of pain led to a seminal event, the postulation of the Gate Control Theory of pain by Melzack and his colleagues (Melzack & Casey, 1968; Melzack & Wall, 1965).

The Gate Control Theory of Pain

The first attempt to amalgamate physiological and psychological factors, and to develop an integrative model of chronic pain that circumvents shortcomings of unidimensional models, was the gate control theory (GCT; Melzack & Casey, 1968; Melzack & Wall, 1965), which had to account for a number of facts: (1) the variable relationship between injury and pain noted; (2) non-noxious stimuli sometimes produce pain; (3) the location of pain and tissue damage is sometimes different; (4) pain can persist long after tissue healing; (5) the nature of the pain and sometimes the location can change over time; (6) pain as a multidimensional experience; and (7) lack of adequate pain treatments. It was precisely these facts that no theory at the time could explain.

Melzack and Casey (1968) differentiated three systems related to the processing of nociceptive stimulation: sensory–discriminative, motivational–affective, and cognitive–evaluative, all of which contribute to the subjective experience of pain. In this way, the GCT specifically includes psychological factors as integral aspects of the pain experience. In addition, by emphasizing central nervous system (CNS) mechanisms, this theory provides a physiological basis for the role of psychological factors in chronic pain.

According to the GCT, peripheral stimuli interact with cortical variables, such as mood and anxiety, in the perception of pain. Pain, then, is not considered either somatic or psychogenic; instead, both factors have either potentiating or moderating effects. From the GCT perspective, the experience of pain is an ongoing sequence of activities, largely reflexive in nature at the outset, but modifiable even in the earliest stages

by a variety of excitatory and inhibitory influences, as well as the integration of ascending and descending CNS activity. The process results in overt expressions communicating pain, and strategies by the person to terminate the pain. Because the GCT invokes the continuous interaction of multiple systems (sensory–physiological, affect, cognition, and behavior) considerable potential for shaping of the pain experience is implied.

Whereas prior to the GCT formulation psychological factors were largely dismissed as solely reactions to pain, this new model suggested that cutting or blocking neurological pathways is inadequate because psychological processes are capable of influencing (i.e., amplifying or diminishing) perception of the peripheral input. Emphasis on the modulation of inputs in the spinal cord and the dynamic role of the brain in pain processes, and ultimately perception, resulted in more serious consideration of psychological variables (e.g., past experience, attention, and other cognitive activities) to adequately understand pain. Perhaps the major contribution of the GCT has been its highlighting of the CNS and, particularly, the brain as an essential component in pain processes and perception.

The physiological details of the GCT have been challenged almost since its initial inception (e.g., Nathan, 1976; Price, 1987). As additional knowledge has been gathered since the original formulation in 1965, specific mechanisms have been disputed and have required revision and reformulation (Melzack, 2001, 2005; Wall, 1989). Overall, however, the GCT has proved remarkably resilient and flexible in the face of accumulating scientific data and challenges to these data. It still provides a "powerful summary of the phenomena observed in the spinal cord and brain, and has the capacity to explain many of the most mysterious and puzzling problems encountered in the clinic" (Melzack & Wall, 1982, p. 261).

The GCT has had enormous heuristic value in stimulating further research in the basic science of pain mechanisms. It has also given rise to new clinical treatments, including neuromodulatory-based procedures (e.g., neural stimulation techniques, neurofeedback, pharmacological advances, behavioral treatments, and interventions targeting modification of attentional and perceptual processes involved in the pain experience; e.g., Flor & Turk, 2011; M. Jensen, Day, & Miro, 2014; M. Jensen & Turk, 2014). After the GCT was proposed, no one could continue trying to explain pain exclusively in terms of peripheral factors and resort to the traditional biomedical model.

The Neuromatrix Theory

Melzack (1999) extended the GCT and integrated it with Selye's (1950) theory of stress. The Neuromatrix Theory (NT) makes a number of assumptions about pain. The central concept proposed by Melzack was that the multidimensional experience of pain is produced by patterns of nerve impulses generated by a widely distributed neural network comprising a "body–self neuromatrix." The neuromatrix is to some extent genetically determined, but it is modifiable by sensory experience and learning. Another important hypothesis of the NT is that the patterns of nerve impulses can be triggered either by sensory inputs or centrally, *independent* of any peripheral stimulation. Furthermore, the NT proposes that the output patterns of the neuromatrix engage perceptual, behavioral, and homeostatic systems in response to injury and chronic stress.

According to Melzack (1999, 2001, 2005), a person's unique body–self-neuromatrix is the *primary* determinant of whether the organism experiences pain, and is the basis for the individual differences observed because the neuromatrix is plastic. A critical component of the NT is the recognition that pain is the consequence of the output of the widely distributed brain neural network rather than a direct response to sensory input following tissue injury, inflammation, and other pathologies (Melzack, 2001). There is a growing body of research confirming Melzack's proposed distributed brain neural network in the perception and response to noxious stimulation (e.g., Apkarian, Bushnell, & Schweinhardt, 2013; Apkarian, Hashmi, & Baliki, 2011; Tracey & Bushnell, 2009).

Another important feature of the NT is that when an organism is injured, it proposes that there is an alteration and disruption of the homeostatic regulation. This deviation from the body's normal state is stressful and initiates a complex of neural, hormonal, and behavioral mechanisms designed to restore homeostasis (Selye, 1950). The negative effects of stress include atrophy of muscle tissue, impairment of growth and tissue repair, immune system suppression, and morphological alterations of brain

structures that, together, might create conditions for the development and maintenance of various chronic illnesses associated with increased *allostatic load* (e.g., Chrousos & Gold, 1992; McBeth et al., 2005; McEwen, 2001; McLean et al., 2005). The concept of allostatic load, and the factors that contribute to physiological burden, is becoming increasingly recognized as an important component across diseases and disabilities (Seng, Graham-Bermann, Clark, McCarthy, & Ronis, 2005; Singer, Friedman, Seeman, Fava, & Ryff, 2005; Tucker, 2005).

Building on the GCT, pain suppression can be produced by sensory and evaluative processes, as well as activation of the endogenous opioid system. Furthermore, Melzack (1999, 2005) hypothesized that prolonged stress and ongoing efforts to restore homeostasis can suppress the immune system and activate the limbic system. The limbic system has an important role in emotion, motivation, and cognitive processes. Moreover, emerging research also suggests that inflammatory responses in the body are capable of crossing the blood–brain barrier (Simnaz et al., 2015) via two possible routes. One proposed route of the inflammatory trigger is from the olfactory bulb into the limbic system (Cutforth, DeMille, Agalliu, & Agalliu, 2016), an area known to be heavily involved in the stress response. Another potential route of bodily inflammation into the CNS may be through the newly discovered lymphatic vessels lining the dural sinuses of the brain (Louveau et al., 2015). These lines of research question the impermeability of the blood–brain barrier, and offer pain researchers and clinicians greater cause to consider the direct impacts of bodily injuries, pain, and inflammatory processes on the brain, and nicely integrate within the NT.

The cumulative effects of stresses that preceded or are concomitant with the current stress may account for the large variation in individual responses to what objectively might appear to be the same degree of physical pathology. In this way, the NT incorporates the prior learning history of the individual with pain to shape the neuromatrix by influencing interpretive processes and individual physiological and behavioral response patterns. A new stressor may amplify baseline stress and related efforts of homeostatic regulation. Prolonged stress augments tissue breakdown as the body continues to attempt to return to its "normal" state. Once pain is established, however, it becomes a stressor in and of itself, as the body continues to attempt return to homeostasis. The presence of pain is a continual threat that initiates and maintains attention, and creates physical demands on the body. Fear, worry about the future, ruminations regarding the meaning of the nociceptive stimulation, and implications for the future contribute to the ongoing stress, producing additional deviations from homeostasis (e.g., Chrousos & Gold, 1992; McEwen, 2001).

