
Contributions of Psychology to the Understanding and Treatment of People With Chronic Pain

Why It Matters to ALL Psychologists

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Chronic pain is a prevalent problem with significant costs to individuals, significant others, and society. In this article, which introduces the American Psychologist special issue on chronic pain, we provide an overview of the seminal contributions made by psychologists to our current understanding of this important problem. We also describe the primary treatments that have been developed based on psychological principles and models of pain, many of which have demonstrated efficacy for reducing pain and its impact on psychological and physical functioning. The article ends with an enumeration of directions for future research and clinical practice. We believe that the chronicle of psychology's role in improving our understanding and treatment of pain provides a model for how psychologists can have a significant influence on many fields, and that the models and approaches developed for understanding and treating pain may be of use to psychologists working in other areas. Thus, we think that chronic pain is an important area of study that offers insights about translational research for ALL psychologists.

Keywords: chronic pain, biopsychosocial model, psychosocial, cognitive-behavioral therapy

Chronic pain (CP) is a prevalent problem with significant costs to individuals, significant others, and society. One international survey (18 countries, 42,249 respondents) found that the 12-month prevalence of CP was 37% in developed countries and 41% in developing countries (Tsang et al., 2008). According to estimates in the report of the Institute of Medicine (2011), 116 million American adults experience some form of CP. CP is a common occurrence among children and adolescents as well, affecting up to 25% of children (Perquin et al., 2000). These data indicate that CP is more prevalent than heart disease, diabetes, and cancer combined.

CP has a negative impact on health and quality of life. It is consistently shown to be associated with negative mood and physical dysfunction and to contribute to depression (Fishbain, Cutler, Rosomoff, & Rosomoff, 1997) and decreased activity levels (van den Berg-Emons, Schasfoort, de Vos, Bussmann, & Stam, 2007). Because of the direct health care costs and indirect costs (e.g., lost productivity) associated with CP, it is also exceedingly expensive for

society. The Institute of Medicine's recent report estimated that the total cost of CP to the U.S. economy ranges between \$560 and \$630 billion annually (in 2010 dollars; Institute of Medicine, 2011), and this estimate is only for adults, excluding those with pain who are in the military, in the Department of Veterans Affairs health care system, incarcerated, or in psychiatric facilities.

The astronomical figures cited above mask the incalculable impact of pain on the individuals experiencing pain directly and on their significant others. For example, the spouses of patients with CP report higher levels of distress than the spouses of pain-free individuals or the spouses of patients with other chronic medical conditions (e.g., Flor, Turk, & Scholz, 1987). In short, people with CP and those who are close to them suffer a great deal, and individuals with CP are at risk for having additional health problems that contribute even further financial burden and to a lower health-related quality of life.

Unfortunately, the currently available medical, pharmacological, and surgical treatments for patients with CP are inadequate and only moderately effective at best (Turk, Wilson, & Cahana, 2011). Thus, there is an urgent need to address the negative effects of CP, including its marked costs and significant social impact. The Institute of Medicine (2011) has asserted that this is a "moral imperative" (p. 3).

Given the magnitude of the problem and the modest benefits from traditional medical, pharmacological, and surgical treatments, there is a growing realization of the importance of considering psychosocial factors when addressing CP and pain-related disability. In this article we provide an overview of many of the seminal contributions made by psychologists to the field of pain, and we outline some directions for future research and clinical practice.

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Psychological Models and Treatments of Chronic Pain

Prior to the 1960s, most people viewed CP as primarily a medical issue that required a physical treatment (e.g., medication management, surgery). However, it became increasingly obvious that biomedical interventions provided by themselves were often inadequate. In fact, relying exclusively on biomedical interventions for CP—many of which do not have evidence supporting their efficacy—often makes CP worse (Chan & Peng, 2011; Deyo & Mirza, 2009). Beginning in the late 1960s, psychologists began applying psychological principles to help understand and treat people with CP. Supported by an expanding body of research demonstrating the influence of psychosocial factors on pain perception and its impact (Boothby, Thorn, Stroud, & Jensen, 1999; Carragee, Alamin, Miller, & Carragee, 2005; Jarvik et al., 2005; Jensen, Turner, Romano, & Karoly, 1991), there was a shift from viewing CP from a purely biomedical perspective (a “disease model”; Fordyce, 1976) to understanding it as having biological, psychological, and social effects and causes, that is, from a *biopsychosocial* perspective (Flor & Turk, 2011; Gatchel, Peng, Peters, Fuchs, & Turk, 2007).¹

Since the 1960s, a number of psychological interventions have been developed based on psychosocial models. These began to be used in conjunction with more traditional medical modalities (see Table 1). The psychological models that have been applied to understanding CP can be grouped into four general categories. The first of these is the operant conditioning model, extended to CP by Wilbert Fordyce and his colleagues in the late 1960s and early 1970s (Fordyce, Fowler, & DeLateur, 1968; Fordyce et al., 1973). This model provided the theoretical foundation for

behavioral pain treatment. Second, peripheral physiological models provided a theoretical foundation for relaxation training and biofeedback interventions. Third, cognitive and coping models, first used to understand and develop treatments for CP in the mid-1980s (Keefe & Bradley, 1984; Turk, Meichenbaum, & Genest, 1983; Turner, 1982), provided the theoretical and empirical foundation for cognitive therapy and the (growing) family of cognitive-behavioral treatments that have emerged. Finally, central nervous system neurophysiological models of pain, starting with the gate control theory in the 1960s (Melzack & Wall, 1965) and extending into more complex models based on contemporary imaging studies (Jensen, 2010; Melzack, 1999), provided neurophysiological explanations for the effects of many psychological interventions as well as a rationale for psychological treatments that target brain processes and activity.

