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Pers Soc Psychol Rev 2014 18: 256 originally published online 12 April 2014

DOI: 10.1177/1088868314527831

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The Positive Consequences of Pain: A Biopsychosocial Approach

Brock Bastian¹, Jolanda Jetten², Matthew J. Hornsey², and Siri Leknes³

Personality and Social Psychology Review
2014, Vol. 18(3) 256–279
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DOI: 10.1177/1088868314527831
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Abstract

Pain is mostly thought of as a problem—as debilitating or harmful. Despite its unpleasantness, however, under some conditions pain can be associated with positive consequences. In this review, we explore these positive biological, psychological, and social consequences of pain. We highlight three different domains in which pain may be considered to have positive consequences. First, pain facilitates pleasure by providing an important contrast for pleasurable experiences, increasing sensitivity to sensory input, and facilitating self-rewarding behavior. Second, pain augments self-regulation and enhancement by increasing cognitive control, reducing rumination, and demonstrating virtue. Third, pain promotes affiliation by arousing empathy from others, motivating social connection, and enhancing group formation. Drawing on evidence scattered across a range of academic fields, we provide for reflection on how pain is represented, generate insights into pain-seeking behavior, and draw attention to the role of painful experiences in maximizing positive outcomes.

Keywords

pain, biopsychosocial, pleasure, sensory, challenge, threat, virtue, empathy, social connection, affiliation

One of the most apparent qualities of pain is its aversiveness. For this reason, people focus primarily on reducing or eradicating pain as reflected in the size of the global analgesics market, which is predicted to reach \$US34.6 billion by the year 2015 (Global Industry Analysts, 2010). Overcoming pain is also a central research agenda. Over 20 scholarly journals are dedicated specifically to the study of pain. These journals are dominated by research highlighting the biological and psychological parameters of pain, often with a view to finding novel ways to ameliorate suffering.

This strong focus on overcoming the aversiveness of pain is clearly warranted. Research examining these issues has produced important results that have improved the lives of many. One side effect of this body of work, however, is that it has eclipsed or obscured our understanding of the complex effects of pain. Although aversive, pain may also be associated with positive outcomes.

So far, no attempt has been made to present a review of the positive consequences of pain. This is may be due to the close association between pain and negative experiences, such as illness, injury, or harm. Pain may also be found, however, in a range of normal and even healthy experiences. Pain may be evident during intense exercise (O'Connor & Cook, 1999), in some extreme sports (Le Breton, 2000), ice-swimming (Zenner, De Decker, & Clement, 1980), the consumption of chili pepper (Rozin & Schiller, 1980), or various forms of therapy such as deep tissue massage. In documenting the

positive side of pain, we draw together—and highlight novel connections between—research that is scattered across a range of fields, including biology, neuroscience, psychiatry, social psychology, evolutionary psychology, clinical psychology, and anthropology. We review and reinterpret this literature from the perspective of pain's capacity to produce positive consequences, thereby decoupling the experience of pain from the experience of suffering (cf. Turk & Wilson, 2009).

By mapping out the diverse effects of pain and by linking them to a range of positive outcomes, we aim to generate a broad template for new lines of inquiry into the experience of pain. Our aim is not to argue that pain is itself a pleasant experience (although for evidence that pain can sometimes feel pleasant see Leknes et al., 2013), but rather that the unpleasantness of pain can in turn lead to positive responses and outcomes. Nor do we attempt to weigh pain's positive consequences against its many (well documented) negative consequences. Our main aim here is simply to document the

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Table 1. The Benefits of Pain and Associated Processes.

Benefit	Process
1. Pain facilitates pleasure	
i. Pain enhances subsequent pleasure	Pain provides a contrast for pleasure, and this increases the relative pleasantness of subsequent experiences.
ii. Pain heightens sensory sensitivity	Pain heightens arousal and constrains attention on sensory experience, thereby increasing sensory receptivity.
iii. Pain facilitates pleasure seeking	Pain provides a justification for indulgence of pleasures that might otherwise arouse a sense of guilt.
2. Pain enables self-regulation and enhancement	
i. Pain increases cognitive-affective control	Pain captures attention and brings cognitive resources on-line for effective problem solving in response to the threat of pain.
ii. Pain enables identity management	Pain promotes a physical experience of the self, thereby reducing high-level self-awareness and enabling identity change.
iii. Pain demonstrates virtue	Pain may be interpreted as providing a symbolic test of a range of personal virtues.
3. Pain promotes affiliation	
i. Pain arouses empathy in others	The expression of pain increases empathy and arouses care and concern in others.
ii. Pain increases relational focus	People seek social support in response to pain. Pain therefore provides a novel source of social connection with others.
iii. Pain increases solidarity	Pain may be used to increase the value of relational ties with others, and shared pain may increase interpersonal bonding.

“other side” of pain. In doing so, we hope to shift attention from the various factors that determine or shape the experience of pain as a dependent variable, and to draw attention to the ways in which pain may produce a range of physical, psychological, and social consequences as an independent variable. In short, by exploring pain’s non-aversive outcomes, we aim to shift a focus from “what can we do for pain?” to a relatively novel account of “what can pain do for us?”

Defining Our Approach to Pain

The International Association for the Study of Pain Task Force on Taxonomy (1994) defines pain as “an unpleasant sensory and emotional experience arising from actual or potential tissue damage or described in terms of such damage” (p. 210). This definition highlights the distinction between *nociception* and *pain*. Nociception involves the stimulation of nerve fibers that convey information about potential tissue damage to the brain. Pain, on the other hand, is a subjective perception that generally arises when nociception reaches a (variable) threshold but that can be completely uncoupled from nociception (e.g., Moseley & Arntz, 2007). In certain cases, pain can arise in the absence of nociception, and in other situations even high-intensity nociception can fail to produce a subjective experience of pain. Moreover, the subjective experience of pain may be activated by a range of other inputs unrelated to nociception (e.g., social rejection, MacDonald & Leary, 2005; meaning threats, Randles, Heine, & Santos, 2013). Our approach to pain is open to a variety of experiences that may be perceived as painful. Although we draw predominantly from research focusing on the

experience of pain arising from nociception, we also draw on evidence documenting different experiences of pain, thereby demonstrating the wider significance of our approach.

The Positive Consequences of Pain

Pain’s primary function is to warn of present and potential harm, thereby promoting survival (Bateson, 1991; Wall, 1999). Indeed, the congenital absence of pain significantly increases the risk of injury and death (Damasio, 1999). Pain prompts the avoidance of harm and signals the need for escape, a function it serves ruthlessly by interrupting other goal pursuits (Eccleston & Crombez, 1999) and triggering swift instinct-based action (Damasio, 1999). Just as importantly, a range of evolved responses to pain have developed to promote recovery and healing (Walters, 1994; A. C. Williams, 2002). This threat-signaling quality of pain triggers a range of biological, psychological, and social responses aimed at promoting action, escape, and recovery. We draw on these evolved responses to pain (among others), in understanding the pathways through which pain may have a number of other positive consequences. These are outlined in Table 1. We refer to nine specific consequences of pain that are grouped according to their role in (1) facilitating pleasure, (2) augmenting self-regulation and enhancement, and (3) promoting affiliation.

Pain Facilitates Pleasure

The association between pain, pleasure, and even beauty has been a topic of historical interest. The romantic view of pain

was that, rather than being an accidental property of human life, it is essential and necessary for revealing true beauty (Morris, 1991). Viewed this way, pain and pleasure are perhaps better understood as interrelated hedonic states as opposed to polarized experiences. We discuss three ways in which pain may serve to facilitate our experience of pleasure.

Pain enhances subsequent pleasure. Pain may provide an important contrast for the experience of pleasure. In his *Discourse on the Nature of Pleasure and Pain*, Verri (1781, cited in Guidi, 1994) argued that pleasure is limited by the amount of pain it removes. That is, pleasure is understood within the context of pain and the relief of pain is itself a pleasurable experience. Consider the enjoyment of food after a long fast, the pleasure of cool water after being in the hot sun, or the sensation of a hot spa following submersion in icy cold water (cf. Leknes & Tracey, 2010). It is well known that contrast, comparison, or framing effects determine the relative value of a stimulus (Kahneman & Tversky, 1979; Seymour & McClure, 2008) and that positive (and even negative) stimuli may be experienced as rewarding in the context of (more) negative stimuli (Breiter, Aharon, Kahneman, Dale, & Shizgal, 2001; Zellner, Allen, Henley, & Parker, 2006). Indeed, a recent study of healthy volunteers found that even the experience of moderate pain can be reported as pleasant when compared to an alternative outcome of intense pain (referred to as “relative relief”; Leknes et al., 2013).

The view of pain as a homeostatic drive (A. D. Craig, 2003) provides an important framework for understanding contrast effects. Pain indicates that something is wrong with the body and that corrective action is needed. Pain is therefore both a distinct sensation as well as a motivation reflecting a behavioral drive toward re-establishing homeostasis. Importantly, this process of restoring balance is often experienced as pleasurable and the more effective a stimulus is in restoring bodily homeostasis, the more that stimulus is experienced as pleasant (Cabanac, 1979; Kringelbach, O’Doherty, Rolls, & Andrews, 2003; Small, Zatorre, Dagher, Evans, & Jones-Gotman, 2001). When a pleasant stimulus relieves an unpleasant state, that stimulus is experienced as more pleasant. Even aversive stimuli may be experienced as pleasant when they serve to relieve other more unpleasant states (e.g., Berns et al., 2006; Cabanac, 1971; Price, Barrell, & Gracely, 1980). For example, when describing his own experience as an eczema sufferer, Launer (2004) reports putting his hands under painfully hot water to relieve the intolerable itch sensation. More commonly, scratching the skin until red and raw is often pleasurable in the context of an itch (Leknes et al., 2006).