Nociception involves activation of energy impinging on specialized nerve endings. The nerve(s) involved conveys information about tissue damage to the CNS. Animal research suggests that repetitive or ongoing nociceptive input can lead to structural and functional changes that may cause altered perceptual processing and contribute to pain chronicity (e.g., Apkarian et al., 2011, 2013; Hashmi et al., 2013). These structural and functional changes demonstrate plasticity in the nervous system and may explain why a person experiences a gradual increase in the perceived magnitude of pain, referred to as "neural (peripheral and central) sensitization." Moreover, once these changes have occurred, they may contribute to nociception even after the initial cause has resolved. These changes in the CNS offer an explanation for the reports of pain in many chronic pain syndromes (e.g., back pain, migraine FM, whiplash-associated disorders) even when no physical pathology is identified (e.g., Yunus, 2015). According to Melzack, these CNS changes can be accounted for by modification of the body–self-neuromatrix. Thus, Melzack's (2001, 2005) NT poses intriguing hypotheses and integrates a great deal of physiological and psychological knowledge. However, components of the theory, and the theory itself, await more systematic investigation. As was the case with the GCT, the NT offers a heuristic way of thinking that should stimulate research.

The Biopsychosocial Perspective: A Basic Description

It is well known that people differ markedly in how frequently they report physical symptoms, in their propensity to visit physicians when experiencing identical symptoms and, as noted, in their response to identical treatments. Therefore, the distinction between disease and illness is crucial to understanding chronic pain. *Disease* is generally defined as an objective biological event that involves disruption of specific body

structures or organ systems caused by pathological, anatomical, or physiological changes. In contrast to this customary view of physical disease, *illness* is defined as a subjective experience or self-attribution that a disease is present; it yields physical discomfort, emotional distress, behavioral limitations, and psychosocial disruption. In other words, illness refers to how the sick person and members of his or her family and wider social network perceive, live with, and respond to symptoms and disability.

The distinction between disease and illness is analogous to the distinction between pain and nociception. *Nociception* entails stimulation of nerves that convey information *about* tissue damage occurring at the periphery, projecting to the spinal cord and, ultimately, to the brain (Melzack & Wall, 1965). *Pain* is a subjective perception that results from the transduction, transmission, and modulation of sensory input, filtered through a person's genetic composition and prior learning history, and modulated further by the person's current physiological status, idiosyncratic appraisals, expectations, current mood state, and sociocultural environment (e.g., Diatchenko et al., 2005; Flor & Turk, 2011; Gatchel et al., 2007). This is why we emphasize assessment of the person because we cannot assess pain removed from the person exposed to the nociception.

In contrast to the biomedical model's emphasis on disease, the biopsychosocial model focuses on *both* disease and illness, a complex interaction of biological, psychological, and social variables. From this perspective, diversity in illness expression, which includes its severity, duration, and consequences for the individual, is accounted for by the interrelationships among biological changes, psychological status, and the social and cultural contexts. Moreover, prior to the development of an injury or disease, each person has a unique genotype and prior learning history. All these variables shape the person's perception and initial and ongoing response to illness (Gatchel et al., 2007; Okifuji & Turk, 2015).

The biopsychosocial way of thinking about the differing responses of people to symptoms and the presence of chronic conditions is based on an understanding of the dynamic nature of these conditions. That is, by definition, chronic syndromes extend over time. Therefore, these conditions need to be viewed longitudinally as ongoing, multifactorial processes in which there is a vibrant reciprocal interplay among biological, psychological, and social factors that shape the experience and responses of patients (see Figure 1.1). Biological factors may initiate, maintain, and modulate physical perturbations, whereas psychological variables influence

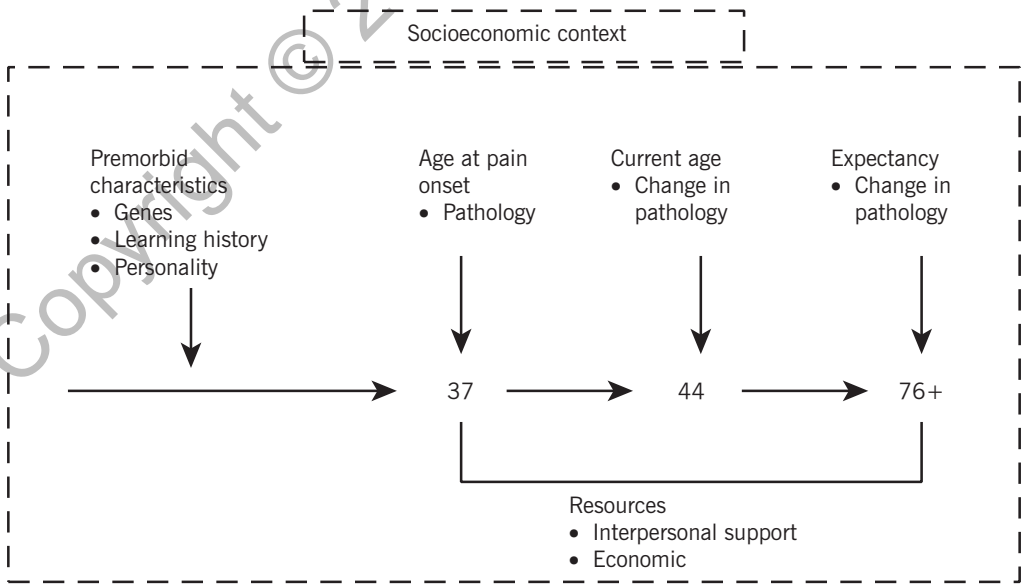

FIGURE 1.1. Longitudinal versus cross-sectional perspective. From Okifuji and Turk (2014, p. 228). Copyright © Springer Verlag France. Reprinted with permission of Springer.

perception of internal physiological signs, and social factors continually shape patients' behavioral responses to the perceptions of their physical perturbations. Conversely, psychological factors may influence biology by directly affecting hormone production (see, e.g., McBeth et al., 2007; McEwen & Kalia, 2010), brain structure and processes (see, e.g., Goffaux, Redmond, Rainville, & Marchand, 2007; Hashmi et al., 2013; Kucyi et al., 2014; Salomons, Johnstone, Backonja, Shackman, & Davidson, 2007), and the autonomic nervous system (see, e.g., Colloca, Benedetti, & Pollo, 2006; McBeth et al., 2005, 2007). Behavioral responses may also affect biological contributors, such as when a person avoids engaging in certain activities in order to reduce his or her symptoms (e.g., Crombez, Eccleston, van Damme, Vlaeyen, & Karoly, 2012; Vlaeyen & Linton, 2000). Although avoidance may initially reduce symptoms, in the long run, it will lead to further physical deconditioning (i.e., loss of muscle mass and strength, endurance, and flexibility), which can exacerbate nociceptive stimulation.

The picture is not complete unless we consider the direct effects of disease factors and treatment on a range of cognitive and behavioral factors. Biological influences and medications (e.g., steroids, opioids) may affect the ability to concentrate, induce fatigue, and modulate people's interpretation of their state, as well as their ability to engage in certain activities.