The Operant Model

In developing and providing the initial tests of the operant model of CP, Fordyce and his colleagues (Fordyce et al., 1968) gave birth to what became the field of psychological pain management. Operant theory hypothesizes that all behavior is sensitive to the effects of environmental responses to that behavior. Behaviors followed by reinforcers will maintain or increase in frequency, and behaviors that are ignored or punished may briefly increase but will ultimately decrease in frequency. 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. 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 argued that pain behaviors, which can be protective in the short run following acute injury, are no longer useful in the context of CP. 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, not (just) because of the presence of significant pain, but because of the presence of reinforcers of pain behaviors as well as the absence of reinforcers for well behaviors (Fordyce, 1976).

¹ Many individual patients (and even some health care providers) continue to view pain in mostly biomedical terms, and an important component of contemporary CP treatment is to facilitate a shift from viewing pain as a problem that requires a biomedical fix to a problem that requires ongoing self-management.



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Research on observational learning or modeling extended this formulation by suggesting that pain behaviors might be learned not only from direct reinforcement but by observation (Goubert, Vlaeyen, Crombez, & Craig, 2011). For example, one early study showed that when patients in the hospital observe how others are treated, they learn to anticipate similar responses and display similar responses themselves (Fagerhaugh, 1974).

Operant pain treatment begins with a behavioral analysis to identify the environmental factors that precede, accompany, and follow the expression of pain behaviors. The analysis seeks to identify consequences that may be reinforcing pain behaviors and to note any potential reinforcers for well behaviors. The clinician then intervenes to facilitate the elimination of the former and encouragement of the latter—"contingency management." Treatment might include educating the patients and the people with whom they live about the operant model and encouraging patients and significant others to arrange for reinforcers to follow well behaviors while ignoring pain behaviors (Flor & Turk, 2011; Fordyce, 1976). When pain behaviors are deeply entrenched, treatment may require removal of patients from their current environments and placement in settings (e.g., an inpatient or outpatient treatment setting; see Gatchel, McGeary, McGeary, & Lippe, 2014, this issue) where the clinician has greater control over social reinforcers. However, generalization from a hospital environment to the home environment is a concern with this technique (e.g., Cairns & Pasino, 1977).

A great deal of research supports the underlying principles of the operant model applied to CP (e.g., Flor, Knost, & Birbaumer, 2002; Jolliffe & Nicholas, 2004; Schwartz, Jensen, & Romano, 2005). Moreover, treatments that incorporate operant principles demonstrate efficacy for re-

ducing reports of pain, disability, and psychological dysfunction (Eccleston, Palermo, Williams, Lewandowski, & Morley, 2009; Henschke et al., 2010; Turner & Chapman, 1982b).

A key component of operant treatment is having patients, their significant others, and clinicians focus attention away from the patient's pain experience and focus instead on the patient's life goals and functioning. This shift in focus is facilitated by making all aspects of treatment goal-contingent or time-contingent rather than pain-contingent. For example, patients who are taking analgesics and sedatives on a *prn* ("as needed") basis are switched to taking medications on a time-contingent basis (on a specific schedule regardless of pain level) and then are almost always tapered off of these medications gradually to decrease their analgesic and sedative use. Physical therapy sessions encourage active stretching and exercise (i.e., well behaviors). Patients are reinforced for improvement, and discussions focus on ways to continue to increase strength, mobility, and activity tolerance rather than on strategies for decreasing pain. Patients are asked to monitor their prog-

Table 1
Psychological Models and Treatments for Chronic Pain

Model	Treatment(s) associated with the model
Operant model	Contingency management
Peripheral physiological models	Relaxation training Biofeedback-assisted relaxation Autogenic training
Cognitive and coping models	Cognitive therapy Cognitive restructuring Motivational interviewing Cognitive-behavioral therapies: Coping skills training Problem-solving training Stress management Communication skills training Graded exposure in vivo Mindfulness-based stress reduction Acceptance and commitment therapy
Central neurophysiological models	Neurofeedback: EEG biofeedback fMRI biofeedback Hypnosis Graded motor imagery Mirror visual feedback Sensory discrimination training

Note. Although treatments are listed with specific models, there is often overlap, and treatments may be used with more than one model. EEG = electroencephalographic; fMRI = functional magnetic resonance imaging.

ress on graphs to provide self-reinforcement for increases in strength and mobility (Fordyce, 1976). Termination of physical activities is associated with accomplishment of predetermined goals. These operant strategies became the foundation of an interdisciplinary pain treatment program that was subsequently adopted and adapted by clinicians throughout the world (Loeser & Egan, 1989).

Fordyce's ideas were revolutionary, and his impact on the field of pain in general, and on psychology's role in understanding and treating patients with CP, cannot be overstated. As mentioned above, Fordyce effectively advocated for a broadening of the target of pain treatment from decreasing *pain intensity* alone (the primary treatment target for most biomedical treatments) to include increases in patient *functioning*, including both physical activity (strength and activity tolerance) and psychological functioning. This shift in outcome goals was subsequently adopted in pain clinical trials (e.g., Dworkin et al., 2005; Turk et al., 2003). Fordyce's pioneering work made it easier for many psychological pain interventions to be accepted and contributed to giving psychology and psychologists a central role in the treatment of patients with CP.

An important consequence of adopting an operant model for understanding CP is that clinicians and researchers take into account the social context of the patient's experience. Investigators who study social factors as they interact with pain behaviors and peoples' reports of pain and suffering are the natural heirs of the operant perspective, and research continues to flourish in this area (e.g., Bailey, McWilliams, & Dick, 2012; Forgeron et al., 2010; Goossens, Dousse, Ventura, & Fattal, 2009). Indeed, social difficulties seem to go hand in hand with CP, and disordered social relations may play a role in the severity and maintenance of CP (Flor & Turk, 2011) and pain treatment outcome (Schulte et al., 2010).