Moving beyond a focus on the hedonic quality of relief-inducing stimuli, Leknes, Brooks, Wiech, and Tracey (2008) demonstrated that relief from pain itself (i.e., the lack of stimulation following the offset of pain) is a positive hedonic experience (see also Franklin, Lee, Hanna, & Prinstein,

2013). Based on the use of painful heat and a skin irritant (capsaicin), their results demonstrated that (1) the sudden termination of a painful sensation elicits self-reported positive affect, (2) relief increases with the intensity of pain, and (3) the pleasantness of relief increases with the efficacy and speed of return to homeostatic balance (i.e., when cooling of the skin facilitated relief). These positive affective states associated with relief from pain have also been demonstrated in conditioning studies, where pairing pain offset with neutral stimuli results in approach toward/liking of those stimuli (see Andreatta, Mühlberger, Yarali, Gerber, & Paul, 2010; Tanimoto, Heisenberg, & Gerber, 2004; Zanna, Kiesler, & Pilkonis, 1970).

Leknes et al. (2008) drew on opponent process theory in describing these effects. This theory holds that, for each unpleasant stimulus or emotion that triggers a negative affective reaction, there is also a process of opposite valence which has a slower onset and offset, returning the system to homeostatic balance (Solomon, 1980). From this perspective, pain produces subsequent pleasurable experiences that arise in response to the relief of pain. Importantly, this opponent “overshoot” would be apparent only when the experience of pain ends abruptly. Pain that recedes slowly (like a headache) would camouflage detection of the opponent process.

A proposed mechanism underlying the pleasurable relief from pain or threat of pain is the activation of the brain’s reward circuitry (Leknes et al., 2013; Leknes et al., 2008; Leknes, Lee, Berna, Andersson, & Tracey, 2011). Indeed, the brain’s reward circuitry may under certain conditions be activated by painful stimulation (e.g., Becerra, Breiter, Wise, Gonzalez, & Borsook, 2001; Gear, Aley, & Levine, 1999; Zubieta et al., 2001). This could help to explain why people in some circumstances repeatedly seek out painful experiences (Fields, 2007; Roth, Ostroff, & Hoffman, 1996; although see Franklin, Puzia, et al., 2013, for evidence that self-harm may not be motivated in these ways). Pain elicits release of dopamine and endogenous opioids, which have been linked to learning, motivation, and the experience of pleasure (e.g., Leknes & Tracey, 2008; Zubieta et al., 2001). Furthermore, molecular imaging studies have demonstrated that the opioid system remains activated after the cessation of pain (e.g., Sprenger et al., 2006). That is, the ongoing release of opioids after the cessation of pain may explain why the relief of pain is pleasant.

The possibility that opioid release triggered by pain may be experienced as pleasurable is supported by research demonstrating that endogenous opioids underpin a positive shift in affect across the hedonic spectrum (i.e., decreasing pain and increasing pleasure; Leknes & Tracey, 2008). Specifically, this positive shift indicates that activation of the opioid system, which may be caused by either pain or pleasure (Smith & Berridge, 2007; Zubieta et al., 2001, 2002), causes positive stimuli to be experienced as more pleasant and negative stimuli as less unpleasant. Direct activation of

opioid receptors with morphine enhances pleasant experiences in rats, increasing the sweet component of a bitter-sweet taste (reflected in positive facial affective reactions; Doyle, Berridge, & Gosnell, 1993; Pecina & Berridge, 1995; Rideout & Parker, 1996) and suppressing negative aversive reactions to bitter tastes (Parker, Maier, Rennie, & Crebolder, 1992). Endorphins have also been linked to the greater enjoyment of sexual behavior (Murphy, Checkley, Seckl, & Lightman, 1990).

The state of euphoria experienced by some people after intense exercise, often referred to as “runner’s high,” is also underpinned by endogenous opioid release. Specifically, in two studies, perceived euphoria was related to opioid release in the brain’s reward system (Boecker et al., 2008), and the “runner’s high” was blocked by opioid antagonist treatment (Daniel, Martin, & Carter, 1992). This research demonstrates that endurance running can produce subsequent positive experiences through activation of opioid receptors.

Importantly, pain is a central feature of intense aerobic exercise (O’Connor & Cook, 1999) which places limits on intensity and performance (Anshel & Russell, 1994; Mauger, Jones, & Williams, 2010; O’Connor, 1992). It may be that nociceptive stimulation is related to the euphoric experiences arising from intense aerobic exercise.

Activation of the reward system has also been linked to the production of analgesic states (Benedetti, Mayberg, Wagner, Stohler, & Zubieta, 2005; Dum & Herz, 1984; Forsberg, Wiesenfeld-Hallin, Eneroth, & Sodersten, 1987). To the extent that pain activates the reward system, the experience of pain may inhibit other painful experiences. Consistent with this notion, Gear and colleagues (1999) showed that sub-dermal injection of capsaicin (a skin irritant made from chilies) or paw immersion in hot water activated antinociception in rats, and this nociceptive control depended both on opioid and dopamine in the nucleus accumbens. Research on human participants also supports pain-induced analgesia (e.g., Piche, Arsenault, & Rainville, 2009). Experimentally induced pain has been shown to attenuate sensory and pain-specific affective responses through activation of the opioid system (Zubieta et al., 2001; although see Gilchrist, Allard, & Simone, 1996, regarding cases of secondary hyperalgesia).

Disruptions in opioidergic brain activity have also been linked to sadness and depression (Kennedy, Koeppel, Young, & Zubieta, 2006; Prossin et al., 2011; Zubieta et al., 2003), suggesting that physical pain may help regulate emotional pain by activating endogenous opioid release. This is analogous to thrill-seeking behavior (Franken, Zijlstra, & Muris, 2006), which may alleviate emotional numbness through activation of the endogenous opioid system. Likewise, a common motivation for the act of self-harm, which itself is known to activate the endogenous opioid system (Nock, 2010a, 2010b; Symons, Thompson, & Rodriguez, 2004), is the relief of emotional numbness and regulation of negative affective states (Franklin et al., 2010; Franklin, Lee, et al.,

2013; see also Franklin, Puzia, et al., 2013, for an account of how pain offset relief may regulate negative affect by commandeering shared neural substrates and thereby incidentally relieving emotional pain). Although the reduction of emotional pain is not, strictly speaking, the same thing as the production of pleasure, relief from emotionally painful states may be pleasurable in the same ways that relief from pain has been found to be (Franklin, Lee, et al., 2013; Leknes et al., 2008).

Considerations. Pain’s capacity to produce pleasant states has been largely demonstrated through experimental research on rats and humans. The evidence is mostly limited to acute, experimentally induced pain, or pain associated with specific activities such as running. To the extent that the pleasurable consequences of pain are leveraged from a distinct experience of pain offset (such as opponent processes and positive affective states), these consequences are unlikely to be comparable in cases of chronic pain, where pain may fluctuate but the threat of future pain is very real.

It remains unclear how these processes may develop over time with repeated pain. Opponent process theory suggests that, over repeated instances, the initial (painful) process should become blunted while the opponent (pleasurable) process increases (Solomon, 1980; Solomon & Corbit, 1974). This increasing reward responsiveness to pain could also reinforce behaviors such as self-harm (perhaps through activation of the endogenous dopamine system; although see Franklin, Puzia, et al., 2013, for evidence that this may not occur), leading to dysfunctional outcomes over the longer term.

Notwithstanding these considerations, the point remains that pain can play a role in providing access to pleasurable experiences. Whether these effects may translate to pain arising from other sources, such as social pain, remains an open question and suggests a fruitful future research direction. To the extent that the experience of social pain activates the endogenous opioid system (MacDonald & Leary, 2005) and would provide a contrast for subsequent pleasure, it may also be linked to the production of pleasant states.

Pain heightens sensory sensitivity. Pain is ontogenetically and evolutionarily disposed to recruit resources aimed at action and escape (Eccleston & Crombez, 1999; Shackman et al., 2011). Pain increases arousal (Pfaff, 2006; Price, 2000) and awareness of the immediate physiological condition of the body (A. D. Craig, 2002, 2003, 2009). In so doing, pain interrupts other goal pursuits by directing attention to the immediate pain event (Crombez, Eccleston, Baeyens, & Eelen, 1996; Legrain et al., 2009). Together these effects facilitate an effective response to the threat of pain.

This evolved response to pain heightens awareness of the immediate sensory experience of pain. It may also, however, have implications for how other sensory experiences, occurring close to the offset of pain, are processed and responded

to. This is because the body remains in a vigilant state after pain, serving to maintain increased arousal and awareness of further physiological and environmental threat. During this state, awareness is generalized to focus on the physiological condition of the body, and this increases receptivity, and therefore sensitivity, to sensory experiences more broadly.

The primary threat-signaling function of pain may serve to facilitate pleasure. Perception research has established that arousal enhances responsiveness to goal-relevant or high-priority stimuli (Mather & Sutherland, 2011). In this way, the arousal-inducing effect of pain may serve to enhance sensory perception. Under conditions of high arousal, participants are faster to respond to goal-relevant stimuli and are better able to ignore irrelevant stimulus characteristics when asked to classify stimuli on a focal dimension (Chajut & Algom, 2003; Cornsweet, 1969). These findings indicate that high-priority stimuli become more apparent in the process of perception under conditions of high arousal. As a powerful source of arousal, pain would be expected to enhance sensory perception in these same ways. Indeed, painful stimulation (electric shock) has been used as a source of arousal in previous research (Cornsweet, 1969).