At different points during the evolution of a disease or impairment, the relative weighting of physical, psychological, and social factors may shift. For example, during the acute phase of a disease, biological factors may predominate, but, over time, as initial physical pathology resolves, psychological and social factors may assume a disproportionate role in accounting for symptoms and disability (Okifuji & Turk, 2015; Skinner, Wilson, & Turk, 2012). Moreover, there is considerable variability in behavioral and psychological manifestations of dysfunction, both across persons with comparable symptoms and within the same person over time (e.g., Arnow et al., 2011).

To understand the variable responses of people to chronic conditions, it is essential that biological, psychological, and social factors each be considered. Moreover, a longitudinal perspective is essential. A cross-sectional approach will only permit consideration of these factors at a specific point in time, and chronic conditions continually evolve (see Figure 1.1). What is observed at any one time is a person's adaptation to interacting biological, personal, and environmental factors. In summary, the hallmarks of the biopsychosocial perspective are (1) integrated action, (2) reciprocal determinism, and (3) development and evolution (Flor & Turk, 2011; Okifuji & Turk, 2015). This perspective can be contrasted with the traditional biomedical model, whose emphasis on the somatogenic–psychogenic dichotomy is too narrow in scope to accommodate the complexity of chronic pain.

Support for the Importance of Nonphysiological Factors

As noted, many studies have revealed rather weak associations between objective indicator reports of both pain and disability (e.g., Brinjikji et al., 2015; Finan et al., 2013), and the predictive role of both cognitive and emotional factors accounting for significantly greater portions of the variance than objective signs in chronic pain (e.g., Carragee, Alamin, Miller, &, Carragee, 2005) and disability (e.g., Severeijns, Vlaeyen, van den Hout, & Weber, 2001). Moreover, psychological factors have consistently been demonstrated to predict pain severity and time to discharge following diverse types of surgery during the postoperative period (e.g., Ip, Abrishami, Peng, Wong, & Chung, 2009; Khan et al., 2011; Pavlin, Sullivan, Freund, & Roesen, 2005), and at 6- and 12-month follow-up (e.g., Peters, Sommer, van Kleef, & Marcus, 2010; Thomee et al., 2008). Psychological variables have also been shown to be important predictors of response to both pharmacological and nonpharmacological treatments for various painful conditions (e.g., Benyon, Hill, Zadurian, & Mallen, 2010), and to duration of disability (e.g., Busch, Goransson, & Melin, 2007).

The history of medicine is replete with descriptions of interventions believed to be appropriate for alleviating pain, many of which are now known to have little therapeutic merit, and some of which may actually have been harmful to patients (Turk, Meichenbaum, & Genest, 1983). Prior to the second half of the 19th century and the advent of research on sensory physiology, much of the pain treatment arsenal consisted of interventions that had no direct mode of action on organic mechanisms associated with the source of the pain. Despite the absence of an adequate physiological basis, these treat-

ments proved to have some therapeutic merit, at least for some patients.

Personality Factors

Prior to the onset of a pain problem, individuals have a range of genetic factors and learning experiences that help shape their personalities. Within the biopsychosocial perspective, these individual-difference variables are viewed as important to the experience, response to, and impact of symptoms (Figure 1.1). The search for specific personality factors that predispose people to develop chronic pain has been a major emphasis of *psychosomatic medicine*. Studies had attempted to identify a specific "migraine personality," a "rheumatoid arthritis personality," and a more general "pain-prone personality" (Blumer & Heilbronn, 1982). However, on the basis of their prior experiences, people develop idiosyncratic ways of interpreting information and coping with stress. Avoidance, and the resulting failure to experience disconfirmation, prevent the extinction or modification of these interpretations and expectations. There is no question that these unique patterns will have an effect on their perceptions of, and responses to, the presence of pain (Weisberg & Keefe, 1999; see also Salas, Kishino, Dersh, & Gatchel, Chapter 2, this volume).

Anxiety sensitivity refers to the fear of anxiety symptoms, based on the belief that they will have harmful consequence (Reiss & McNally, 1985). Anxiety sensitivity appears to be a vulnerability factor (i.e., diathesis) that may condition specific fears that contribute to the development and maintenance of distress (Asmundson, Coons, Taylor, & Katz, 2002). Coupled with the fact that pain is essential for survival, attention may be "primed" to process painful stimuli ahead of other attentional demands. People with high levels of anxiety sensitivity may be especially hypervigilant to pain, as well as to other noxious sensations. Selective attention directed toward threatening information, such as bodily sensations, leads to greater arousal. Because of this attentional process, those with high anxiety sensitivity may be "primed," such that even minor painful stimuli may be amplified.

Preliminary studies that demonstrate the importance of anxiety sensitivity as a predispositional factor in chronic pain have been reported. For example, Asmundson and Norton (1995) found a positive association between anxiety sensitivity and pain-related anxiety, escape/avoidant behaviors, fear of negative consequences of pain, and negative affect. Not only were patients with high anxiety sensitivity more likely to experience greater cognitive disturbance as a result of their pain, but they were also likely to use greater amounts of analgesic medication to control equal amounts of pain compared to those with low or medium anxiety sensitivity. Furthermore, Asmundson and Norton (1995) demonstrated that anxiety sensitivity directly exacerbates fear of pain and, indirectly, exacerbates pain-specific avoidance behavior even after they controlled for the direct influences of pain severity on these variables (for a more extensive review, see Asmundson et al., 2002).

General fearful appraisals of bodily sensations may sensitize predisposed people and cause high awareness of bodily sensations. Thus, *anxiety sensitivity* is only one individual-difference characteristic that might predispose people to develop and maintain chronic pain and disability. For example, somatization, negative affectivity, bodily preoccupation, and catastrophic thinking also may be involved (see McGeary, McGeary, & Nabity, Chapter 26, this volume).

Sociocultural Factors

People are social beings, functioning within a cultural context that begins at birth and colors experiences throughout their lives. Attempting to understand people's experience of pain without consideration of their historical and current context will be inadequate (Okifuji & Turk 2012, 2015). Commonsense beliefs about illness and health care providers are acquired from both prior learning experiences and social and cultural transmission of meaning and expectations. Ethnic group membership influences how one perceives, labels, responds to, and communicates various symptoms, as well as from whom one elects to obtain care when it is sought, and the types of treatments received. Sociocultural factors influence how families and local groups respond to and interact with patients (see discussion of operant learning mechanisms later). Furthermore, ethnic and racial expectations and sex and age stereotypes may influence the practitioner–patient relationship (e.g., Anderson, Green, & Payne, 2009; Cook & Chastain, 2001; Lazakani et al., 2015;

McGuire, Nicholas, Asghari, Wood, & Main, 2014).

Social Learning Mechanisms

The role of social learning has received some attention in the development and maintenance of chronic pain states. From this perspective, pain behaviors (i.e., overt expressions of pain, distress, and suffering) may be acquired through observational learning and modeling processes; that is, people can learn responses that were not previously in their behavioral repertoire by observing others who respond in these ways (e.g., Goubert, Vlaeyen, Crombez, & Craig, 2011; Levy, 2011). Children acquire attitudes about health and health care, perceptions and interpretations of symptoms, and appropriate responses to injury and disease from their parents, cultural stereotypes, and the social environment (see, e.g., Fisher, Aaron, & Palermo, Chapter 29, this volume). Based on their experiences, children develop strategies to help them avoid pain and learn "appropriate" (acceptable) ways to react. Children are exposed to numerous minor injuries throughout the day, and how adults address these experiences provides ample learning opportunities (Levy, 2011). Children's learning influences whether they will ignore symptoms or respond or overrespond to symptoms. The observation of others in pain is an event that captivates attention. A large amount of experimental evidence, going back several decades, demonstrates the role of social learning in controlled studies in the laboratory (Craig, 1986; 1988), and observations of patients' behavior in clinical settings (e.g., Levy, 2011). For example, in an early study, Richard (1988) found that children whose parents had chronic pain chose more pain-related responses to scenarios presented to them and were more external in their health locus of control than were children with healthy or diabetic parents. Moreover, teachers rated the pain patients' children as displaying more illness behaviors (e.g., complaining, days absent, and visits to school nurse) than the children of the diabetics and healthy controls.