Peripheral Physiological Models

Relaxation training procedures were developed in the 1930s (Jacobson, 1938; Schultz, 1932) and then initially adopted by behavioral clinicians to treat anxiety disorders in the 1950s (Wolpe & Lazarus, 1955). Neal Miller's (1969) research demonstrating that it is possible to teach people to gain control over autonomic peripheral nervous system activity (previously thought to be involuntary) provided an additional intervention (biofeedback) that could potentially be used to facilitate relaxation training as well as directly modify physiological processes that might be associated with the initiation, maintenance, or amplification of pain (e.g., excessive muscle tension). Biofeedback-assisted relaxation training began to be used as a technical enhancement to progressive muscular relaxation (Jacobson, 1938) and, along with autogenic training (Schultz, 1932), was used as a treatment for insomnia, stress, and stress-related medical conditions (Canter, Kondo, & Knott, 1975; Davis, Saunders, Creer, & Chai, 1973; Kahn, Baker, & Weiss, 1968). As interest in these treatments escalated, they were adopted by psychologists involved in treating

pain (Budzynski, Stoyva, Adler, & Mullaney, 1973; Tung, DeGood, & Tenicela, 1979).

The use of psychological procedures to target and reduce peripheral muscle tension was a natural fit for CP patient treatment, given that muscle tension was thought to be a causal factor in many CP conditions (e.g., tension-type headache, temporomandibular disorders, and low back pain). In theory, by giving patients greater control over muscle tension, they could learn to manage pain themselves, and a significant underlying cause of pain could be addressed.

This application of relaxation with the focus on muscle tension adheres to a medical model in which the treatment targets what are believed to be the physical mechanisms causing pain or at least exacerbating pain. However, although evidence has demonstrated that relaxation treatments can reduce pain intensity, at least in the short run (Ostelo et al., 2005; Turner & Chapman, 1982a), research has shown that its benefits on pain are *not* necessarily mediated by its effects on actual muscle tension (Andrasik & Holroyd, 1980; Holroyd, Andrasik, & Westbrook, 1977; Nouwen & Solinger, 1979). Rather, studies indicate that the beneficial effects of relaxation training are mediated by the changes produced in patients' outcome and cognitive (self-efficacy) *beliefs*, which then contribute to reductions in stress and the experience of pain (Blanchard et al., 1986; Holroyd et al., 1984; Nouwen & Solinger, 1979). Thus, even though evidence supports the efficacy of treatments based on peripheral physiological models of pain, evidence indicates that the benefits are the result of *central* rather than peripheral changes.

Interest in relaxation training as a treatment for pain continues, and relaxation training is often a component of interdisciplinary pain treatment and cognitive-behavioral therapy regimens (Buenaver, Campbell, & Haythornthwaite, 2010). Relaxation training is also sometimes used as a stand-alone treatment for tension-type headaches. However, there is an increasing recognition that the beneficial effects of relaxation training alone on pain tend to be limited (Jensen et al., 2009; Thorsell et al., 2011).

Cognitive and Coping Models

During the 1970s and early 1980s, the field of psychology expanded to include a greater interest in cognitions (e.g., beliefs, attributions, expectations) and cognitive treatments (Beck, 1979; Dember, 1974; Ellis & Grieger, 1977; Lazarus & Folkman, 1984; Meichenbaum, 1976; Segal & Lachman, 1972), and psychologists began to apply cognitive models to the problem of CP (Turk et al., 1983). Cognitive models argue that our understanding of and ability to predict and influence behavior and mood are enhanced when we take into account an individual's beliefs, attributions, motivation, and intentions. These factors are reflected in an individual's thoughts, and thought processes represent viable treatment targets. Perhaps the most common intervention to emerge from this time period was cognitive therapy, which consists of teaching the patient to be aware of his or her thoughts and to evaluate those thoughts with respect to their overall rationality and help-

fulness (vs. their irrationality and unhelpfulness). As treatment progresses, patients are encouraged to develop and focus on adaptive thoughts when irrational or unhelpful thoughts are identified (Beck, 1979; Ellis & Grieger, 1977).

Given the strong support already established for the importance of behavioral factors, as well as the evidence confirming the efficacy of behavioral pain treatment, clinicians did not replace behavioral treatments with cognitive ones. Rather, they added cognitive interventions to behavioral treatments they were already providing (often including biofeedback and relaxation). These treatment packages were called “cognitive-behavioral therapy” (CBT), with the emphasis on the hyphen.