Pain's capacity to capture attention and focus awareness on the immediate physiological condition of the body can also increase sensory engagement. This effect of pain is sometimes used to increase sexual enjoyment and excitement (Baumeister, 1988). Work by Masters and Johnson (1970) in the area of sex therapy promotes the use of a "sensate focus" which involves directing attention to immediate bodily sensations. The notion that shifting awareness to bodily sensation, and away from evaluative self-awareness, increases the intensity of sensory experience is also supported by the use of mindfulness-based interventions for eating disorders which, among other things, aim to increase physical sensations such as taste (Kristeller, Baer, & Wolever, 2006).

Consistent with these effects of mindfulness, evidence suggests that the offset of acute pain enhances the capacity to savor and enjoy positive sensory experiences (Bastian, Jetten, & Hornsey, 2014). For example, after experiencing laboratory-induced pain (the cold-pressor task), participants reported greater enjoyment of pleasant tasting food (chocolate). In order to determine whether this effect may be in part explained by increased sensitivity to taste, two follow-up studies found that pain increased the rated intensity of a range of flavors (both pleasant and unpleasant) and increased sensitivity to different flavor. Other research found similar effects in the case of chronic pain patients, who rated gustatory stimuli as more intense and were also more sensitive to these stimuli (Small & Apkarian, 2006).

Considerations. In detailing pain's capacity to heighten sensory sensitivity, we have drawn on well-known effects of pain, and converging evidence from other research domains. We have also reported a series of experimental

studies designed to directly examine these effects of pain in the domain of taste. More research is needed to provide a better understanding of these sensitizing effects of pain and whether they extend to all sensory domains.

It is noteworthy that research examining the sensitizing effect of pain has to date largely focused on its downside. For example, heat injury to the skin may result in primary and secondary hyperalgesia (increased sensitivity to pain at, or near, the site of pain: Raja, Campbell, & Meyer, 1984) and this increased sensitization may also spread to unrelated bodily regions and become chronic (e.g., complex regional pain syndrome; see Birklein, 2005). Increased sensitivity to pain (nociceptive sensitivity) may arise due to increased excitability of the nociceptor terminals (i.e., peripheral sensitization, Julius & Basbaum, 2001) or increased reactivity of central pain-signaling neurons (i.e., central sensitization, R.-R. Li, Kohno, Moore, & Woolf, 2003). Thus, pain's capacity to increase sensitivity can have a range of negative effects. Although converging evidence suggests that sensitization in response to pain may also enhance positive sensory experiences, more research is needed.

Furthermore, we would expect that these effects are largely limited to painful experiences that are physical in nature. For example, research has provided evidence that social pain causes cognitive deconstructive states, emotional numbness, and a loss of time perception (Twenge, Catanese, & Baumeister, 2003). It is unlikely that increased sensory awareness would correlate with these outcomes.

Pain facilitates pleasure seeking. Pain may provide a convenient justification for people to seek out personal pleasures. Adversity is a common motivator of self-reward (Fetchenhauer & Huang, 2004; Freud, 1916/1957; L. Li & Moore, 2001) and unfair treatment makes people feel more entitled and more likely to compensate themselves (Austin & Walster, 1975; Zitek, Jordan, Monin, & Leach, 2010). Pain is not only adverse, but is also often associated with concepts of justice and fairness. People often report feeling punished by their pain (Glucklich, 2001; Koffman, Morgan, Edmonds, Speck, & Higginson, 2008), and the link between pain and punishment is evident across a range of contexts: parents spank their children, crime has historically had torturous consequences, and pain is often used as an effective negative reinforcement for behavior (Skinner, 1938). Indeed, the Latin word for pain—*poena*—is literally translated as "to pay the penalty." As such, experiences of pain may also activate concepts associated with punishment and justice (L. E. Williams, Huang, & Bargh, 2009), and "unfair" pain may allow people to feel justified in their indulgence of "guilty pleasures."

Bastian, Jetten, and Stewart (2013) directly explored this possibility in two studies. In the first study, they found that participants who experienced pain were more likely to self-reward by taking sweets from a bowl than those who did not experience pain. This effect, however, was evident only

when pain was preceded by a reminder of their past moral behavior. When participants recalled an immoral (as opposed to moral) past behavior, pain did not increase self-reward beyond that observed in a no-pain condition (where participants just wrote about a moral behavior). This pattern indicated that only “unfair” pain leads to self-indulgence. In the second study, Bastian et al. (2013) asked participants to choose a gift from a bowl containing either highlighters or chocolates. It was predicted that pain not only leads to self-reward, but that it specifically allows people to indulge in pleasures that would normally arouse a sense of guilt (i.e., the chocolate—a “guilty pleasure”). Indeed, participants who experienced pain were more likely to take the chocolate. Furthermore, the effect was evident only for people who were especially sensitive to being the victims of injustice (i.e., high in justice sensitivity, M. Schmitt, Gollwitzer, Maes, & Arbach, 2005). As such, both studies provided support for the role of justice-related cognition in determining responses to pain, a response that was found to shape pain-related self-indulgent behavior.

Converging evidence for self-indulgence in response to pain comes from work investigating economic decision making. In one study, participants who experienced acute pain (laser induced heat to the hand) accepted more unfair offers in an economic ultimatum game, but this occurred at the expense of altruistic punishment of unfair proposals (a response which serves to reinforce social norms for fair behavior; Mancini, Betti, Panasiti, Pavone, & Aglioti, 2011). Similar findings are reported from a study on chronic pain patients whose decisions in a gambling game were motivated by maximizing immediate gains, but which resulted in larger future losses (Apkarian et al., 2004). Research focusing on other kinds of pain has also revealed a propensity for self-indulgence. After an episode of social pain, participants engage in increased entitlement behaviors (Poon, Chen, & DeWall, 2013), indulge in unhealthy but rewarding snacks (Twenge, Catanese, & Baumeister, 2002), and focus on immediate rewards versus longer term goals (Twenge et al., 2003). Together with the above evidence, these findings support the notion that people are more responsive to immediate rewards after pain, albeit at the cost of longer term benefits.

Considerations. Evidence for pain’s capacity to facilitate pleasure seeking comes from experimental research focusing on self-reward and economic decision making, and spans both acute and chronic pain. There are, however, only a handful of studies reporting these effects. Moreover, these same responses to pain may well become problematic in the longer term. As demonstrated by Mancini et al. (2011), seeking immediate gains may come at the expense of longer term gains. This downside is also evident from work showing that chronic pain patients may overindulge, leading to medication abuse and dependence (Kouyanou, Pither, & Wessely, 1997) and substance abuse more generally (Fishbain, Rosomoff, & Rosomoff, 1992). Chronic and persistent social pain

has also been linked to higher rates of smoking (Landrine & Klonoff, 1996), and drug and alcohol use (Gibbons, Gerard, Cleveland, Wills, & Brody, 2004). To conclude, a tendency to self-indulge in immediate rewards is likely to lead to poor consequences in the longer term. Nonetheless, pain may facilitate increased enjoyment of these rewards in the short term.

In sum, we have reviewed evidence that pain not only provides an important contrast for the experience of pleasure, it may also produce pleasurable experiences, enhance sensitivity to pleasurable stimuli, and facilitate self-rewarding behavior. Together, these consequences of pain demonstrate an important link between the experience of pain and the experience of pleasure. We next turn our attention to how pain can enhance self-regulation and bolster self-image.

Pain Enables Self-Regulation and Enhancement

In this section, we discuss the relationship between pain and three aspects of self-regulation, including the ability to direct and control thought and action, the ability to regulate emotion, and the capacity to assert a positive identity and negotiate identity change.

Pain increases cognitive-affective control. Environments in which physical pain is present are commonly defined by uncertainty, substantial risk, and competing behavioral responses. Optimal instrumental behavior in such threatening environments requires cognitive control (J. A. Gray & McNaughton, 2000; Norman & Shallice, 1986). For this reason, the primitive flight/fight response to pain requires that cognitive resources are brought on line to determine an optimal course of action. This link between pain and increased cognitive control is directly supported by the adaptive control hypothesis (Shackman et al., 2011). Drawing from observations that the anterior midcingulate cortex (amCC) makes a similar functional contribution to negative affect, pain, and cognitive control, Shackman and colleagues have argued that all three tend to engage the same processes to solve conceptually similar problems (see also Yeung, Botvinick, & Cohen, 2004). By triggering this neural system, pain therefore increases the capacity for cognitive control and behavioral inhibition (Botvinick, 2007; Cisek & Kalaska, 2010).

In addition to recruiting cognitive control, pain may also enhance emotion regulation. Distraction is an effective emotion regulation strategy (Gross, 1998) and pain fulfills this function very effectively. As noted by Nock (2010a, 2010b), physical pain associated with self-harm serves as a distraction from emotionally distressing thoughts and feelings, thereby reducing the tendency to ruminate on these mental states. Although self-harm regulates undesirable affective states, pain in the context of self-harm is complicated by self-destructive tendencies. Thus, people sometimes replace self-harm with non-harmful but painful methods such as holding ice, snapping one’s wrist with a rubber band, or intense

physical exercise (Klonsky & Glenn, 2008). Although these alternative approaches are not empirically supported treatments for self-injury (Nock, 2010a), case evidence suggests that physical exercise may be an effective replacement behavior for self-injury (Wallenstein & Nock, 2007), presumably because this activity also has the capacity to regulate undesirable affective states.