Operant Learning Mechanisms

Early in the 1900s, Collie (1913) discussed the effects of environmental factors in shaping the experience of people with persistent pain. However, a new era in thinking about pain was initiated with Fordyce's (1976; for a historical reflection and extension, see Main, Keefe, Jensen, Vlaeyen, & Vowles, 2015; see also Sanders, Chapter 5, this volume) description of the role of operant factors in chronic pain. The operant approach stands in marked contrast to the biomedical model of pain described earlier. Operant theory hypothesizes that all behavior is sensitive to the effects of environmental responses to that behavior. Fordyce noted that "pain behaviors"—the things that people do that *communicate* pain to others (i.e., overt expressions of pain and suffering such as limping and grimacing)—are no different than any other behavior with respect to their sensitivity to environmental influences. Overt behaviors, by their very nature, are observable and hence capable of eliciting responses. Pain behaviors followed by reinforcing events, such as affection or sanctioned time out from social responsibilities, will increase in frequency. However, if pain behaviors are systematically ignored, and behaviors incompatible with them—so-called "well-behaviors" such as exercise and maintaining an active lifestyle including employment—are encouraged or positively reinforced, then over time these well-behaviors will increase and pain behaviors will decrease.

Fordyce (1976) argued that pain behaviors, which can be protective in the short run following acute injury, are no longer useful in the context of chronic pain. In fact, once healing has occurred, pain behaviors often become maladaptive—they can contribute to disability (e.g., ongoing resting and guarding behaviors cause muscle atrophy) and maintain pain. Also, these behaviors may continue beyond any expected healing time because of the presence of not only significant pain but also reinforcers of pain behaviors, as well as the absence of reinforcers for well behaviors.

In the operant formulation, behavioral manifestations of pain, rather than pain per se, are central. When people are exposed to a stimulus that causes tissue damage, their immediate response is withdrawal or an attempt to escape from the noxious sensations. Their behaviors are observable and, consequently, are subject to the principles of reinforcement. Behaviors that are positively reinforced increase and persist, whereas behaviors that receive no positive response decrease and become diminished. Those behaviors that permit avoidance of aversive events (negatively reinforced) will also increase.

The operant view proposes that through external contingencies of reinforcement, acute pain

behaviors, such as limping to protect a wounded limb from producing additional nociceptive input, may evolve into chronic pain problems. Pain behaviors may be positively reinforced directly (e.g., by attention from a spouse or health care provider). They may also be maintained by the escape from noxious stimulation through the use of drugs or rest, or avoidance of undesirable activities such as work.

In addition, "well behaviors" (e.g., activity and working) may not be sufficiently positively reinforced and will be extinguished. Pain behaviors originally elicited by organic factors may therefore occur totally, or in part, in response to reinforcing environmental events. Because of the consequences of specific behavioral responses, Fordyce (1976) proposed that pain behaviors might persist long after the initial cause of the pain is resolved or greatly reduced. The operant conditioning model does not concern itself with the initial cause of pain. Rather, it considers pain an internal subjective experience that may be maintained even after its initial physical basis is resolved. A number of studies have provided evidence that supports the underlying assumptions of the operant conditioning model (e.g., Eck, Richter, Straube, Miltner, & Weiss, 2011; Jolliffee & Nicholas, 2004).

Treatment from the operant perspective focuses on extinction of pain behaviors and increasing well behaviors by positive reinforcement. This treatment has proven to be effective for select samples of patients with chronic pain (see, e.g., Henschke et al., 2010; Thieme, Turk, & Flor, 2007; see also Sanders, Chapter 5, this volume). Although operant factors undoubtedly play a role in the maintenance of pain and disability, the operant conditioning model of pain has been criticized for its exclusive focus on motor pain behaviors, failure to consider the emotional and cognitive aspects of pain, and failure to treat the subjective experience of pain (e.g., Okifuji & Turk, 2015; Skinner et al., 2012).

Respondent Learning Mechanisms

Factors contributing to chronicity that have previously been conceptualized in terms of operant learning may also be initiated and maintained by respondent conditioning. In an early study, Fordyce, Shelton, and Dundore (1982) hypothesized that intermittent sensory stimulation from the site of bodily damage, environmental reinforcement, or successful avoidance of aversive social activity are not necessarily required to account for the maintenance of avoidance behavior or protective movements; anticipation of pain may be sufficient to maintain avoidance behavior. Vlaeyen and colleagues (e.g., Asmundson, Norton, & Vlaeyen, 2004; Crombez et al., 2012; Vlaeyen & Linton, 2000) have reviewed a wealth of studies confirming that avoidance of activities is related more to anxiety about pain than to actual pain.

Once an acute pain problem is established, fear of motor activities that the patient *expects* to result in pain may develop and motivate avoidance of activity (Crombez et al., 2012; Vlaeyen & Linton, 2000). Nonoccurrence of pain is a powerful reinforcer for future reduction of activity. In this way, the original respondent conditioning may be followed by an operant learning process, whereby the nociceptive stimuli and the associated responses need no longer be present for the avoidance behavior to occur.

In acute pain states, it may be useful to reduce movement and, consequently, to avoid pain, in order to accelerate the healing process. Over time, however, anticipatory anxiety related to activity may develop and act as a conditioned stimulus for sympathetic activation (the conditioned response), which may be maintained after the original unconditioned stimulus (injury) and unconditioned response (pain and sympathetic activation) have subsided (e.g., Philips, 1987). Indeed, sympathetic activation and increases in muscle tension may be viewed as unconditioned responses that can elicit more pain. Even when no injury is present, pain related to sustained muscle contractions may also be conceptualized as an unconditioned stimulus, and conditioning may proceed in the same fashion as outlined previously. Although an original association between pain and pain-related stimuli may result in anxiety regarding these stimuli, with time, the expectation of pain related to activity may lead to avoidance of adaptive behaviors, even if the nociceptive stimuli and the related sympathetic activation are no longer present. Even in acute pain, many activities that are otherwise neutral or pleasurable may elicit or exacerbate pain, and are therefore experienced as aversive and avoided. Over time, more and more activities may be seen as eliciting or exacerbating pain, and are therefore feared and avoided (i.e., *stimulus generalization*).

Avoided activities may involve simple motor behaviors, as well as work, leisure, and sexual

activity. In addition to the avoidance learning, pain may be exacerbated and maintained in an expanding number of situations because anxiety-related sympathetic activation and accompanying muscle tension may occur both in anticipation and as a consequence of pain (cf. Flor & Turk, 2011; Main et al., 2015). Thus, psychological factors may directly affect nociceptive stimulation and need not be viewed merely as reactions to pain. We return to this point later in this chapter.