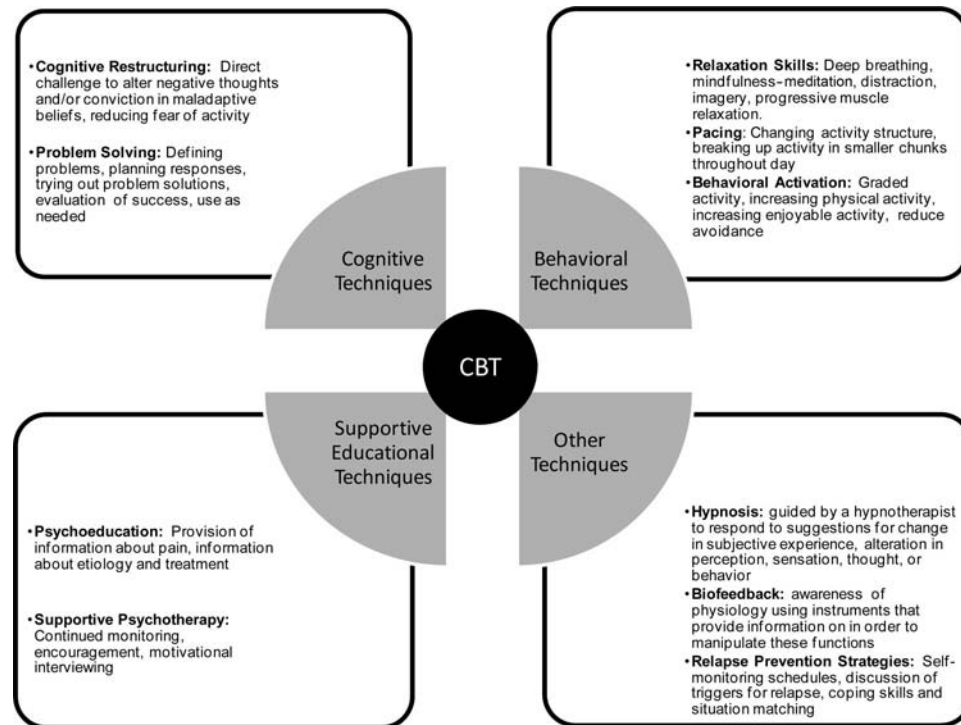
As the field of psychology accepted CBT interventions for addressing multiple problems, pain researchers and clinicians followed suit. The seminal book on this topic was published in 1983 (Turk et al., 1983). CBT remains the dominant pain treatment provided by psychologists who treat individuals with CP. However, given that the specific contents and components of CBT often vary from clinician to clinician and from research study to research study, CBT can be difficult to define and operationalize (Gatchel et al., 2007; Morley, 2011). This makes it equally difficult to compare the findings from different clinical trials.

The primary assumptions shared by all CBT interventions are as follows: (a) People are active processors of

information; (b) people are capable of gaining control over their thoughts, feelings, behaviors, and to some extent physiological processes; and (c) there are interrelationships among thoughts, feelings, behaviors, and physiological processes, and changes in one or more of these factors may result in changes in the others (see Figure 1). Moreover, with CBT there is an emphasis on or at least an inclusion of components that target maladaptive cognitive content or processes. Finally, all CBT approaches emphasize patients’ self-management of their lives coupled with optimism about peoples’ abilities to function even when experiencing symptoms such as pain or fatigue (Flor & Turk, 2011; Turk & Flor, 2006). Despite the tactical problem related to differences in the specific therapeutic elements of CBT interventions, research supports the efficacy of CBT interventions for reducing pain and improving physical and psychological functioning in adults and children with persistent pain (Eccleston, Williams, & Morley, 2009; Morley, 2011; Ostelo et al., 2005; Palermo, Eccleston, Lewandowski, Williams, & Morley, 2010), at least modestly and to a degree comparable to that for other treatments (A. C. Williams, Eccleston, & Morley, 2012).

The list of CP interventions based on cognitive and coping models (i.e., CBT interventions) is large and appears to be growing. It includes coping skills training (e.g., Keefe et al., 1999), mindfulness-based stress reduction

Figure 1
Summary of Cognitive-Behavioral Therapy (CBT) Techniques



Note. From “Cognitive-Behavioral Perspective and Cognitive-Behavioral Therapy for People With Chronic Pain: Distinctions, Outcomes, and Innovations” by M. Skinner, H. D. Wilson, and D. C. Turk, 2012, *Journal of Cognitive Psychotherapy*, 26, p. 98. Copyright 2012 by Springer Publishing Company.

(e.g., Schmidt et al., 2011), motivational interviewing (e.g., Vong, Cheing, Chan, So, & Chan, 2011), acceptance-based interventions (e.g., McCracken & Vowles, 2014, this issue; Veehof, Oskam, Schreurs, & Bohlmeijer, 2011), and graded exposure in vivo (e.g., Leeuw et al., 2008) (see Table 1).

Although a number of different treatments can be classified as CBT interventions, each has a different emphasis. For example, cognitive therapy focuses on teaching patients to monitor and evaluate their thoughts with respect to how adaptive (e.g., reassuring, calming) or maladaptive (e.g., alarming, distressing) they are, to facilitate the adaptive cognitions, and to replace maladaptive cognitions with more adaptive ones. Motivational interviewing targets “change talk” that is hypothesized to increase the probability of the use of coping responses thought to be adaptive and to decrease the probability of the use of coping responses thought to be maladaptive.

Although there is some controversy regarding whether mindfulness-based and acceptance-based treatments reflect a qualitatively different new direction (a so-called “third wave”) in CBT or are approaches most appropriately viewed as providing exercises and interventions that target cognitive coping responses that are similar to those provided by traditional CBT interventions (i.e., the classic “adaptive cognition” from Reinhold Niebuhr’s Serenity Prayer, “God, grant me the serenity to accept the things I cannot change . . .,” appears relevant to all cognitive approaches; Skinner, Wilson, & Turk, 2012), the explicit focus and emphasis of mindfulness- and acceptance-based approaches do differ in emphasis from those of cognitive therapy. Specifically, whereas the target of cognitive therapy is mostly (but not exclusively) cognitive content, or *what* one thinks about pain, emotions, and one’s plight, the target of mindfulness and acceptance approaches is mostly on *how* one thinks about pain and emotions (McCracken & Vowles, 2014).