Additional evidence that pain can regulate unwanted affective states comes from work on interventions such as mindfulness-based therapies (Hofmann & Asmundson, 2008) or acceptance and commitment therapy (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). These interventions rest on the insight that patients suffering from depression can escape unhelpful rumination on negative thought content by focusing their attention on objects and events that are immediately present. These kinds of interventions are not dissimilar to traditional forms of meditation that are often utilized to “empty the mind” and “clear the head” (Epstein, 1999; Kabat-Zinn, 1991). In short, bringing people’s awareness into the present moment appears to be a particularly good strategy for regulating unwanted emotion states. Physical pain serves this purpose ruthlessly, capturing attention and reducing awareness of mental content.

Direct evidence for the role of pain in triggering cognitive-affective regulation comes from work on non-suicidal self-injury (Franklin et al., 2010). Franklin and colleagues found that participants who were exposed to pain (cold-pressor task) showed increased affect regulation (startle-alone reactivity) compared to a no-pain control group. The study also provided evidence for enhanced quality of information processing in response to pain (measured as prepulse inhibition, which has been associated with greater executive functioning, Bitsios & Giakoumaki, 2005) in a self-harming clinical sample. More recently, Franklin and colleagues (Franklin, Lee, et al., 2013; Franklin, Puzia, et al., 2013) demonstrated that pain offset relief serves to regulate affective valence, by increasing positive affect and reducing negative affect.

Considerations. The evidence that enhanced cognitive-affective regulation can be a positive consequence of pain comes primarily from studies examining acute pain, such as pain associated with self-harm, including both case studies and experimental research. Not all types of pain or all stages in the experience of pain may produce these effects. The attention-grabbing quality of ongoing pain or fear of impending pain is likely to impair cognitive-affective regulation (Crombez, Eccleston, Baeyens, & Eelen, 1997). Therefore, persistent or chronic pain can produce deficits rather than improvements in the ability to regulate (Kewman, Vaishampayan, Zald, & Han, 1991). Consistent with the focus of this review, it is only at the offset of pain that we would expect to find enhanced regulation of cognition and affect. Future research could examine whether these effects of pain may be evident in tasks involving self-control. For example, does

the experience of physical pain enhance subsequent executive function and memory, and does it enhance self-control in other domains such as behavioral inhibition or persistence on aversive tasks?

It is critical to note that although we draw on evidence from studies on self-harm, we believe it is the “hurt” of pain and not the “harm” associated with self-injurious behavior that enhances cognitive-affective regulation. In fact, the injuries associated with self-harm are commonly a source of anger, guilt, and shame about having engaged in the act (Klonsky, 2009), serving to undermine rather than enhance cognitive-affective regulation. It is thus instructive to note, as we do above, that a number of less harmful activities (e.g., holding ice) that also involve pain may be substituted for acts of self-harm. This also suggests that in non-clinical samples, pain may be an effective avenue through which self-regulation is enhanced. Take for example the cliché of slapping oneself when tired and driving a car to maintain attention and alertness to the task at hand. In everyday life, people are often exposed to contexts that reduce self-regulation (Baumeister, Bratslavsky, Muraven, & Tice, 1998) and pain may be one avenue through which this resource can be bolstered.

Pain enables identity management. By pulling attention to a real or potential injury site, pain grounds people within an immediate bodily awareness of themselves (cf. Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). This effect of pain not only distracts people from emotional content, but it also reduces high-level awareness of a symbolically mediated, temporally extended identity (i.e., thoughts about oneself in the past or future). Although people generally prefer to be aware of themselves in high-level terms, applying a broad perspective on one’s activities and relationships (see Wegner, Vallacher, Macomber, Wood, & Arps, 1984), reducing high-level awareness of oneself may be both desirable and useful in some contexts. Shifting between different levels of self-awareness provides an avenue for effective identity management. For example, Baumeister (1988) proposed that the practice of masochism (generally involving the experience of controlled and injury free pain) reduces the individual’s high-level awareness of him- or herself, replacing this with a low-level awareness of oneself as a mere body experiencing sensations and movements. As noted by Califia (1983), “A whip is a great way to get someone to be here now. They can’t look away from it, and they can’t think about anything else” (p. 134). Scarry’s (1985) analysis of pain in the context of torture also supports this notion. She suggested that the sensation of pain reduces broader awareness of oneself and the world, that is, bodily pain supersedes high-level awareness. In such cases, reflective awareness is temporarily unavailable, and attention is narrowed to the immediate present, both spatially and temporally.

This effect of pain may allow people to “escape the self” as experienced at higher levels of awareness. The desire to

escape from high-level self-awareness may be very common. High-level awareness can easily become aversive due to unfavorable evaluations, awareness of potential failure, or the experience of interpersonal rejection. Indeed, people are often unable to live up to their ideals and goals, and this realization is troubling (Gibbons & Wicklund, 1976). In these contexts, pain leads people to focus on immediate, low-level aspects of themselves, thereby relieving the adverse effects of high-level self-awareness.

By promoting a focus on low-level representations of oneself, pain also provides a mechanism to seek out new higher level representations. People are sensitive to the larger meanings and implications of what they are doing; they are motivated to re-emerge from low-level awareness to higher level conceptual representations (Vallacher & Wegner, 1987; Wegner et al., 1984). Pain provides a vehicle through which the individual becomes open to novel higher level representations made available within the immediate context.

This effect of pain is often exploited in initiation ceremonies in which the explicit purpose is to provide a passage for the individual into a new identity (e.g., passage into adulthood or a new social identity). Initiation ceremonies often involve beatings, exposure to cold, withdrawal of food and water, bodily mutilation, and flagellation (Aronson & Mills, 1959; Whitehouse, 1996). van Gennep (1977) described this process as separating oneself from one's current status as a member of one group (e.g., children, lower status) and transitioning to a new status as a member of a new group (e.g., adults, higher status). By disrupting high-level awareness, painful initiation rites facilitate a shift in identity, allowing for redefinition of the self and therefore personal alignment with new roles or memberships.

Considerations. Our argument that pain facilitates identity management is based on indirect and anecdotal evidence regarding the effects of pain in this domain. To this end, the processes that we articulate remain to be fully tested and represent a promising avenue for future research. It would be expected that the capacity to manage one's identity through the use of pain would be most apparent for instances of acute pain, and may easily occur over repeated occasions. Experiences of chronic pain have been linked to maladaptive changes to the self-image (Gatchel, Peng, Peters, Fuchs, & Turk, 2007).

We draw on painful initiation ceremonies in detailing this benefit of pain. As with examples of self-harm, we argue that the important ingredient in these ceremonies is pain, and not the harm, mutilation, or potential trauma associated with these practices that allows for identity management. Indeed, the exposure to psychological trauma tends to fracture one's identity. As such, we would expect these benefits to arise in cases where people feel challenged, rather than threatened and traumatized, by these initiation experiences.

Pain demonstrates virtue. Pain can also serve to demonstrate one's character. It has been argued that painful experiences

provide a basis for furnishing the self with new meaning (Baumeister, 1988; cf. Sartre, 1938/1949). Enduring pain communicates certain qualities about oneself, and these qualities reflect the meaning and purpose given to pain (Morris, 1991; Schneider, 2009; cf. Bem, 1972). Enduring pain may be understood as a challenge in some contexts (Blascovich & Tomaka, 1996), highlighting qualities of the individual relevant to the particular challenge. For example, enduring pain (such as through self-flagellation) within religious contexts can highlight positive spiritual qualities (Glücklich, 2001). In sporting contexts or war, enduring pain highlights heroic or perhaps masculine qualities, and in childbirth, feminine qualities.

Morris (1991) noted that tolerance of pain fosters a perception that a person is noble and heroic (see also Nietzsche, 1882/1974). Pain has historically been understood as something that ennobles even as it destroys. Images of St. Sebastian pierced with arrows and Jesus Christ hanging on the cross provide clear examples of the way enduring pain may reveal inner virtue. Virtue revealed through the tolerance of pain is also evident in many contemporary sporting contexts, where injured players are praised for continuing to compete regardless of their pain. Demonstrations of bravery and heroism through the tolerance of pain are often motivating to others, persuading those others to join the hero's cause.

Pain is a particularly visceral challenge. Overcoming pain requires that people moderate their responses to a primary defense system that has the capacity to interrupt all other goal pursuits and to overwhelm complex thought and emotion. Maintaining composure and alternative goal pursuits in the face of pain is a clear demonstration of self-mastery and determination.

Work on affect control theory (MacKinnon, 1994; Smith-Lovin & Heise, 1988) suggests that when people are able to exert control over pain, they experience that event as identity affirming. This finding is consistent with work on challenge and threat theory (Blascovich & Mendes, 2010; Blascovich & Tomaka, 1996) showing that when the demands of pain are experienced as a challenge, they will promote an approach-like state where people experience a sense of pride and increased self-esteem. When people endure painful experiences for a particular reason or purpose, and when they feel challenged rather than overwhelmed, those experiences are capable of producing positive emotions signifying accomplishment (Schneider, 2009). Overcoming pain provides a sense of self-efficacy, mastery, and competence. Feeling that one possesses control over one's life is not only important for healthy psychological functioning (e.g., Leotti, Iyengar, & Ochsner, 2010), but the experience of maintaining or regaining control over pain is likely to highlight one's personal capacity for self-directed action. In short, the control of pain is an achievement that creates pride and reflects positively on the individual.

