The Journal of Sex Research

ISSN: 0022-4499 (Print) 1559-8519 (Online) Journal homepage: https://www.tandfonline.com/loi/hjsr20

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To cite this article: Cara R. Dunkley, Craig D. Henshaw, Saira K. Henshaw & Lori A. Brotto (2019): Physical Pain as Pleasure: A Theoretical Perspective, The Journal of Sex Research, DOI: 10.1080/00224499.2019.1605328

To link to this article: https://doi.org/10.1080/00224499.2019.1605328

Published online: 02 May 2019.

THE JOURNAL OF SEX RESEARCH, *0*(0), 1–17, 2019

ISSN: 0022-4499 print/1559-8519 online
DOI: https://doi.org/10.1080/00224499.2019.1605328

Physical Pain as Pleasure: A Theoretical Perspective

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Physical pain represents a common feature of Bondage and Discipline/Dominance and Submission/Sadism and Machochism (BDSM) activity. This article explores the literature accounting for how painful stimuli may be experienced as pleasurable among practitioners of BDSM, and contrasting this with how it is experienced as painful among non-BDSM individuals. We reviewed the available literature on pain and on BDSM, and used the findings to postulate a theory accounting for how painful stimuli are experienced as pleasurable. Our theory was then checked with BDSM practitioners. The emotional, physiological, and psychological elements of pain interact to facilitate the experience of pain as pleasure in BDSM. A multitude of interconnected factors was theorized to alter the experience of BDSM pain, including: neural networks, neurotransmitters, endogenous opioids and endocannabinoids, visual stimuli, environmental context, emotional state, volition and control, interpersonal connection, sexual arousal, and memories. The experience of pain in this context can bring about altered states of consciousness that may be similar to what occurs during mindfulness meditation. Through understanding the mechanisms by which pain may be experienced as pleasure, the role of pain in BDSM is demystified and, it is hoped, destigmatized.

In recent years, BDSM—an overlapping acronym referring to the practices of Bondage and Discipline (BD), Dominance and Submission (DS), and Sadism and Masochism (SM)—has garnered an increasing amount of attention from researchers and laypeople alike. Bondage and discipline involves using psychological and/or physical restraints. Dominance and submission involves the exchange of power and control. Sadism and masochism, or sadomasochism, involves taking pleasure in one's own or another's pain or humiliation (Hébert & Weaver, 2014). Pain represents a characteristic commonly involved in a sadomasochistic scene (Moser & Kleinplatz, 2007). In a broad sense, sadism and masochism refer to the giving and receiving of physical or psychological pain or sensation for erotic pleasure. As BDSM may or may not involve power exchange, the current article generally uses the terms *Top* to denote the giver of noxious stimulation and *Bottom* (or *masochist*, depending on the research being discussed) as the receiver of stimulation. This article focuses on physical masochism, which can be defined as the consensual receiving and enjoyment of physical sensations that would characteristically be classified as painful. Pain represents an emotional sensory experience that is influenced by psychological, contextual, and social factors. The purpose of this article is to review the extant literature on the processing of pain versus pleasure in relation to BDSM from a basic scientific perspective in hopes of considering how a painful stimulus might be experienced as pleasure by someone practicing BDSM, but experienced as suffering by someone who does not engage in BDSM play. Figure 1 depicts the interplay of factors that contribute to the processing of pain as pleasure. Table 1 summarizes the findings and themes of the literature reviewed.

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Consensual Masochism

Evolutionary theory casts pain as a warning system, a sensory notification that protects the body against threat or danger. Within this framework, pain functions as an alarm that orients the recipient to potential environmental threat to prioritize escape and recovery (Williams, 2002). Pain automatically evokes a fight-or-flight response that allows the recipient to briefly experience blunted pain sensations via neurophysiological responses that block pain signals to achieve safety and subsequently heal (Wall, 1999). The pain that emerges after initial injury to bodily tissue serves to set limits on activities that may interfere with healing. From this perspective, pain has no reward in and of itself.