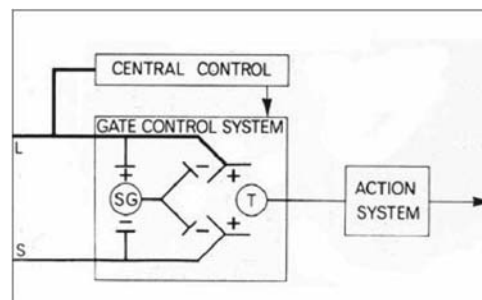
Thus, the most recent CBT approaches might be viewed as emphasizing emotion regulation as opposed to cognition regulation. Indeed, there has been increasing interest in the role that emotion—both negative and positive—plays in adaptation to CP. For example, Velasco Furlong, Zautra, Peñacoba Puente, López-López, and Barjola-Valero (2010) examined psychological vulnerability (represented by measures of domains such as depression, stress, and negative affect) and psychological assets (represented by measures of domains such as pain self-efficacy and positive affect) and found that these were associated with different outcomes in patients with fibromyalgia. Specifically, a composite measure of psychological vulnerability was associated with pain and related symptoms, whereas a measure of psychological assets was associated with better physical functioning and pain tolerance. Although evidence does not support the superiority of the newer CBT treatments over more traditional approaches (Veehof et al., 2011), it remains possible that different patients may respond more to one approach than to another. Research is needed to explore this possibility.

However, it may also be that the specific techniques used and mediating variables targeted by the different CBT interventions may turn out to be less important than the overall objective of helping patients change their view of themselves from one in which they are helpless, passive, and dependent to one in which they are active agents who are resourceful and capable of self-managing their symptoms and their lives (Flor & Turk, 2011). That is, there may be a small subset of critical change mechanisms that explain the effects of the many different psychological treatments (Jensen, 2011). The cognitive-behavioral perspective is broader than the specific cognitive and behavioral techniques used (Flor & Turk, 2011; Skinner et al., 2012). It can also be expanded to understanding how health care providers view CP and their CP patients, thereby impacting the treatments that they prescribe for them. Furthermore, the cognitive-behavioral perspective is particularly relevant in the case of chronic diseases, where cures have not been identified and the goal is rehabilitation and prevention of, or reduction in, disability.

Central Neurophysiological Models of Pain

The history of the understanding of pain reflects a shift in primary focus from peripheral to central processes. One critical turning point came with the publication of the gate control theory by psychologist Ronald Melzack and anatomist Patrick Wall (Melzack & Wall, 1965). This influential model hypothesized that the amount of nociceptive input (information from the peripheral nervous system indicating physical damage or the threat of damage) that reached the brain, and that therefore could contribute to the experience of pain, was modulated at the dorsal horn in the spinal cord by both ascending (i.e., input from the periphery) and descending (i.e., output from the brain) activity (see Figure 2). An example of ascending inhibition is that produced by rubbing a body area, which sends information to the dorsal horn that “closes” the hypothetical gate and decreases nociceptive input, thereby decreasing the amount of pain experienced. Melzack and Wall (1965) argued that

Figure 2
Gate Control Model of Pain



Note. From “Pain Mechanisms: A New Theory” by R. Melzack and P. D. Wall, 1965, *Science*, 150, p. 975. Copyright 1965 by American Association for the Advancement of Science.

a number of brain processes also influence how “open” or “closed” the pain gate is and therefore the intensity of experienced pain. These include processes related to attention, affect, interpretation, and memories.

The publication of the gate control theory had a tremendous influence on the field. It inspired research that resulted in significant advances in our understanding of the neurophysiology of pain. Moreover, the theory provided a neurophysiological model that gave psychological factors, which could be targeted by psychosocial treatments, a critical role in the pain experience. For this reason, it was often incorporated as part of psychological pain treatment, providing patients with a rationale for the importance of learning and practicing pain coping skills (e.g., Turk et al., 1983). Over time—and in particular following the development of imaging technology that allowed for a more detailed examination of pain-related brain activity—researchers have come to a greater understanding of the nervous system structures involved in the creation and experience of pain. This allows for better understanding of the impact of medical as well as psychological treatments on the central nervous system (Jensen, 2010; Melzack, 1999).

Current neurophysiological models note that there is no single “pain center” within the brain (Apkarian, Baliki, & Geha, 2009). Rather, in order to experience pain, multiple, integrated cortical systems are engaged. Pain relief occurs when these same cortical systems are disengaged or interrupted. Importantly, the brain areas involved in the processing of pain include those that underlie many psychological processes: the prefrontal cortex (involved in processing the meaning of pain), the anterior cingulate cortex (involved in the processing of the emotional or affective response to pain), and the insula (involved in the processing of information related to a person’s sense of his or her physical condition as it is related to motivation) (Jensen, 2008, 2010).

Like the gate control theory, contemporary neurophysiological models of pain provide a physiological explanation for how psychological treatments might influence the experience of and adjustment to pain. For example, any treatments that alter pain-related thoughts—which include virtually all psychological pain interventions—could be beneficial at least in part because they alter activity and processes in the prefrontal cortex. Because the prefrontal cortex is actively involved in the processing of nociceptive information that might subsequently be interpreted as pain, changes in activity in this area could potentially increase or decrease the experience of and response to pain. Treatments that alter one’s sense of physical comfort and psychological calm (e.g., relaxation training, biofeedback, hypnosis) could potentially alter activity and processing in the sensory cortex and limbic system (including both the anterior cingulate cortex and insula), which could explain how these treatments alter pain and provide patients an increased sense of control over pain.

Just as peripheral models of pain provided a rationale for the development and adaptation of psychological treatments that target peripheral activity, central neurophysio-

logical models of pain provide a rationale for developing and adapting psychological treatments that target central neurophysiology. These include electroencephalographic (EEG) biofeedback (Jensen, Grierson, Tracy-Smith, Baciagalupi, & Othermer, 2007), functional magnetic resonance imaging (fMRI) biofeedback (deCharms et al., 2005), hypnosis (Jensen, 2011), graded motor imagery (Moseley, 2006), mirror visual feedback (McCabe et al., 2003), and sensory discrimination training (Flor, Denke, Schaefer, & Grusser, 2001; Moseley, Zalucki, & Wiech, 2008).