Persistent avoidance of specific activities prevents disconfirmations that are followed by corrected predictions (Rachman & Arntz, 1991). Early studies have shown that prediction of pain promotes pain avoidance behavior, and overprediction of pain promotes excessive avoidance behavior (Schmidt, 1985a, 1985b). Insofar as pain avoidance succeeds in preserving the overpredictions from repeated disconfirmation, they will continue unchanged. By contrast, people who repeatedly engage in behavior that produces significantly less pain than they *predicted* will likely make adjustments in subsequent expectations, which will eventually become more accurate. Increasingly accurate predictions will be followed by reduction of avoidance behavior (Vlaeyen, de Jong, Geilen, Heuts, & van Breukelen, 2001). These observations support the importance of physical therapy and exercise quota, with patients progressively increasing their activity levels despite their fears of injury and discomfort associated with renewed use of deconditioned muscles.

From the respondent conditioning perspective, individuals with chronic pain may have learned to associate increases in pain with all kinds of stimuli that were originally associated with nociceptive stimulation (i.e., stimulus generalization). As the pain symptoms persist, more and more situations may elicit anxiety and anticipatory pain and depression because of the low rate of reinforcement obtained when behavior is greatly reduced. Sitting, walking, cognitively demanding work or social interaction, sexual activity, or even thoughts about these activities, may increase anticipatory anxiety and concomitant physiological and biochemical changes (Flor & Turk, 2011). Subsequently, patients may respond inappropriately to many stimuli, reducing the frequency of numerous activities, in addition to those that initially induced nociception. Physical abnormalities often observed in patients with chronic pain (e.g., distorted gait, decreased range of motion, and muscular fatigue) may actually result from secondary changes initiated in behavior through learning rather than continuing nociception. In short, the anticipation of suffering or prevention of suffering may be sufficient for the long-term maintenance of avoidance behaviors.

Cognitive Factors

People are not passive responders to physical sensation. Rather, they actively seek to make sense of their experience. They appraise their conditions by matching sensations to some preexisting implicit model, and they determine whether a particular sensation is a symptom of a particular physical disorder that requires attention or can be ignored. In this way, to some extent, each person functions with a uniquely constructed reality (i.e., a body–self neuromatrix). When information is ambiguous, people rely on general attitudes and beliefs based on experience and prior learning history. These beliefs determine the meaning and significance of the problems, as well as the perceptions of appropriate treatment. If we accept the premise that pain is a complex, subjective phenomenon that is uniquely experienced by each person, then knowledge about idiosyncratic beliefs, appraisals, and coping repertoires becomes critical for optimal treatment planning and for accurately evaluating treatment outcome (Flor & Turk, 2011; Okifuji & Turk 2014; Skinner et al., 2012).

Research investigating the impact of poor emotional coping, maladaptive thought processes, and appraisals of pain have consistently demonstrated that patients' attitudes, beliefs, and expectancies about their plight, themselves, their coping resources, and the health care system affect their reports of pain, activity, disability, and response to treatment (e.g., Okifuji & Turk, 2012; Smeets, Vlaeyen, Kester, & Knottnerus, 2006). For example, a belief that pain is "damaging" and "dangerous" in patients with chronic pain has been shown to be associated with greater pain and disability (Turner, Jensen, & Romano, 2000). Conversely, modification in maladaptive beliefs about their pain can directly affect brain processing of nociceptive stimulation (e.g., K. Jensen et al., 2012) and seems to predict changes in pain and disability following treatment (e.g., Burns, Glenn, Bruehl, Harden & Lofland, 2003; Robinson, Theodore, Dansie, Wilson, & Turk, 2013).

Beliefs about Pain

Clinicians working with patients with chronic pain are aware that patients who have similar pain histories may differ greatly in their beliefs about their pain. Certain beliefs may lead to maladaptive coping, exacerbation of pain, increased suffering, and greater disability. For example, if pain is interpreted as signifying ongoing tissue damage, rather than as being the result of a stable problem that may improve, it is likely to produce considerably more suffering and behavioral dysfunction, even though the amount of nociceptive input in the two cases may be equivalent. People who believe that their pain is likely to persist may be quite passive in their coping efforts and may fail to make use of cognitive or behavioral strategies to cope with pain (e.g., Benyon et al., 2010). Moreover, beliefs of individuals with chronic pain about the implications of a disease can affect their perception of symptoms (e.g., Benyon et al., 2010; Okifuji, Turk, & Sherman, 2000), and their impact (e.g., Zale, Lange, Fields, & Ditre, 2013). For example, Spiegel and Bloom (1983) found that the pain severity ratings of cancer patients could be predicted by patients' use of analgesics and by their affective state, as well as their *interpretations of pain*. Patients who attributed their pain to a worsening of their underlying disease experienced more pain than did patients with more benign interpretations, despite the same level of disease progression. In light of the description of the plight of individuals with chronic pain, Okifuji and colleagues (2000) raised the provocative question as to why they all do not become depressed. They investigated the mediating factors between pain and depression, and determined that feelings of control over symptoms and life in general, and the elevated perception about the effect of negative impact of pain on many areas of functioning, predicted a significant amount of the variance in depressive symptoms. Thus, a person's cognitions (beliefs, appraisals, expectancies) regarding the consequences of an event, and his or her ability to deal with it, are hypothesized to affect functioning in two ways—by directly influencing mood and indirectly influencing coping efforts (e.g., Arnow et al., 20011; Crombez, Eccleston, van den Broeck, Goubert, & van Houdenhove, 2004; Geisser et al., 2003).

The presence of pain may change the way people process pain-related and other information. For example, chronic pain may focus attention on all types of bodily sensations. In this way, instead of employing a healthy coping strategy, such as distraction, individuals with persistent pain engage in the opposite and become body preoccupied (Crombez et al., 2004). Thus, it is possible that patients with pain become preoccupied with, hypervigilant toward, and overemphasize physical symptoms and interpret them as painful stimulation (see Turk, Chapter 20, and van Tilburg & Whitehead, Chapter 24, this volume, supporting the presence of what appears to be hypersensitivity characterized by a lowered threshold for labeling stimuli as noxious). Individuals may interpret pain symptoms as indicative of an underlying disease, and they may do everything to avoid pain exacerbation, most often by resorting to inactivity (e.g., Vlaeyen & Linton, 2000; see also Vlaeyen, den Hollander, de Jong, & Simons, Chapter 9, this volume, and the other chapters in Part III). For example, in acute pain states, bed rest is often prescribed to relieve pressure on the spine. These individuals may subsequently ascribe to a belief that any movement of the back may worsen their condition, and they may still maintain this belief in the chronic state, when inaction is not only unnecessary but also detrimental.

Once cognitive structures (based on memories and meaning) about a disease are formed, they become relatively stable, which makes them difficult to modify. Individuals tend to avoid experiences that could invalidate their beliefs, and they guide their behavior in accordance with these beliefs and expectations, even in situations in which the beliefs are no longer valid. Consequently, as noted previously in describing respondent conditioning, they do not receive corrective feedback disconfirming the erroneous beliefs. In addition to beliefs about the ability to function despite pain, beliefs about pain per se appear to be important in understanding patients' adherence to treatment recommendations, response to treatment, and disability (Flor & Turk 2011).