Virtues such as patience, endurance, perseverance, self-mastery, temperance, respect, concern, care, and humility are

often associated with people who conquer painful challenges (Throop, 2008). It is not surprising that pain therefore can be employed as a symbol of a diverse range of virtues. For example, market research by Tylenol revealed that 18- to 34-year-old adults rate pain as “cool” (Grapentine, 2004): “For this new generation pain is a badge. Pain is a rite of passage; it means you are living life to the fullest” (Mehr, 2005). Other work focusing on a sector of the lesbian population in China found that the tolerance of pain associated with tattooing was used as evidence of “butch” or masculine qualities (Liu, Liu, & Elliott, 2010). This work demonstrated that this population deliberately sought pain and cemented their new identities by transcending their suffering and creating new meaning. In these cases, tolerating pain is used as a symbolic behavior from which people may infer valuable internal attributes (e.g., Bem, 1972).

One reason that pain may be particularly effective in conferring virtue on the individual is that pain endows events, and the meaning associated with them, with a highly arousing and visceral reality (Scarry, 1985). This effect of pain is also noted in anthropological observations. For example, Tedlock (1976) reported the use of pain to demonstrate honesty in Zuni Indian culture where the swearer puts an arrow down his throat to show that the words emanating from his mouth had their source in the realm of material substance. Hutton (1968) similarly reported a case where a member of the Sema Naga people from India, when taking an oath, bit off his own finger to demonstrate his dedication. Pain provides a particularly valuable vehicle through which virtues can be communicated to oneself and others.

In addition to providing proof of virtue, pain has the capacity to restore virtue when an individual’s integrity has been threatened. As we noted earlier, people often interpret pain within a justice-related framework (Glucklich, 2001). When interpreted this way, the experience of pain provides a vehicle through which people restore a sense of their own integrity and restore their virtue in the eyes of others. Pain is used in these ways within many religious traditions, serving as a form of repentance to God for humanity’s sinful nature. For example, Shia Muslims whip themselves with *zangirs*, whips made of knife blades, until their backs are covered with blood. In the Hindu ritual of *kavadi*, believers use meat hooks and skewers to pierce their legs, face, and tongue. In Christianity, “mortification of the flesh” is evident across many cultures. Practices range from wearing hair shirts and chains to various forms of self-flagellation, even self-castration. Pain, it seems, is the embodiment of atonement. That is, pain may be understood as having the capacity to re-balance the scales of justice through processes akin to retributive justice (Darley & Pittman, 2003; Freud, 1916/1957).

Research has demonstrated that people are motivated to self-punish when they feel guilty (Nelissen & Zeelenberg, 2009). Moreover, pain provides a particularly effective avenue for self-punishment. Bastian, Jetten, and Fasoli (2011) found that participants who were made to feel guilty held

their hand in ice-water for longer and also rated the experience as more painful compared to those who were not made to feel guilty. That is, they were motivated to experience pain. Critically, subjecting themselves to pain also reduced participants’ guilt and did so to a greater degree than participants in a control condition who were also made to feel guilty but completed a non-painful physical task (see also Inbar, Pizarro, Gilovich, & Ariely, 2013). Pain can therefore reduce guilt and restore one’s integrity and virtue.

Pain also serves to reduce the perception of one’s guilt by others. The expression of pain has been shown to reduce others’ judgments of guilt for past wrong-doing (K. Gray & Wegner, 2010) and the perception that one has the capacity to experience pain reduces attributed blame for moral transgressions (K. Gray & Wegner, 2011). What is critical about these links between pain and restoration, as opposed to more severe or damaging forms of self-punishment, is that even pain experienced in positive contexts (such as exercise or other physical challenges) may have the capacity to restore virtue.

Considerations. The evidence that pain may serve to demonstrate and restore virtue comes from anecdotal, historical, anthropological, and sociological accounts of pain. More recently, however, experimental evidence using pain induced in the laboratory and within non-clinical populations has confirmed these effects. Not all pain will necessarily enhance virtue, however, and when stupidity or careless behavior leads people to experience pain, this is unlikely to be identity affirming. For example, responding to acute pain with fear and intimidation would tend to undermine rather than strengthen a perception of virtue. Furthermore, although people who manage chronic pain may be praised for their ability to overcome adversity, constant reminders of this virtue may become tiresome. Other types of pain may also be used for this purpose. For example, long periods of solitude (social pain) are often viewed as indicating strength of character, and may be used to demonstrate virtues such as self-reliance and emotional fortitude. Enduring undeserved ostracism may also be understood in these same ways.

We have reviewed evidence that pain increases self-control, disrupts high-level awareness (thereby reducing mental rumination and facilitating identity change), and demonstrates and restores a range of personal virtues. We next turn to ways that pain may promote social affiliation.

Pain Promotes Affiliation

The primary evolutionary function of physical pain is to alert us to potentially harmful biological threats. Our response to this threat is to seek out safety and protection, both of which are manifest in social support from others. By highlighting that people seek affiliation and social support in response to pain, we aim to show that pain serves to promote connection with others and increase the value we place

on social bonds. Indeed, strengthening our social connections with others provides a range of positive outcomes, improving health and well-being (Jetten, Haslam, & Haslam, 2011), reducing depression and distress (Brook, Garcia, & Fleming, 2008; Iyer, Jetten, Tsivrikos, Postmes, & Haslam, 2009), and even reducing susceptibility to the common cold (Cohen, Doyle, Turner, Alper, & Skoner, 2003). Close relationships represent a basic and positive element of human life (Buss & Schmitt, 1993) and are an important element of psychological development and emotional equanimity (Baumeister & Leary, 1995; Bowlby, 1969/1982). We review and discuss three ways that pain may promote affiliation and social bonding.

Pain expression arouses empathy in others. One way in which pain may promote affiliation is through the expression of pain to others within one's immediate environment. Indeed, it is well documented that people express pain to facilitate assistance from others to escape threat, recover, and heal (for a review of pain communication see Hadjistavropoulos et al., 2011). Here we move to a focus on the expression of pain, as opposed to the experience of pain, and outline how pain may trigger empathy and therefore affiliative responses from others.

Evidence suggests that human beings have evolved a distinct and specific facial expression of pain (A. C. Williams, 2002). This expression is observable from infancy to old age, is consistent across a range of pain-eliciting stimuli, and is recognizable as pain by observers. The facial expression of pain is incorporated with verbal and non-verbal vocal activity, posture, and movement in an overall category of pain behavior. Interestingly, facial expressions of pain are more easily detected by observers when the individual attempts to suppress rather than amplify or simulate their pain. This finding indicates that people have poor voluntary control over their expressions of pain (A. C. Williams, 2002). Even so, pain expressions can be adjusted to some degree through suppression or exaggeration (Crombez & Eccleston, 2002; Larochette, Chambers, & K. D. Craig, 2006), and these expressions are sensitive to the presence of others (Sullivan, Adams, & Sullivan, 2004; Vervoort et al., 2008). In short, the expression of pain occurs both at an automatic reflexive level and at a controlled, intentional, and reflective level.

Importantly, this split between automatic and controlled expression of pain also characterizes observer reactions to pain (K. D. Craig, Versloot, Goubert, Vervoort, & Crombez, 2010). Witnessing others reacting to acutely painful events can instigate immediate "visceral" or gut level emotional experiences (K. D. Craig, 1968) leading to the arousal of empathy in the observer (K. D. Craig, 2009; Goubert et al., 2005; T. Singer et al., 2006) and the activation of pain-related brain regions (Jackson, Meltzoff, & Decety, 2005; Ochsner et al., 2008; Simon, Craig, Miltner, & Rainville, 2006). These automatic, uncontrollable reactions are also accompanied by immediate attention and parallel controlled reflective

appraisal of the causes of the other person's pain. Automatic and controlled pain behaviors appear to have evolved to elicit both automatic and controlled empathic responses in the observer, functioning to engage social support which in turn serves to reduce or ameliorate the experience of pain (Craig, 2009; A. C. Williams, 2002).

Empathy for pain is apparent across different types of pain. For example, there are numerous studies demonstrating that, just as physical pain elicits automatic and empathic responses in others, so does the observation of social pain (Wesselmann, Williams, & Hales, 2013). Observing others' social pain leads to similar psychological need threats (Wesselmann, Bagg, & Williams, 2009), similar behavioral responses (Masten, Morelli, & Eisenberger, 2011; Over & Carpenter, 2009), and activation of similar neural regions (Masten et al., 2011; Meyer et al., 2013) as when people actually experience social pain. This indicates that people vicariously experience others' social pain and suggests an automatic empathic response.

The expression of pain may also serve to fulfill a range of broader social needs as illustrated by work on secondary gain, where social support through pain expression becomes a goal in itself (Fishbain, Rosomoff, Cutler, & Rosomoff, 1995; Freud, 1916/1957). In such cases, a patient's expression of pain goes beyond eliciting assistance from others to deal with the pain. In these cases, patients aim to satisfy other motives such as gaining attention, assistance, and concern from others more generally. Work on self-harm (Nock, 2010a, 2010b) also highlights this function of pain. Although self-harm tends to occur in private, and it is the injury rather than the expression of pain that generates empathy from others, the social signaling hypothesis provides insight into why pain expression may be particularly effective in eliciting empathy and social support. According to this hypothesis, people engage in self-harm because it is a more effective means of eliciting help from others than other forms of communication, such as speaking, yelling, or crying. This social signaling function of self-harm is corroborated by clinical descriptions of self-injurious behavior (Favazza, 1996; Strong, 1998; Walsh & Rosen, 1988).