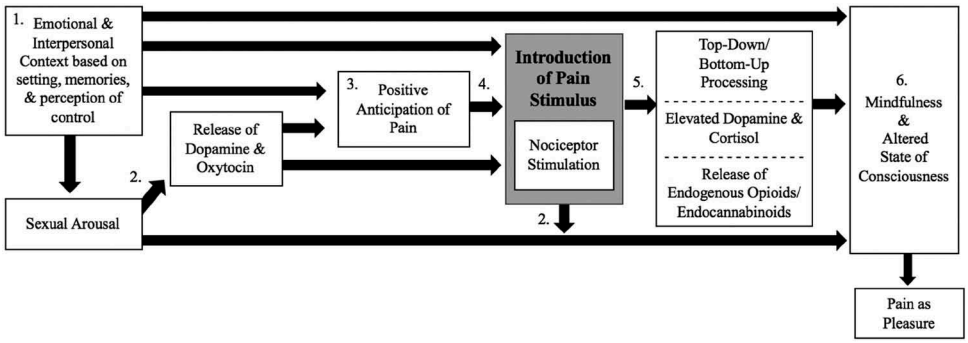

Figure 1. Key points for an integrative model of processing pain as pleasure in the context of BDSM.

1. Prior to the experience of pain, there is a preexisting emotional and interpersonal context based on present circumstances, memories of related past experiences, and the extent to which one feels in control. These situational factors may facilitate sexual arousal.
2. The presence of sexual arousal prior to (and/or alongside) the infliction of pain stimuli serves as an analgesic, altering levels of dopamine and oxytocin.
3. Contextual factors and sexual arousal lead to a positive anticipation of pain.
4. Context, sexual arousal, and the positive anticipation of pain set the stage for receiving pain sensations and fostering the experience of pain as pleasure.
5. Once pain is introduced, nociceptor stimulation engages bottom-up/top-down processing and produces changes in levels of dopamine, cortisol, endogenous opioids, and endogenous endocannabinoids, further influencing the psychological and physiological response to pain sensations.
6. These conditions may promote mindfulness and lead to an altered state of consciousness, colloquially called *subspace*, which contributes to the various mechanisms through which pain is experienced as pleasure in the context of BDSM.

The pain or intensity that characterizes sadomasochistic exchanges is a specific type of pain that is experienced as rewarding or serving some benefit (Moser & Kleinplatz, 2007). A distinction can also be made between hurt and harm in SM involving physical pain and emotional pain; the sensations of being hurt can be arousing and enjoyable, whereas harm is viewed as something negative that can cause damage and is to be avoided (Holt, 2016). Accidental pain or pain experienced outside the context of a sadomasochistic (SM) scene is typically not considered desirable (Nichols, 2006; Scott, 1983). Pain in the context of BDSM is qualitatively different from the way pain is typically experienced or thought of (Nichols, 2006; Scott, 1983). For some Bottoms, the experience of pain might be analogous to the pain experienced by high-intensity athletes (Barker, Iantaffi, & Gupta, 2007). For example, one study evaluated the perception of experimentally induced pain among masochistic individuals compared to non-masochistic controls, and examined whether the masochists' experiences and attitudes toward pain were related to emotional context (Defrin, Arad, Ben-Sasson, & Ginzburg, 2015). Whether pain was reported as pleasurable and rewarding was context dependent among Bottoms; pain inflicted during intimate interpersonal SM sessions, which were typified as being frequent and voluntary, were reported to be experienced as pleasurable, compared to accidental environmental pain, which was reported to be negative and unpleasant.