The results of several studies suggest that when successful rehabilitation occurs, there appears to be an important "cognitive shift"—a shift from beliefs about helplessness and passivity to resourcefulness and ability to function regardless of pain (e.g., Burns et al., 2003; Busch et al., 2007; M. Jensen, Turner, Romano, 2007). Clearly, it appears essential for people with chronic pain to develop adaptive beliefs, and corrections of maladpative beliefs and expectations about the relation among impairment,

pain, suffering, and disability, and to deemphasize the role of experienced pain in their regulation of functioning. Indeed, results from numerous treatment outcome studies have shown that changes in pain level per se do not parallel changes in other variables of interest, including activity level, medication use, return to work, rated ability to cope with pain, and pursuit of further treatment (see Morley, Williams, & Eccleston, 2013; Williams, Eccleston, & Morley, 2012).

Beliefs about Controllability

Many studies demonstrate that perceived controllability of aversive stimulation reduces its impact (e.g., Okifuji et al., 2000; Salomons et al., 2007). Conversely, there is evidence that the explicit expectation of uncontrollable pain stimulation may cause subsequent nociceptive input to be perceived as more intense (e.g., Colloca et al., 2006). Because people who have associated activity with pain may expect heightened levels of pain when they attempt to get involved in activity, they may actually perceive higher levels of pain or avoid activity altogether (e.g., Vlaeyen & Linton, 2000).

Many individuals with chronic pain perceive a lack of personal control, which probably relates to their ongoing but unsuccessful efforts to influence the pain they experience (e.g., Okifuji et al., 2000). Such negative, maladaptive appraisals about the situation and their personal efficacy may reinforce the experience of demoralization, avoidance of activity, and overreaction to nociceptive stimulation commonly observed. A sense of control over pain may also influence pain experience. When people are experimentally led to believe that they have control over the noxious level of stimuli, the neural activation in the areas implicated in attentional and emotional response to pain is attenuated (Salomons, Johnstone, Backonja, & Davidson, 2004), relative to others who believed that they had no control over the stimulation intensity.

Self-Efficacy

Closely related to the sense of control over aversive stimulation is the concept of *self-efficacy* (Bandura, 1997). A self-efficacy belief is a type of personal conviction that the person can effectively do something to produce a desired outcome (e.g., managing symptoms) in a given context (e.g., stressful situation). Low levels of self-efficacy have been consistently shown to be related to greater intensity of reported clinical pain in many chronic pain conditions (Buckelew, Murray, Hewett, Johnson, & Huyser, 1995; Chong, Cogan, Randolph, & Racz, 2001; Stewart & Knight, 1991). Poor self-efficacy beliefs have been shown to be related to functional disability (Benyon et al., 2010; Sarda, Nicholas, Asghari, & Pimenta, 2009), and to mediate the relationship among pain and physical and psychological functioning (e.g., Arnstein, 2000) in chronic pain.

There is ample evidence today of the impact of perceived self-efficacy on pain (e.g., Hashmi et al., 2013; Robinson et al., 2013; Salmons et al., 2004). One of the early findings that self-efficacy may significantly interact with the pain-related physiological process was demonstrated in the 1980s. Bandura, O'Leary, Taylor, Gauthier, and Gossard (1987) demonstrated that improved self-efficacy belief via treatment is associated with decreased pain sensitivity, but the effects can be reversed by naloxone. The results are suggestive of the role of self-efficacy belief in directly modulating the endogenous opioid system, directly influencing the nociceptive processes of patients with chronic pain. A "self-efficacy expectation" is defined as a personal conviction that one can successfully execute a course of action (i.e., perform required behaviors) to produce a desired outcome in a given situation. This construct appears to be a major mediator of therapeutic change. Bandura (1997) suggested that if a person has sufficient motivation to engage in a behavior, the person's self-efficacy beliefs are what determine which activities to initiate, the amount of effort expended, and the extent of persistence in the face of obstacles and aversive experiences. Efficacy judgments are based on the following four sources of information regarding one's capabilities, in descending order of impact: (1) one's own past performance at the task or similar tasks; (2) the performance accomplishments of others who are perceived to be similar to oneself; (3) verbal persuasion by others that one is capable; (4) and perception of one's own state of physiological arousal, which in turn is partly determined by prior efficacy estimation.

Encouraging patients to undertake subtasks that are increasingly difficult or close to the desired behavioral repertoire can create performance mastery experience. From this perspective, the occurrence of coping behaviors is conceptualized as being mediated by the person's

beliefs that situational demands do not exceed his or her coping resources. Converging lines of evidence indicate that perceived self-efficacy operates as an important cognitive factor in adaptive psychological functioning (e.g., Benyon et al., 2010; M. Jensen et al., 2007; Sarda et al., 2009), disability (e.g., Benyon et al., 2010; Busch et al., 2007; Sarda et al., 2009), and treatment outcome (e.g., Huffman, Pieper, Hall, St. Clair, & Kraus, 2015; M. Jensen et al., 2007). Bandura (1997) suggested that those techniques that most enhance mastery experiences would be the most powerful tools for bringing about behavioral change. He proposed that cognitive variables are the primary determinants of behavior, but that these variables are most affected by performance accomplishments. The studies on headache, back pain, and RA cited earlier appear to support Bandura's proposal.

Catastrophizing

Catastrophizing is a type of maladaptive belief with exaggerated interpretation of problems as much worse than what is realistic or warranted. A pain-related catastrophizing thought pattern is fairly common in chronic pain and shows significant relationship to functional disability (Arnow et al., 2011; Crombez et al., 2004). For example, for patients undergoing surgery, catastrophizing predicts postoperative pain severity and poor quality of life, as well as later development of chronic pain (Khan et al., 2011). Catastrophizing also alters perception of noxious stimulation. In addition, catastrophizing is related to greater sensitivity to experimentally induced pain in patients with pain (Geisser et al., 2003; Somers, Keefe, Carson, Pells, & Lacaille, 2008). The relationship has been observed in both healthy adults (Edwards, Smith, Stonerock, & Haythornthwaite, 2006) and children (Lu, Tsao, Myers, Kim, & Zeltzer, 2007).

Imaging studies have shown how catastrophizing is associated with specific brain regions (Gracely et al., 2004; Kucyi et al., 2014; Seminowicz & Davis, 2006). Weissman-Fogel, Sprecher, and Pud (2008) used the diffuse noxious inhibitory control/conditioned pain modulation (DNIC/CPM) paradigm to test how catastrophizing may influence the pain modulatory process in pain-free humans. The results indicated that the level of pain catastrophizing was linearly related to pain sensitivity and negatively correlated with the DNIC/CPM, suggesting that catastrophizing may attenuate the descending inhibitory system. The results were consistent with the functional MRI study (Seminowicz & Davis, 2006) that showed the association between diminished prefrontal cortical modulation and catastrophizing under moderate-intensity painful stimulation. In another imaging study, Gracely and colleagues (2004) reported that catastrophizing seems to be related to the activation of the cortical regions implicating attentional, anticipatory, and emotional activities in response to pain, suggesting that catastrophizing may augment pain experience through increased attention and anticipation of pain.

As further support for the biopsychosocial model, George and colleagues (2008) explored the interaction of catastrophizing and a genetic diplotype (catechol-*O*-methyltransferase [*COMT*]) and demonstrated that the effects of catastrophizing may be moderated by genetic factors. Ip and colleagues (2009) also demonstrated that, in the case of postsurgical pain, cognitive coping strategies and catastrophizing thoughts correlated significantly with medication use and pain reports, and Parr and colleagues (2012) demonstrated that catastrophizing predicts both pain intensity and disability independent of objective measures of muscle injury in patients with subacute pain. In a systematic review, Wertli and colleagues (2014) reported that catastrophizing was a prognostic factor predicting outcomes of patients with low back pain. Conversely, following treatment, reductions in catastrophizing were related to reduction in pain intensity and physical impairment, and maintenance of treatment benefits (Moore, Thibault, Adams, & Sullivan, 2016). (For more detailed discussions of catastrophizing, see Gatchel, 2017; Sullivan et al., 2001; Turner & Aaron, 2001.)