In short, the brain is not a passive recipient of information entering from the periphery or the dorsal horn but actively processes and selects information, seeks additional information, and interprets that information. Psychological interventions for pain may have grown in prominence and continue to demonstrate efficacy in large part because these treatments target the organ that is responsible for the experience of pain and how a patient copes with and adapts to that pain.

Future Directions

Understanding the Mechanisms of Psychological Pain Treatments

Neurophysiological correlates and mechanisms of psychological treatments. A problem inherent in studying and treating patients with pain is that there are currently no objective measures to determine or validate the extent of an individual’s pain that are comparable to physiological measures such as temperature, blood pressure, or levels of serum creatinine. The only ways we have to assess pain are (a) to ask patients to report on their subjective experience and (b) to observe patients’ behavior (or to ask others to observe patient behavior) and make inferences about their subjective experience on the basis of these observations. Self-reports are important as they reflect the personal experiences of the individual. Also, as discussed previously, the thinking of persons experiencing CP influences the initiation, exacerbation, attenuation, and maintenance of pain, pain behaviors, affective distress, adjustment to CP, health care seeking, response to treatment, and disability (e.g., Carragee et al., 2005; Jarvik et al., 2005). For example, in one important prospective study, Jarvik and colleagues (2005) demonstrated that levels of depression predicted the development of low back pain three years following the initial assessment. They found that patients with depression at baseline were 2.3 times more likely to report back pain than those who did not report depression at baseline. Moreover, depression was a much stronger predictor of incident back pain than any other clinical or anatomic risk factor.

With the advent of sophisticated imaging procedures such as fMRI, it has become possible to identify regions of the brain associated with self-reports of pain. Recent studies using fMRI have been able to document unique physiological responses in the brain that are associated with prolonged pain, emotional responses accompanying pain, attentional foci, and processing of noxious stimulation

(e.g., Apkarian, Hashmi, & Baliki, 2011; Seminowicz & Davis, 2006).

Of particular interest is the use of this technology to identify changes in brain function that accompany alterations in pain perception and responses following pain treatments. Jensen (2010) has hypothesized, for example, that different psychological pain treatments and changes in the psychological factors targeted by these treatments (e.g., catastrophizing cognitions, reassuring thoughts, pain acceptance) could potentially have different effects on activity in different brain structures and processes. CBT has been shown to result in changes in brain imagery measures in a number of populations (Beauregard, 2007; Bryant et al., 2008; Felmingham et al., 2007; Frewen, Dozois, & Lanius, 2008). However, the extent to which psychological pain treatments are associated with specific changes in pain-related brain activity or structures remains to be examined. To the extent that such links are identified, it might be possible to combine treatments that target activity in these structures directly (e.g., EEG or fMRI biofeedback) with verbal-based therapies (e.g., cognitive therapy) as a way to enhance the efficacy of both.

Psychosocial correlates and mechanisms of pain treatments. Research performed over the past two decades confirms that psychological pain treatments are more effective than no treatment, standard care, and treatment conditions that control for the effects of time, therapist attention, and treatment outcome expectancies (such as pain education or relaxation training only). However, most psychological treatments result in similar outcomes (e.g., Turner & Clancy, 1988; Wetherell et al., 2011), and none completely eliminates pain for the majority of patients (A. C. Williams et al., 2012). Jensen has hypothesized that the many different extant psychological interventions ultimately impact only a small subset of primary psychological factors: specifically, (a) what patients think (cognitive content), (b) how patients think (cognitive processes or cognitive coping), and (c) what patients do (behavioral coping) (Jensen, 2011). These factors are also hypothesized to influence each other reciprocally, so that a treatment that targets only one factor likely ends up producing changes in the other factors as well. For example, operant treatment targeting behavioral change may also produce changes in beliefs and emotional states, and all three of these key variables could then influence outcome.

It remains to be determined whether any one of these factors is most important—and therefore represents a single primary final common pathway of all psychological pain treatments—or whether, and more likely, two, three, or additional possible factors contribute synergistically to outcome. With the focus in the last several decades on *if* psychological pain treatments are effective, the field has to a large extent ignored asking *which ones, provided how, when, and with whom, on what outcomes, with what level of maintenance, compared to what alternatives, and at what costs* psychological pain treatments “work.” We anticipate that addressing these other questions will be a focus of great interest in the coming decades.

Genetic variations. The rapidly expanding field of genetics has already made important contributions to the understanding of individual differences in the experience and response to pain. Genetic variations have been implicated in explaining predetermined vulnerabilities related to the distribution of sensory sensitivity, emotional distress, and initiation and persistence of pain (e.g., Diatchenko et al., 2006; Diatchenko et al., 2005). Understanding of genotypes and phenotypes related to pain is in its infancy. In the future, research on phenotypic responses may identify individuals who are predisposed to high levels of pain severity following trauma (e.g., surgery, motor vehicle collision). If “high-risk” individuals can be identified in advance, it may be possible to selectively and differentially intervene to teach these individuals adaptive self-management skills in an effort to prevent the onset of prolonged pain and related disability.

Technologically Enhanced Psychological Pain Treatments

The availability of appropriately trained therapists to provide psychological treatments for patients with CP is often limited to large urban areas and academic centers. Moreover, it is inconvenient for some patients with significant physical impairments to travel to and participate in treatment programs that extend over time. Importantly, as noted previously, no currently available pharmacological, medical, or psychological treatments are able to provide cures for the majority of people who experience persistent pain, although many of these treatments can provide reductions in symptoms and improvements in physical and emotional functioning (Turk et al., 2011). Consequently, successful pain treatment involves helping individuals learn skills that foster self-management of residual symptoms and live their lives in general.