Thus, physical stimulation, and the threshold at which sensations are experienced as painful or painful to the point of unpleasantness, can be regarded as a continuum that differs between individuals as well as within an individual across situations and over time (Barker et al., 2007). Practitioners tend to differ not only in preferred types of stimulation, but also in terms of what areas of the body they prefer to receive stimulation (Moser & Kleinplatz, 2007). BDSM practitioners often have preferences for specific types of sensations produced by different kinds of "play," a term used to refer to BDSM activity. Further, those who enjoy the experience of pain do not necessarily enjoy all types of pain with regard to the wide range of possible activities and associated sensations BDSM has to offer.

Motivation for Masochism

What underlies the desire to experience pain with respect to masochism? Based on extensive ethnographic research in a public BDSM community, Newmahr (2010) proposed four discourses of pain within the context of BDSM, with transformed pain and autotelic pain being particularly relevant. Transformed pain centers on the reframing of pain, such that pain is experienced as "not hurting" (p. 398) and instead is transformed almost instantly into pleasure. This discourse frames pain as an objective stimulus wherein pain is real but rendered as something other; it does not *hurt* and is thus not *bad*. In this sense, the Bottom actively modifies painful sensations in such a way that it is processed as *not* pain and experienced as pleasure. Conversely, autotelic pain describes the enjoyment of actual pain: The pain hurts, but the hurt feels good. The

Table 1. *A Summary of the Literature Reviewed*

Category of Literature	Articles	Theories and Findings
Sadomasochistic pain	Moser & Kleinplatz, 2007; Holt, 2016; Nichols, 2006; Scott, 1983; Barker et al., 2007; Williams, 2002; Moser & Kleinplatz, 2007; Newmahr, 2010; Silva, 2015	SM pain is qualitatively different from other forms of pain. Preferences for SM pain are variable and subjective. SM pain serves many purposes and takes many forms.
The purpose of pain	Williams, 2002; Wall, 1999	Pain is a warning system that protects the body against threat and physical damage.
Neurological and physiological processing of pain as pleasure	Leknes & Tracey, 2008; Silva, 2015; Wood, 2008; Dietrich & McDaniel, 2004; Hébert & Weaver, 2015; Holden et al., 2005; Rhudy & Meagher, 2000; Raichlen et al., 2012; Fuss et al., 2015; Calignano et al., 1998; Ogles & Masters, 2003; Sachs & Pargman, 1979; Fuss et al., 2015; French & Torkkeli, 2009; Richardson, 2000; Richardson et al., 1998; Calignano et al., 2000; Dietrich & McDaniel, 2004	There is a neurological overlap between pain and pleasure. Top-down and bottom-up processing may alter the experience of pain. Pain and physical exertion release endogenous opioids and cannabinoids, which alter the subjective experience of pain. Nociceptors respond to physical stimulation and transmit sensory information to the brain; these could play a role in individual preferences for certain kinds of SM pain.
Emotions and pain processing	Craig, 2003; Merskey & Bogduk, 1994; Rhudy & Meagher, 2000; Franklin, 1998; Rhudy et al., 2010 ; Rainville et al., 2005; Ploghaus et al., 1999; Ploghaus et al., 2001; Apkarian, Bushnell, Treede, & Zubieta, 2005; Newmahr, 2010; Kamping et al., 2016	Pain is an emotional sensory experience. Negative emotions exacerbate pain, while positive emotions mitigate pain. The emotion–pain relationship is supported by neuroimaging research and research on acute versus chronic pain. Emotions modify the experience of SM pain.
Social connection and interpersonal relationships	Nichols, 2006; Ambler et al., 2016; Hébert & Weaver, 2015; Sagarin et al., 2009; Coan et al., 2006; Montoya et al., 2004; Benedetti et al., 2013	There are romantic and sexual benefits of SM, such as enhanced relationship closeness. SM requires and fosters trust. The presence of loved ones can mitigate the experience of pain or threat of pain. Pain can be rewarding in certain contexts, and reward can increase pain tolerance.
Emotional pain play	Barker et al., 2007; Moser & Kleinplatz, 2007; Hébert & Weaver, 2015; Meredith, Strong, & Feeney, 2006; Sandnabba, Santtila, Alison, & Nordling, 2002	Emotional or psychological pain play may not involve any physical stimulation. Fear play or gratification from the threat of pain can serve similar functions as physical SM pain. Attachment style research lends support to the important role of interpersonal connection and the modulation of noxious stimuli.
Volition and control	Cross & Matheson, 2006; Langdridge & Butt, 2005; Newmahr, 2010. Moser & Kleinplatz, 2007; Sagarin et al., 2009; Easton & Hardy, 2001; Weinberg & Kamel, 1983; Weisenberg, 1977	SM pain can be used as a method to establish, maintain, or intensify power dynamics. Domination and submission represents a bidirectional exchange of power and control. Domination and submission largely rests on the illusion of power exchange, as the Bottom has the control to end the scene at any time. Pain is experienced as less painful when the individual receiving pain is in control of the pain stimulus.
Pain and sexual arousal	Ambler et al., 2016; Leknes & Tracey, 2008; Paterson et al., 2013; Leknes & Tracey, 2008; Paterson et al., 2013; Komisaruk & Whipple, 1984; Whipple & Komisaruk, 1985, 1988; Budygin et al., 2012; Lepton & Stewart, 1996; Kender et al., 2008; Wood 2008; Bianchi-Demicheli & Ortigue, 2007; Younger et al., 2010; Rhudy et al., 2008; Carmichael et al., 1987, 1994; Schneiderman et al., 2012; Eliava et al., 2016; Goodin et al., 2015; Tracy et al., 2015; Tracy et al., 2015; Tay & Yamamoto, 2016; Basson et al., 2008	Sexual arousal is a common aspect of SM, with or without actual accompanying sexual activity. Considerable research supports the analgesic effect of sexual arousal. Pain and pleasure are theorized to be mutually inhibitory. Pain releases dopamine and increases sexual activity in rodents. Sexual arousal and orgasm is associated with neural reward system activity and dopamine release, which has an analgesic effect. Due to the intimate nature of SM, oxytocin could be released during play, which may have an analgesic effect on pain. The array of factors that contribute to sexual response in conventional settings also play important roles in SM.