Coping

Self-regulation of pain and its impact depends on people's specific ways of dealing with pain, adjusting to pain, and reducing or minimizing distress caused by pain, in other words, their coping strategies. Coping is assumed to involve spontaneously employed purposeful and intentional acts, and it can be assessed in terms of overt and covert behaviors. Overt behavioral coping strategies include rest, use of relaxation techniques, or medication. Covert coping strategies include various means of distracting oneself from pain, reassuring oneself that the pain will diminish, seeking information, and prob-

lem solving. Coping strategies are thought to act to alter both the perception of pain intensity and the ability to manage or tolerate pain, and to continue everyday activities (e.g., Flor & Turk, 2011; Skinner et al., 2012). Some studies have found active coping strategies (efforts to function in spite of pain or to distract oneself from pain; e.g., engaging in activity or ignoring pain) to be associated with adaptive functioning, and passive coping strategies (e.g., depending on others for help in pain control and restricting one's activities), to be related to greater pain and depression (e.g., Benyon et al., 2010; Ip et al., 2009; Samwel, Evers, Crul, & Kraaimaat, 2006). However, beyond this, there is no evidence supporting the greater effectiveness of any one active coping strategy compared to others. It seems more likely that different strategies will be more effective than others for some people at some times, but not necessarily for all people all the time.

Affective Factors

Pain is ultimately a subjective, private experience, but it is invariably described in terms of sensory and affective properties. As defined by the International Association for the Study of Pain: "[Pain] is unquestionably a sensation in a part or parts of the body but it is also always unpleasant and therefore also an emotional experience" (Merskey & Bogduk, 1986, p. S217). The central and interactive roles of sensory information and affective state are supported by an overwhelming amount of evidence (e.g., Eck et al., 2011; Hashmi et al., 2013; McLean et al., 2005; Sarda et al., 2009). The affective components of pain include many different emotions, but they are primarily negative in quality (Lumley et al., 2011). Anxiety and depression have received the greatest amount of attention in patients with chronic pain. The importance of anxiety in maintaining chronic pain was described previously.

Depression

After reviewing a large body of literature, Bair, Robinson, Katon, and Kroenke (2003) found that significant percentages of people with chronic pain are significantly depressed; however, the actual percentage varies depending on a number of variables. For example, the prevalence estimates for population-based studies range from 4.7 to 22%, studies in primary care range from 5.9 to 46%, and, in specialty care samples, from 12.1 to 72%. In addition to the sample included, the variability is likely related to the definition (e.g., psychiatric diagnosis, depressive symptoms), the criteria (e.g., specific symptoms used), severity (e.g., any level, severe), and the assessment methods used (e.g., questionnaire, interview). Regardless of the absolute prevalence rate, in the majority of cases, depression appears to be people's reaction to their plight. Some have suggested that chronic pain is a form of "masked depression." Although this may be true in a small number of cases, there is no empirical support for the hypothesis that depression precedes the development of chronic pain. Nevertheless, given our description of the plight of the person with chronic pain, it is not surprising that a large number of individuals with chronic pain are depressed. It is interesting to ponder the other side of the coin. How is it that all people with chronic pain disorders are *not* depressed? As noted, Okifuji and colleagues (2000) examined this question and determined that patients' appraisals of the impact of the pain on their lives, and of their ability to exert any control over their pain and lives, mediated the pain–depression relationship; that is, those patients who believed that they could continue to function despite their pain, and that they could maintain some control despite their pain, did not become depressed.

Anxiety

Anxiety is commonplace in chronic pain. Pain-related fear and concerns about harm avoidance appear to exacerbate symptoms (e.g., Asmundson & Katz, 2009; Asmundson, Norton, & Vlaeyen, 2004; Crombez et al., 2012; Vlaeyen & Linton, 2000). Anxiety is an affective state that is influenced by appraisal processes; to cite Hamlet, "There is nothing either bad or good but thinking makes it so." There is a reciprocal relationship between affective state and cognitive–interpretive processes, whereby thinking affects mood, and mood influences appraisals, and ultimately the experience of pain. Indeed, the threat of intense pain captures attention and is difficult to disengage. Continual vigilance and monitoring of noxious stimulation, and the belief that they signify disease progression, may render even low-intensity nociception less bear-

able. As we noted in our discussion of respondent conditioning, the experience of pain may initiate a set of extremely negative thoughts and arouse fears—fears of inciting more pain, injury, and the future impact (see Crombez et al., 2012; Vlaeyen et al., Chapter 9, this volume; Vlaeyen & Linton, 2000). Fear of pain and anticipation of pain are cognitive–perceptual processes that are not driven exclusively by the actual sensory experience of pain, and can exert a significant impact on the level of function and pain tolerance (Colloca et al., 2006). As noted earlier, fear of pain, driven by the anticipation of pain and not by the sensory experience of pain, is a strong negative reinforcement for the persistence of avoidance behavior and functional disability (see also Crombez et al., 2012; Joliffe & Nicholas, 2004; Sanders, Chapter 5, this volume).

Avoidance behavior is reinforced in the short term through the reduction of suffering associated with nociception. Avoidance, however, can be a maladaptive response if it persists and leads to increased fear, limited activity, and other physical and psychological consequences that contribute to disability and persistence of pain. Studies have demonstrated that fear of movement and fears of (re)injury are better predictors of functional limitations than are biomedical parameters (e.g., Crombez et al., 2012; Vlaeyen & Linton, 2000). For example, early studies by Vlaeyen, Crombez, and colleagues (Crombez, Vlaeyen, & Heuts, 1999; Vlaeyen, Kole-Snijders, Rootevell, Ruesink, & Heuts, 1995) indicated that pain-related fear was the best predictor of behavioral performance in trunk extension, flexion, and weightlifting tasks, even after partialing out the effects of pain intensity. They also found that fear of movement/(re)injury was the best predictor of the self-reported disability among patients with chronic back pain, and that physiological sensory perception of pain and biomedical findings did not add any predictive value. Clearly, pain-related anxiety and concerns about harm avoidance all play an important role in chronic pain, and need to be assessed and addressed in treatment (Crombez et al., 2012; Vlaeyen & Linton, 2000).

Posttraumatic Stress Disorder

Enduring psychological and functional limitation following a traumatic event is frequently indicative of posttraumatic stress disorder (PTSD). Traumatic events have been associated with a set of symptoms, including nightmares, recurrent and intrusive recollections about the trauma, avoidance of thoughts or activities associated with the traumatic event, and symptoms of increased arousal, such as insomnia and hyperarousal. When this set of symptoms closely follows a known traumatic event over an extended period of time, it is labeled PTSD.

Significant minorities of individuals with chronic pain attribute the onset of their symptoms to a specific trauma such as a motor vehicle accident (Asmundson et al., 2002; see Sterling, Chapter 21; Wolf & Otis, Chapter 27, this volume). Results of research suggest an exceedingly high prevalence of PTSD in patients presenting to chronic pain clinics (e.g., Scioli-Salter et al., 2015; Sharp & Harvey, 2011). Symptoms associated with PTSD may exacerbate and perpetuate the experience of chronic pain (Asmundson et al., 2002). The high prevalence of PTSD in patients with chronic pain suggests that clinicians should assess the presence of these symptoms because the failure to attend to them in treatment may undermine successful outcomes.