Beyond self-harm, which has a range of maladaptive outcomes, other examples of pain presentation are also motivated by the desire to elicit empathy and social support from others. Research has demonstrated that pain catastrophizers (those who respond to anticipated or actual pain with increased negative cognition and affect) exaggerate responses to pain to maximize the probability that their pain will be recognized by others (Sullivan, Martel, Tripp, Savard, & Crombez, 2006). Sullivan and colleagues (2004) found that high catastrophizers exhibited communicative pain behaviors (e.g., facial displays, vocalizations) for a longer duration in response to lab-based cold-pressor pain when another person was present compared to high pain catastrophizers who were alone during the pain procedure. Catastrophizing the experience of pain also appears to fulfill broader attachment

needs. For example, McWilliams and Holmberg (2010) found that pain catastrophizing was correlated with insecure attachment styles, and specifically anxious attachment, suggesting that pain catastrophizing is used to secure attention and empathy when people feel insecure in their relationships with others.

Converging support for the ability of pain expression to generate empathy in the observer comes from work on attribution processes and moral reasoning. Pain expression sends information about a person's *capacity* to experience pain. The capacity for pain (i.e., sentience) has long been considered a basis on which an entity should be considered as entitled to equal consideration (Bentham & Browning, 1843; Kant, 1785/1959; P. Singer, 1979). Although all people are known to possess such capacities, reminders of the extent to which an individual feels pain has subtle implications for social information processing (H. M. Gray, Gray, & Wegner, 2007; Waytz, Gray, Epley, & Wegner, 2010). For example, differences in perceived pain sensitivity are associated with differences in perceptions of humanity (Fiske, Cuddy, & Glick, 2007; Haslam, 2006) and reminders of a subject's capacity for pain increases the motivation to protect him or her from harm (Bastian, Laham, Wilson, Haslam, & Koval, 2011; K. Gray & Wegner, 2009).

This effect of pain expression has been demonstrated to directly shape how others morally judge a person. In a study investigating the impact of pain expression on judgments of guilt, K. Gray and Wegner (2010) asked participants to listen to a recording of a person being "tortured" by ostensibly placing their hand in ice-water. Participants were told that the person may have cheated on a previous task and were asked to indicate whether they thought the person was guilty or not. Participants who heard a confederate express high levels of pain judged them to be less likely to have cheated than when the confederate expressed low levels of pain. That is, pain expression reduces judgments of guilt. Subsequent research also showed that, in cases of misconduct, taking on a victim role arouses perceptions of one's capacity to experience pain, which in turn reduces people's tendency to attribute blame for moral transgressions (K. Gray & Wegner, 2011). This work indicates that expressing pain communicates the need for protection and support, therefore reducing the motivation for retribution.

Considerations. Evidence from clinical samples, experimental and brain-imaging studies, as well as anecdotal evidence from pathological behavior such as self-harm suggests that observers experience empathy in response to the expression of pain. This possibility also motivates certain forms of pain expression, aimed at arousing empathy and social support from others. These effects may be moderated by a number of factors. Pain may also send escape cues to others when pain expression indicates an acute threat in the environment (A. C. Williams, 2002; Yamada & Decety, 2009), thereby reducing access to social support. Furthermore, prolonged

or repeated pain may erode or undermine relationships by exhausting social support from others (K. D. Craig, 2009; Werner, Isaksen, & Malterud, 2004). Over time care-givers may become tired of repeated attempts to draw empathy by those experiencing pain, and it is this longer term outcome which demonstrates the dysfunctional elements of self-harm. This same "empathy drain" may be evident in cases of chronic pain, where observers feel they can no longer continue to empathize with another individual's pain (Matthias et al., 2010). Indeed, research suggests that empathy for pain "hurts" because it activates both the sensory and affective components of pain experience (Loggia, Mogil, & Bushnell, 2008). Work on pain catastrophizing in chronic pain patients provides evidence for a positive relationship between the extent of catastrophizing behavior and the perception that one's partner responds with irritation, frustration, and anger (Boothby, Thorn, Overduin, & Ward, 2004).

It is also noteworthy that others' empathy may have deleterious effects on the experience of pain. Although social support can enhance psychological well-being for persons with chronic pain (Hadjistavropoulos et al., 2011), when it is excessive and becomes solicitous (i.e., expressions of concern, support, and provision of assistance), it can lead persons with chronic pain to display more pain and disability (Boothby et al., 2004; Flor, Breitenstein, Birbaumer, & Fürst, 1995; McCracken, 2005).

Notwithstanding these potential downsides, the experience of pain, especially moderate and controlled pain, affects how people orient themselves toward others, providing a pathway for accessing the many benefits of social connection.

Pain increases relational focus. Beyond expressing pain, people may actively seek out social support in response to the experience of pain because social support is often an effective pain management mechanism (i.e., by soothing pain; Bowlby, 1969/1982). Physical distress of babies can be alleviated through physical contact with others (Bowlby, 1973), and tired or sick babies seek the proximity of a primary caregiver (Ainsworth, 1973). This soothing effect of social support on pain has also received direct evidence. Lopez-Martinez, Esteve-Zarazaga, and Ramirez-Maestre (2008) found that perceived social support predicted pain adjustment among patients who suffer chronic pain. Other research has demonstrated that social support during childbirth is associated with lower self-rated labor pain and use of analgesics (Cogan & Spinnato, 1988; Lidderdale & Walsh, 1998; Niven, 1985). In laboratory-based research, Brown, Sheffield, Leary, and Robinson (2003) demonstrated that participants who were asked to endure experimentally induced pain (cold-pressor task) reported less pain when they were provided with social support. Critically, whether this support was provided by a friend or a stranger, and whether it was characterized as active or passive did not matter. However, simply having an interaction with another person who

was not intended to be supportive did not reduce ratings of pain. Other work has shown that looking at the photograph of one's partner reduces pain perception during experimentally induced pain (Master et al., 2009) and that being reminded of one's membership in multiple groups increases pain tolerance (Jones & Jetten, 2011; see also Platow et al., 2007). Taken together, the evidence strongly supports the notion that social support is an effective pain management mechanism, suggesting that people are likely to seek out social support when they experience painful events.

Converging evidence comes from work showing that a range of threats and stressors motivate affiliation with others. For example, existential threats increase college students' interest in pictures of people more than pictures of things (Zhou, Lei, Marley, & Chen, 2009), and the fear of electric shock motivates people to seek physical proximity to others (Rofe, 1984; Shaver & Klinnert, 1982). Other research has shown that the experience of acute stress increases approach behavior (i.e., pro-social responses: von Dawans, Fischacher, Kirschbaum, Fehr, & Heinrichs, 2012). These findings are consistent with the tend-and-befriend hypothesis (Taylor, 2006; Taylor et al., 2000), which holds that, under conditions of stress, tending to offspring and affiliating with others ("befriending") are at least as common responses to stress in humans as fight-or-flight. Pain is an evolutionary alarm system that represents the potential for substantial physical threat and, on this basis, would be expected to motivate affiliative responses similar to other sources of stress.

Central to this affiliative response is the role of biobehavioral mechanisms that are sensitive to social threats or loss of contact. Evidence indicates that brain opioids and oxytocin are triggered when social relationships are threatened (see MacDonald & Leary, 2005; Panksepp, 1998; Taylor et al., 2006), and oxytocin has also been argued to provide an impetus for social contact (Insel, 1997; Panksepp, Nelson, & Bekkedal, 1999; Taylor, 2006). For example, exogenously administered oxytocin is related to increases in physical proximity, social bonding, and increased maternal behavior in animals (Panksepp, 1998) as well as humans (Carter, 1998; Taylor, 2002). A broad array of affiliative behaviors may be subserved by oxytocins. Critically, oxytocin plays a central role in regulating pain (Carter, 1998; Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003; Lund et al., 2002; Yang et al., 2007). This suggests that oxytocin may provide a biobehavioral mechanism that motivates affiliative behavior in response to pain, as well as threat and stress (see Taylor, 2002; Taylor et al., 2000).

This affiliative response to pain is also apparent in response to social pain. As with physical pain, social support ameliorates the effects of social pain (Noh & Kasper, 2003; Twenge, Baumeister, DeWall, Ciarocco, & Bartels, 2007). Smart Richman and Leary (2009) outline a range of relationship-promoting responses that arise in response to social pain. For example, social pain may increase sensitivity to social information (Gardner, Pickett, & Brewer, 2000;

Pickett, Gardner, & Knowles, 2004), increase the perceived value of relationships (Maner, DeWall, Baumeister, & Schaller, 2007), and motivate people to demonstrate socially valued personal qualities (Ouwkerk, Kerr, Gallucci, & Van Lange, 2005; K. D. Williams, Cheung, & Choi, 2000). Non-conscious automatic behaviors known to enhance social relations, such as increased mimicry (Lakin & Chartrand, 2003), and affiliative social tuning (Sinclair, Lowery, Hardin, & Colangelo, 2005) are also enhanced after social pain.

Considerations. Evidence for the effect of pain on increasing relational focus is largely derived from research highlighting the beneficial effects of social support on the pain experience, suggesting that people should be motivated to seek out this resource in response to pain. Models of responses to stress provide converging evidence, in that pain is a significant source of stress, with recent evidence showing pro-social responses to social stress (von Dawans et al., 2012). Converging support also comes from evidence that affiliative behavior is enhanced following social pain. However, direct evidence for these responses in the case of acute episodes of pain induced through physical tasks such as the cold-pressor pain induction or other lab-based procedures is lacking. Furthermore, research that seeks to understand how painful experiences may trigger affiliative responses in ecologically valid contexts would provide valuable and important insights.