However, significant problems can arise related to adherence to self-management programs and maintenance of initial positive benefits over long periods of time—often years if not decades. Studies that have examined maintenance of life-style changes (e.g., weight loss, smoking reduction, reduction of substance abuse) have demonstrated significant relapse rates. Thus, strategies are needed to facilitate adherence to long-term change.

One approach to addressing problems with long-term maintenance is to make use of sophisticated and rapidly evolving technologies. The evolution of Web-based programs, smart-phone applications, use of e-mail communication, and other service delivery platforms offers opportunities that can address both treatment barriers and issues of maintenance and generalization (Naylor, Naud, Keefe, & Helzer, 2010), often with the added benefits of convenience and privacy (Murray, Burns, See, Lai, & Nazareth, 2005). Findings from a number of preliminary studies support the potential of these approaches with adults (Ruehlman, Karoly, & Enders, 2012; D. A. Williams et al., 2010) and adolescents (Palermo, Wilson, Peters, Lewandowski, & Somhegyi, 2009).

Macea, Gajos, Daglia Calil, and Fregni (2010) identified 11 studies, including 2,953 patients, that evaluated

the effects of Web-based interventions for CP. Using a meta-analysis, these authors found the pooled effect size for pain reduction (standardized mean difference between intervention vs. waiting-list group means) from a random effects model was a modest but significant .29 (95% confidence interval = [.15, .42]) favoring the Web-based interventions. Other positive outcomes reported included reductions in pain behaviors, decreased depression and anxiety, greater capacity for work, reduction in medication, and reduction in physician visits.

The results achieved with technical enhancements must be viewed with caution because the studies show wide variability in the outcome assessments used, the populations studied, and both the content and the duration of the interventions. Also, there are limitations to the use of these technologies, such as difficulty in providing feedback to patients, difficulty in addressing patient questions and concerns, lack of patient motivation, and lack of patient discipline to follow treatment assignments. The relatively high attrition rates identified (greater than 25%) may be attributable to some of these factors (Macea et al., 2010). Also, the Internet pain treatment studies published to date have not included placebo control groups. Because placebo response rates in pain treatment studies are high, it will be important for future studies to incorporate attentional-control groups. Finally, although statistically significant, the effects from these treatments are small and their clinical meaningfulness has yet to be determined. On the other hand, given the relatively low cost of Web-based interventions and their ability to address concerns about treatment access, further research to refine advanced technological approaches as well as to identify the characteristics of patients who might benefit from them is clearly warranted. Furthermore, future research should investigate the potential of integrating the evolving technology with face-to-face treatments and the possibility that these technologies might be able to reduce the number of direct, face-to-face patient-therapist contacts.

Sophisticated "gaming" systems such as Nintendo Wii™ and Microsoft Kinect™ incorporate motivational enhancements to maintain players' interest in physical activity and exercise. These programs could potentially be customized to provide individually tailored encouragement and positive reinforcement. They also have the advantage of storing performance data that can be downloaded directly to computers to provide objective measures of outcome. Long-range telemetric applications may permit rapid transmission of performance data to a central computerized database in real time.

The available technological devices and programs are relatively rudimentary at this time but have significant potential for use in rehabilitation (Deutsch, Borbely, Filler, Huhn, & Guarrera-Bowlby, 2008; Shih, Shih, & Chiang, 2010). Of course, there are inherent limitations to the gaming programs as they currently exist, and they will improve with the ability to make things more personally relevant. A machine will not likely replace a clinician but can supplement what is done more directly in the clinic. Research is needed to determine how to take advantage of

the possibilities and to evaluate various parameters that can be manipulated in these systems.

Combined Treatments

As we have noted several times, current treatments for persistent pain are inadequate. When it comes to pharmacological treatment, most clinicians acknowledge that in many instances treatment of CP requires more than a single medication. Although the use of combinations of medications is common in clinical practice, there are only a handful of studies that have evaluated the potential additive benefits of multiple medications (e.g., Gilron et al., 2005; Keskinbora, Pekel, & Aydinli, 2007). Moreover, in addition to concerns about the side effects of individual medications, with drug combinations there is the added concern about potential drug-drug interactions among some of the medications most frequently combined. For example, when opioids that also have serotonergic effects, such as tramadol and tapentadol, are combined with selective serotonin reuptake inhibitors (SSRIs) and/or serotonin-norepinephrine reuptake inhibitors (SNRIs), serotonin syndrome may result.

Despite the potential value of combinations of medications such as opioids with antidepressants and antidepressants with anticonvulsants, the limited evidence available shows rather modest additive effects. Additional studies are needed to evaluate what combinations of treatments are most effective for patients with what characteristics. The potential of genomic research to match treatments to patients has great potential and offers exciting opportunities to improve pain management.

Over a decade ago, Turk (2001) suggested that the combination of behavioral and pharmacological interventions might be particularly advantageous. Systematic studies examining the efficacy of combining pharmacological and psychological treatments have been limited, however (e.g., García, Simon, Duran, Cancellor, & Aneiros, 2006; Holroyd, Nash, Pingel, Cordingley, & Jerome, 1991). Whereas behavioral interventions might target a specific brain region, pharmacological interventions have the disadvantage that they occupy all receptors, including those that may not be desirable targets and that may lead to unwanted side effects. On the other hand, behavioral interventions often do not show the immediate beneficial effects that pharmacological agents might. One systematic review recommended cognitive interventions combined with exercise for chronic low back pain (van Tulder, Koes, Seitsalo, & Malmivaara, 2006), and two evidence-based clinical practice guidelines recommended the combination of medication, exercise, and CBT for patients with fibromyalgia (Goldenberg, Burckhardt, & Crofford, 2004; Häuser, Thieme, & Turk, 2010).