Anger

Anger has been widely observed in patients with chronic pain (e.g., Bruehl, Chung, & Burns, 2006). Frustrations related to persistence of symptoms, limited information on etiology, and repeated treatment failures, along with anger toward employers, insurance companies, the health care system, family members, and themselves, contributes to the general dysphoric mood of patients who, in turn, may amplifying perceptions of pain (Okifuji, Turk, & Curran, 1999). The precise mechanisms by which anger and frustration exacerbate pain are not known (Bruehl et al., 2006). One reasonable possibility is that anger exacerbates pain by increasing autonomic arousal. Anger may also block motivation for, and acceptance of, treatments oriented toward rehabilitation and disability management rather than cure. Yet rehabilitation and disability management are often the only treatments available for these patients.

It is important to be aware of the role of negative mood in individuals with chronic pain because it is likely to affect treatment motivation and adherence to treatment recommendations.

For example, depressed patients who feel helpless may have little initiative to comply; patients who are anxious may fear engaging in what they perceive as physically demanding activities; and patients who are angry at the health care system are not likely to be motivated to respond to recommendations from yet another health care professional.

It is reasonable to suggest that anger serves as a complicating factor, by increasing autonomic arousal, influencing the body–self neuromatrix hypothesized by the NT, and blocking motivation and acceptance of treatments oriented toward rehabilitation and disability management rather than cure, which are often the only treatments available for chronic pain (Asmundson et al., 2002). Endogenous opioid mechanisms have been shown to be related to anger expression (Bruehl, Burns, & Chung, 2009). The biological associations between anger and pain may explain results demonstrating that suppression of anger affects pain intensity (e.g., Quartana & Burns, 2007), and predicts worse outcome following pain rehabilitation (Burns, Johnson, Devine, Mahoney, & Pawl, 1998).

Implications for Treatment

Throughout this chapter, we have emphasized that pain is a subjective perceptual event that is not solely dependent on the extent of tissue damage or organic dysfunction; hence, the *biopsychosocial* alternative. The intensity of pain reported, and the responses to the perception of pain, are influenced by a wide range of factors, such as meaning of the situation, attentional focus, mood, prior learning history, cultural background, environmental contingencies, social supports, and financial resources, among others (see Figure 1.1). The research we reviewed supports the importance of these factors in the etiology, severity, exacerbation, and maintenance of pain, suffering, and disability.

Treatment based on the biopsychosocial perspective must not only address the biological basis of symptoms but also incorporate the full range of social and psychological factors that have been shown to affect pain, distress, and disability. Therefore, treatment should be designed not only to alter physical contributors but also to change the patient's behaviors, regardless of the patient's specific pathophysiology and without necessarily controlling pain per se (Flor & Turk 2011). Thus, from the biopsychosocial perspective, treatment focuses both on addressing identified physical pathology that may be initiating and perpetuating pain, and on providing the patient with techniques to gain a sense of control over the effects of pain on his or her life, by modifying the affective, behavioral, cognitive, and sensory facets of the experience. Behavioral experiences help to show patients that they are capable of more than they assumed they were, thus increasing their sense of personal competence. Cognitive techniques help to place affective, behavioral, cognitive, and sensory responses under a patient's control. The assumption is that long-term maintenance of behavioral changes will occur only if the patient has learned to attribute success to his or her own efforts. There are suggestions that these treatments can result in both changes in beliefs about pain, coping style, and reported pain severity, and direct behavioral changes (e.g., Burns et al., 2003; M. Jensen et al., 2007; see chapters in Parts II and III of this volume describing treatments based on the biopsychosocial model applied to different chronic pain disorders).

An important implication of the biopsychosocial perspective is the need first to identify the relevant physical, psychological, and social characteristics of patients, then to develop treatments matched to patients' characteristics and evaluate their efficacy. In light of recent studies showing direct links between inflammatory markers in the body and neuropsychiatric effects in the brain, psychologists treating patients with chronic pain now have additional factors to take into consideration. How would treatment of patients change if some of their symptoms could be attributed to CNS that has been impacted by bodily inflammation? Still, the ultimate aim is the prescription of treatment components that have been shown to maximize outcome for different subsets of patients (Morley & Williams, 2015; Turk, 2005).

Summary and Conclusions

Pain that persists over time should not be viewed as either solely physical or solely psychological. Rather, the experience of pain is a complex amalgam maintained by an interdependent set of biomedical, psychosocial, and behavioral factors whose relationships are not static but instead evolve and change over time.

The various interacting factors that affect a person with chronic pain suggest that the phenomenon is quite complex and requires a *biopsychosocial perspective*. From the biopsychosocial perspective, each of these factors contributes to the experience of pain and the response to treatment. The interaction among the various factors is what produces the subjective experience of pain. There is a synergistic relationship whereby psychological and socioenviromental factors can modulate nociceptive stimulation and the response to treatment. In turn, nociceptive stimulation can influence patients' appraisals of their situation and the treatment, their mood states, and the ways they interact with significant others, including medical practitioners. An integrative, biopsychosocial model of chronic pain needs to incorporate the mutual interrelationships among physical, psychological, and social factors, and the changes that occur among these relationships over time (Flor & Turk 2011; Gatchel et al., 2007).

The variability of patients' responses to nociceptive stimuli and treatment is somewhat more understandable when we consider that pain is a personal experience influenced by attention, the meaning of the situation, and prior learning history, as well as physical pathology. In the majority of cases, biomedical factors appear to instigate the initial report of pain. Over time, however, secondary problems associated with deconditioning may exacerbate and maintain the problem. Inactivity leads to increased focus on, and preoccupation with, the body and pain, and these cognitive–attentional changes increase the likelihood of misinterpreting symptoms, the overemphasis on symptoms, and the patient's self-perception as disabled. Reduction of activity, anger, fear of reinjury, pain, loss of compensation, and an environment that perhaps unwittingly supports the *role of the pain patient* can impede alleviation of pain, successful rehabilitation, reduction of disability, and improvement in adjustment. A model and treatment approach that focuses on only one or two of these three core sets of factors (i.e., biological, psychological, sociocultural) is inevitably incomplete.

CLINICAL HIGHLIGHTS

- The traditional biomedical model of chronic pain, with its mind–body dualism, is inadequate, because it does not adequately explain (1) the variable relationship among the presence of objective pathology, pain intensity, and the extent of disability; (2) the variability of treatment response by patients with ostensibly the same amount of physical pathology; (3) the persistence of pain in the absence of detectable pathology and long after tissue healing; and (4) the variability of responses of individuals with chronic pain responses to equivalent degrees of objective pathology.
- Psychosocial factors can affect biological processes (e.g., hormonal/stress responses, endogenous pain regulation) and brain structures associated with the exacerbation and maintenance of pain symptoms.
- Research suggests that a number of trait and state psychosocial characteristics (e.g., personality, learning history, environment, supports, beliefs and expectations, and mood states [anxiety, depression, anger]) and processes (e.g., reinforcement, PTSD) interact with biological perturbations that contribute to the experience of pain, adaptation over time, and response to treatment.
- It is important to view chronic pain from a longitudinal perspective: How do factors that preceded the onset the onset of symptoms influence perception and response; how do the current set of psychosocial factors influence the current experience of pain; and how will these factors contribute to the effects of pain over time?
- Psychosocial factors likely play important roles in the perception and response to nociception, as well as treatment.
- Understanding a person with chronic pain and successful treatment requires attention to all of these factors.

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