It should be kept in mind that there may also be many anti-social responses to pain. There is a well-established link between experiences of acute pain and aggressive behavior in rodents (Ahmad & Harvey, 1968; Hutchinson, Ulrich, & Azrin, 1965; Ulrich, 1966). Pain has also been linked to anger and aggression in humans (Berkowitz, 1993), and people who experience chronic pain often exhibit anti-social behaviors (Carson et al., 2005; Fernandez & Turk, 1995; Okifuji, Turk, & Curran, 1999). This is consistent with the common finding that the social relationships of people with chronic pain often deteriorate over time (Hadjistavropoulos & Craig, 2004). Anger and aggression are also common responses to social pain. Leary, Twenge, and Quinlivan (2006) reviewed the evidence on this relationship, concluding that there are strong, consistent relationships between social pain and anger/aggression. For example, social pain enhanced the willingness to blast another participant with white noise (Twenge, Baumeister, Tice, & Stucke, 2001), enhanced the motivation to let another person listen to aversive audiotapes (Buckley, Winkel, & Leary, 2004), and increased the insistence that a person who did not like spicy food ate hot sauce (Warburton, Williams, & Cairns, 2006). Importantly, just like with chronic pain, chronic and pervasive social rejection would be expected to lead to withdrawal and avoidant patterns of response (Smart Richman & Leary, 2009).

Pain increases solidarity. When pain is experienced in the presence of other people or shared with others, it can be a powerful force in drawing people together. For example,

entry into many sporting communities is marked by willingness to endure pain and suffering (Downey, 2007; Rodrick, 2006; Wacquant, 1995). The experience of pain can produce a sense of “team spirit” or camaraderie (Turner & Wainwright, 2003), which may be part of the reason why soldiers are often required to endure pain as part of their training (Harper, 2006).

Shared experience in general facilitates liking and feelings of closeness to others with whom we share the experience (Pinel, Long, & Crimin, 2010; Pinel, Long, Landau, Alexander, & Pyszczynski, 2006). Shared experiences seem to be particularly potent in facilitating attachment to others when the experiences are challenging or traumatic (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001). Painful and emotionally intense events produce enduring and vivid episodic memories for the ordeals and the other group members who uniquely shared in the ritual (Atkinson & Whitehouse, 2010; Whitehouse, 2004). The result is the perception of oneness with the co-participants. Providing direct evidence for the role of pain in promoting group commitment and prosociality, Xygalatas et al. (2013) found that participants in, and observers of, painful rituals (the Kavadi) donated more money compared with participants who engaged in non-painful rituals (collective prayer). Moreover, the perceived painfulness of the ritual (both from the perspective of observers and participants) was directly related to the amount donated (by both observers and participants), with greater perceived pain associated with larger donations.

Painful experiences may also lead to group formation in the context of initiation rites (van Gennep, 1977; Whitehouse, 1996). One outcome of these painful rites of passage is that group memberships are more highly valued. Of course the positive consequences of these rituals are likely to be most apparent when the rituals themselves serve as a significant challenge rather than when they are extreme, overwhelming, and invoke traumatic responses that undermine any positive affiliative outcomes.

A classic study by Gerard and Mathewson (1966), extending on an original paradigm by Aronson and Mills (1959), demonstrated how pain may be used to enhance the value of group membership. They invited college women to listen to a group discussion on sex. To gain permission to hear the group discussion, the women were told either (a) they had to undergo a mild electric shock or (b) they had to undergo a strong electric shock. Women who experienced the severe shock rated both the discussion and the discussants more positively. However, this effect was evident only when the women were told that the shock was a necessary pre-requisite to join the group discussion. When they were told it was unrelated to whether or not they could join the discussion, severity of the shock did not affect liking for the group. This study provides support for a dissonance explanation regarding the role of pain in increasing the value of group membership, and therefore why painful practices are common in initiation ceremonies. Dissonance arises in these cases because doing

something that is unpleasant or painful is akin to acting in a way that is inconsistent with one’s beliefs (e.g., I don’t like experiencing pain, but I am going to choose to experience pain). However, if the experience of pain leads to a desirable and valuable reward, this provides justification for putting oneself through pain, thereby reducing dissonance.

Considerations. Anecdotal, anthropological, and a small body of experimental research suggest that shared experiences of pain should promote group formation, prosociality, and solidarity. Direct evidence for the role of pain in group formation is somewhat scant. Classic studies demonstrate these effects via dissonance related mechanisms, but the substantive effects of pain on group cohesion and formation are missing from the literature and represent a promising area for future research. It is likely that these responses to pain should occur in response to a range of painful experiences, although over time chronic pain would likely have deleterious effects. It has also been argued that social pain may facilitate group formation, cohesion and identification (Smart Richman & Leary, 2009). For example, M. T. Schmitt and Branscombe (2002) described processes by which group identification protects the well-being of disadvantaged (and chronically rejected) groups. They suggested that perceiving prejudice increases group-based identification which, in turn, enhances well-being.

In this section we have reviewed evidence that pain triggers empathy and social support from others; that those who experience pain are motivated to seek out and consolidate their relationships with others; and that shared experiences of pain promote shared identity, a sense of belonging, and increased valuing of group memberships. We now turn our attention to a consideration of factors that influence when pain may have positive outcomes and when people are likely to seek out pain.

Potential Moderators of the Positive Consequences of Pain

Pain is often harmful, both physically and psychologically. As Scarry (1985) argued, the experience of bodily pain has the capacity to reduce the world and everything we care about to insignificance. Secondary disturbances such as anger, anxiety, and depression often accompany chronic and severe pain (Berkowitz, Cochran, & Embree, 1981; Berkowitz & Thome, 1987; Leventhal, 1993), and chronic pain patients are at heightened risk of suicide (Fishbain, 1999). At the biological level, prolonged and intense pain also has the effect of atrophying muscle tissue, impairing tissue growth and repair, suppressing the immune system, and causing morphological alterations to brain structures (Gatchel et al., 2007; see also Seminowicz et al., 2011). Despite the fact that there are many negative outcomes of pain, positive consequences may be apparent even in contexts where negative outcomes clearly predominate. A

number of factors related to the pain experience itself influence the likelihood of positive consequences: control, intensity, duration, and meaning. We consider each of these here.

Having control over pain not only allows people to moderate its intensity and duration, but the perception of control itself directly moderates or down-regulates the aversiveness of painful stimuli (Arntz & Schmidt, 1989; Crombez, Eccleston, De Vlieger, Van Damme, & De Clercq, 2008; Thompson, 1981) and attenuates neural responses to pain (Salomons, Johnstone, Backonja, & Davidson, 2004). Although control is important for reducing the aversiveness of pain, it may be less important for determining whether positive consequences arise from the experience of pain. Many of the positive consequences we have outlined here are not limited to cases of controlled pain. Uncontrolled pain also has the potential to facilitate pleasure, enhance self-regulation, and promote affiliation. Indeed, control may undermine some of the benefits that we report here. For example, controlled pain may elicit less empathy from others.

Intensity is an important dimension of the pain experience. Extreme forms of pain can become so overwhelming that any positive consequences are barely apparent. Put simply, extremely painful experiences are more threatening. According to challenge and threat theory (Blascovich & Mendes, 2000, 2010; Blascovich & Tomaka, 1996), people will experience pain as a *challenge* when perceived resources outweigh the demands of pain; however, they will experience pain as a *threat* when the demands of pain are greater than perceived resources to cope. When people experience pain as a challenge (usually when pain is of low intensity), they will likely be more receptive to its positive outcomes. This is not to say, however, that more intense pain cannot produce more benefits. Consider, for example, experiences of pain that are used to demonstrate virtue. Pain intensity in these cases is likely to be positively related to perceived virtue. Indeed, most of the positive consequences of pain reviewed here may be strengthened by more intense pain.

When discussing duration of pain, we distinguish between chronic pain that is long-lasting and unrelenting, and acute pain that may last seconds, minutes, or days and has a discrete and detectable period of duration. In cases of persistent chronic pain, many potential benefits of pain will not be apparent because they only occur after pain has ceased (e.g., pain as contrast effect for pleasure or the effects of pain offset relief). Also, chronic pain fatigues and drains people of resources, potentially leading to a loss of meaning, cognitive decline, social withdrawal, and negative self-evaluations (Fishbain, 1999; Gatchel et al., 2007).

One factor that may reduce the negative consequences of chronic pain (and that may allow positive consequences to emerge) is when people are able to establish secondary control over their experience. For example, people can shift their attention away from pain (i.e., distraction; McCaul & Haugtvedt, 1982), manage their relationship to pain (i.e., acceptance; McCracken, Vowles, & Eccleston, 2005;

McMullen et al., 2008), give meaning to pain (Beecher, 1956; Cioffi, 1991; Melzack & Wall, 1965), and even learn to directly control pain-related brain activation (deCharms et al., 2005). Like primary control, these secondary control strategies can reduce the perceived intensity or unpleasantness of pain (although the evidence is mixed; see Salomons et al., 2004; Thompson, 1981). Secondary control can also positively affect physical and psychological functioning in chronic pain patients (Asghari & Nicholas, 2001; Marks, 2001) and increase pain tolerance in laboratory studies (Dolce et al., 1986). The fact that people are able to establish a sense of secondary control over pain suggests that they may feel in control of pain even when the source of pain itself is outside of primary control. This response to pain may allow people to feel they have overcome a major personal challenge, to demonstrate virtues of self-control and personal strength to others, and to increase social connectedness with others.