Preliminary studies have described the potential additive effects of pharmacological and psychological treatments for persistent headaches. For example, Holroyd and colleagues (1995) reported that the combination of thermal biofeedback, relaxation training, and propranolol hydrochloride provided significantly greater reductions in headache activity than any of the treatments alone. Similar

results have been reported for the combination of stress management and tricyclic antidepressants for tension-type headache (Holroyd et al., 2001). Keefe and colleagues (Keefe et al., 2011) evaluated the effects of coping skills training and sertraline (an antidepressant) alone and in combination in patients with noncardiac chest pain. Although each of the active treatments significantly reduced pain intensity and pain unpleasantness, the combination had the largest effect when compared with placebo alone and had a greater impact on anxiety than did either treatment alone. Thus, evidence indicates that both with headaches and noncardiac chest pain, combination treatments had greater benefits than *either* pharmacological or psychological treatments alone for at least some outcomes. In contrast, one small study found that CBT was more effective for fibromyalgia patients than either cyclobenzaprine alone or in combination with CBT (García et al., 2006).

In a sense, most interdisciplinary pain rehabilitation programs are combination treatments in that they offer both psychological and physical treatment approaches (Gatchel et al., 2014; Jeffery, Butler, Stark, & Kabne, 2011). However, to date there have been few studies designed to dismantle these comprehensive treatments and determine the necessary and sufficient treatment components or to identify the characteristics of patients most likely to benefit from intensive rehabilitation programs.

Treatment Responders and Treatment Matching

It is important to consider that treatment response is individual, and no one approach is likely to benefit all patients. Matching of patients to particular treatments based on relevant predictive characteristics would be ideal if we had knowledge of the appropriate matching variables (Turk, 2005). Preliminary research has been conducted to identify treatment responders (e.g., 30% improvement in pain severity, 20% improvement on a functional outcome) and then use regression analyses to identify the characteristics (predictors) of treatment response. For example, Thieme and colleagues (Thieme, Turk, & Flor, 2007) identified different pretreatment characteristics associated with different response rates to CBT, relative to a treatment based on operant conditioning. More research to identify likely treatment responders is needed.

It is important to acknowledge, however, that the definition of a “responder” in such studies is critical. Clinical trials in which posttreatment or follow-up responses at a single point in time are used to define a responder may provide spurious conclusions, given the probability that outcome assessed at a single point in time may be less reliable than outcome assessed over multiple assessment points. It will likely be most useful to define responders as meeting a specific criterion at several intervals and to label them as “consistent responders.”

Prospective studies could be conducted to determine whether treatments customized to address specific patient characteristics do, indeed, produce the desired effects. Research in this area would provide an empirical basis for prescribing treatments to those most likely to benefit. It

could also inspire the development of treatments that will match to characteristics of patients who may not have responded. This strategy would lead to improved patient outcomes and would be more cost-effective than the current approach of treating all patients the same—with treatment selected based on the preferences and training of the providers rather than on the results of clinical trials. There is a great need for research that goes beyond asking the question of whether a particular treatment is effective and instead addresses what treatment is effective for which patient, and under what circumstances.

As previously discussed, given the diverse range of psychological pain treatment modalities that often demonstrate similar benefits, it is important to investigate common mechanisms that may account for the benefits observed (e.g., enhanced self-efficacy, acceptance of self-management). This can be viewed as the converse of treatment matching, where there may be common mechanisms and effects that transcend treatment modalities. Treatment recommendations should be flexible and, where possible, include patient preferences. If there is no demonstrated improvement in patient pain and functioning, then an alternate treatment approach should be recommended. Setting realistic expectations with patients is also critical, as expectations of eradication of pain are unrealistic, and false hopes unfulfilled can lead to even greater distress.

Why Knowing About Psychological Pain Treatments Should Matter to ALL Psychologists

Over the past half century, a great deal has been discovered about the nature and causes of CP and the treatment of people with CP. The more that has been learned, the more the field has recognized the critical contribution of psychologists and behavioral and cognitive science to our understanding. This may be due, at least in part, to the fact that the expertise of psychologists—expertise about the brain, behavior, and their interaction—is at the heart of both the problem of and the solution to CP. Given the fact that the focus of CP research has steadily shifted from the periphery to the brain, we anticipate that psychologists’ central role in treatment development and provision will continue to grow. In CP, psychology matters, and it will likely matter more and more as the field continues to evolve.

Psychologists who are not directly involved in pain research or treatment might use psychology’s contributions to understanding CP as a source of inspiration for theory and treatment development in other areas. For example, research in CP has identified a number of specific pain-related beliefs and coping responses consistently associated with adjustment (Jensen, 2011; Jensen et al., 1991). As briefly summarized in the previous section of this article, a large number of treatments have been developed to target said beliefs and responses. It is likely that some of these treatments could prove effective for the management of other symptoms and conditions, such as chronic itch (pruritus), fatigue, and sleep problems.

Increased appreciation of the interconnections among genetics, neurophysiology, psychology, and a plethora of

technological innovations has truly made this the “golden age” of pain study. There has never been a time when there was more optimism about improved treatment for large numbers of people with persistent pain and more hope for the prevention of prolonged pain and disability. Psychologists have made and continue to make significant contributions to the science of relieving human suffering. ALL psychologists may find it useful to understand these contributions, to continue to follow research and clinical findings in the field, and to build on and extrapolate from what has been learned to other clinical areas.

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