The context within which pain is experienced and the meaning attributed to the experience of pain is important for determining the intensity and unpleasantness of pain (K. Gray & Wegner, 2008; Mosely & Arntz, 2007; see also Cioffi, 1991). Meaning is also important for determining how people respond to pain and what they derive from pain. As such, meaning may also determine when the positive consequences of pain will be apparent. For example, pain that is understood as justice may resolve guilt (Bastian et al., 2011), and pain that is viewed as a personal challenge may promote perceptions of virtue.

Finally, it is also important to consider the timeline of pain in producing positive consequences (e.g., Andreatta et al., 2010; Tanimoto et al., 2004). Our focus in this review has been primarily on the outcomes of pain and therefore what occurs after pain has ceased. Indeed, some of the positive consequences described, such as the experience of pleasure and increased cognitive-affective regulation, will only become apparent at the point of pain offset. Others, however, are tied to the timeline of pain from onset through to offset, such as the use of pain to transition from one identity to another. Finally, some of the consequences may be evident at all stages of the pain experience. For example, increased affiliation may occur before, during, and after pain, as may the experience of empathy from observers. The reflection of virtue may also arise at any point along the timeline of pain.

When Will People Seek Out the Positive Consequences of Pain?

By casting light on the benefits that might arise from painful experiences, our review provides novel insights into pain-seeking behavior: People often intentionally seek out painful experiences. Although the concept of “pain-seeking behavior” is generally linked to non-normative activities such as sexual masochism (Baumeister, 1988), ice-swimming (Zenner et al., 1980), or painful religious rituals (Glucklich, 2001), it is also central to a range of more normative human

behaviors. Pain-seeking lies at the core of an array of rites and initiations (Morris, 1991). Painful therapeutic practices such as deep tissue massage or whole body cryotherapy (exposure to extreme cold; Costello, Algar, & Donnelly, 2011) are popular health treatments. Culinary preferences often engage pain through the consumption of hot chili pepper (Rozin & Schiller, 1980) or other irritants (e.g., strong spices or spirits). Exercise, when performed with intensity, represents a commonly sought form of physical pain (O'Connor & Cook, 1999), and people often seek out the experience of pain in extreme sports (Le Breton, 2000). This anecdotal evidence suggests that people commonly seek out pain through a range of normative, healthy, and enjoyable pursuits.

Viewing pain as only a problem, as debilitating and harmful, cannot shed light on why people engage in pain-seeking behavior. People seek out pain because, beyond being an aversive event, pain has potential to make experiences more meaningful, intense, and engaging (Liu et al., 2010), and pain itself may even be experienced as rewarding (e.g., Benedetti, Thoen, Blanchard, Vighetti, & Arduino, 2013; Leknes et al., 2013; Moerman, 2002). People's decision to engage with pain, however, may be determined by a number of factors. This raises the question of the conditions under which people are likely to seek out the positive consequences of pain.

The most apparent factor in determining whether people will choose to endure pain is whether the expected benefits are believed to outweigh the expected costs. In understanding the psychological parameters of pain-seeking behavior, Prospect Theory (Kahneman & Tversky, 1979) can provide a number of useful insights. First, people may apply different weights to the potential gains from pain, and this weighting process will determine the perceived cost-benefit ratio. When benefits are highly weighted, pain will appear more attractive, such as when engaging in pain will demonstrate desirable qualities to other people. Second, if positive outcomes are perceived to be certain, they will appear more desirable to people, making the cost of pain more bearable. For example, if entry into a desired group is a certain outcome from enduring a painful experience, this positive outcome is likely to be viewed as more attractive, again making the experience of pain appear worthwhile. Third, the value of potential gains may depend on a person's reference point. For example, if a person experiences emotional numbness or emotional pain, physical pain may appear more desirable due to its capacity to regulate emotion. In this case, the relative benefit of pain represents a greater positive change compared to a case in which the individual was already feeling emotionally stable and satisfied with life.

A Broader Perspective

Although our analysis has been limited to benefits arising from pain, we acknowledge that many of these benefits may arise in response to other kinds of negative affective

experiences. Indeed, in many cases these other affective experiences may be implicated in instances of pain and may share many of the same qualities as pain (e.g., physiological arousal and negative affect; Price, 2000). For example, fear may arise in anticipation of painful events, and fear in the case of chronic pain may be more disabling than pain itself (Crombez, Vlaeyen, Heuts, & Lysens, 1999). As for pain, overcoming fear may be an exhilarating experience, be used as a symbol of courage and personal strength, and the experience of fear may bring people in touch with an acute awareness of the immediate moment (e.g., Le Breton, 2000). Furthermore, a range of stressors and threats would be expected to produce many of the same affiliative responses that we detail here (Rofe, 1984; Taylor, 2006).

Other adverse experiences may also lead to some of the benefits outlined here. Indeed there has been a recent move to uncover the various benefits of experiencing and expressing negative emotions (e.g., Fischer & Manstead, 2008; McNulty, 2010), moving away from the idea that a rich and meaningful life is comprised purely of positive experiences (e.g., Hayes, Strosahl, & Wilson, 1999). Similarly, there has long been a focus on the concept of post-traumatic growth (e.g., Joseph & Linley, 2008) with recent work highlighting that exposure to experiences of death may serve adaptive functions (Vail et al., 2012). By highlighting the positive side of physical pain, we aim to contribute to this broader perspective, providing greater insights into the benefits that might arise from adverse experiences.

Future Directions

By positing pain as an important source of human experience, this review provides a platform from which potentially important research questions can be generated. This review explicitly places the spotlight on the consequences of pain. In contrast, the more common pain management focus treats pain as a dependent variable with pain treatment or pain management techniques as the independent variables. Even where pain has been studied outside of clinical contexts, or contexts dedicated to understanding factors that reduce the experience of pain, it is often employed as a measure of tolerance for an aversive experience (e.g., Jones & Jetten, 2011), as something that people will pay to eradicate (Vlaev, Seymour, Dolan, & Chater, 2009), or with a focus on how the experience of pain is affected by contextual (e.g., Moseley & Arntz, 2007) and protective factors (e.g., Master et al., 2009; Zhou & Gao, 2008). Focusing on the outcomes of pain—that is pain's neurobiological, psychological, or social effects—will require that pain is explored as an independent variable in research designs.

Examining how pain may enhance pleasure, self-regulation, and social bonding could advance a basic understanding of the consequences of pain. We believe that this research would be important for a number of reasons. First, it is only by focusing on the positive consequences of pain that we can

begin to understand why people may seek out pain. This not only has implications for understanding common and healthy behaviors, such as intense exercise or other painful but healthy pursuits, but also for understanding why people may engage in less common and unhealthy behaviors such as self-harm. Indeed, there has been little research directly investigating the effects of pain that may underpin the functions of self-injury (Nock, 2010b). Second, understanding the positive reinforcements that people gain from pain may provide important insights into pain maintenance behaviors. Just as research has identified that solicitous behaviors from others may lead to pain maintenance behavior (Boothby et al., 2004; Flor et al., 1995), understanding other positive outcomes, such as a sense of entitlement arising from pain or the reinforcement of ones' virtuous identity, may provide novel insights into motivations for the maintenance of pain behavior. Third, perhaps due to a pervasive focus on negative effects, research has tended to examine pain in contexts associated with illness, injury, and harm. Pain, however, is commonly experienced in a range of normative, enjoyable, and healthy pursuits. Our knowledge regarding the role of pain within these domains in reinforcing behavior, providing for a sense of goal achievement, or facilitating social bonding is limited. We hope that by highlighting the "other side" of pain, we may draw research attention not only to the positive qualities of pain, but to domains in which pain is commonly experienced yet in which the role of pain is less commonly acknowledged.

Conclusions

Pain has many qualities, but its sheer aversiveness has eclipsed other perspectives on pain. The common assumption that people seek to maximize pleasure and minimize pain is mostly true. We argue, however, that engaging with some pain may be an important pathway toward realizing a range of beneficial outcomes. Moreover, some of these outcomes may never be fully realized through a focus on pleasure alone. In this way, we provide a different perspective on how pain is evaluated and represented. Pain is commonly viewed as something that should be minimized, while pleasure is an experience that many seek out. A focus on minimizing or eradicating pain communicates to people that "the good life is the pain-free life." People are regularly exposed to pain, however, and viewing pain as exclusively aversive provides few tools to make sense of and understand pain.

This has two important implications. First, many daily activities require the endurance of some form of pain. Whether it is intense exercise, physical labor, culinary preference, or social and religious rituals, the experience of pain has the potential to make these experiences intense, meaningful, and rewarding. Focusing exclusively on the cost of pain promotes avoidance rather than engagement with a range of challenging activities that may have beneficial outcomes. Second, giving meaning to pain provides an important pathway toward pain management and treatment (Cioffi,

1991; Morris, 1991). Changing the meaning of pain from negative to positive increases pain tolerance via activation of the opioid and cannabinoid systems (Benedetti et al., 2013). That is, framing pain as positive increases natural analgesic responses to pain. This finding attests to the importance of highlighting the positive consequences of pain, which may in turn have important implications for pain management and intervention.

By highlighting the positive consequences that arise from engaging with pain, this review provides a counter-point to a focus on the costs of pain. We hope this perspective will shed new light on a range of important questions, motivate new research directions focusing on the non-aversive outcomes of pain, and assist people in understanding and managing their experiences of pain.

Acknowledgment

We would like to thank Geoff MacDonald, William B. Swann, Mike Lee, and Bruno Laeng for helpful comments on an earlier version of this paper.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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