(*Continued*)

Table 1. (*Continued*)

Category of Literature	Articles	Theories and Findings
Altered states of consciousness	Hennen, 2008; Landridge, 2007; Sagarin et al., 2015; Hébert & Weaver, 2015; Taylor & Ussher, 2001; Pitagora, 2017; Baumeister, 1988, 1997; Newmahr, 2010; Sagarin et al., 2015; Klement et al., 2017; Westerfelhaus, 2007; Dietrich, 2003; Csikszentmihalyi, 1990; Ambler et al., 2016; Pitagora, 2017; Sagarin et al., 2015; Sagarin et al., 2015	Masochism can be used to achieve altered states of consciousness, often called subspace. SM pain can allow individuals to escape from the burdens and responsibilities of day-to-day life. Altered states of consciousness elicited by SM pain may be akin to those elicited by intense physical activity or extreme rituals. Hypofrontality and flow contribute to altered states of consciousness in SM. Altered state of consciousness in SM have the potential to enhance connection and intimacy between partners.
Pain and mindfulness	Kabat-Zinn, 1982; Kabat-Zinn et al., 1985; Brown & Jones, 2010; Garland et al., 2012; Grant & Rainville, 2009; Oshiro et al., 2009; Zeidan et al., 2010; Kingston et al., 2007; Kingston et al., 2007; Perlman et al., 2010, Grant & Rainville, 2009; Zeidan et al., 2011; Grant et al., 2011; Zeidan et al., 2011	Mindfulness-based therapies are used to treat a variety of pain conditions. Mindfulness practice and training attenuates the experience of pain and pain catastrophizing and increases pain tolerance. Mindfulness practitioners experience less laboratory-induced pain and greater pain tolerance than nonpractitioners. The association between mindfulness and pain has a neurologically supported basis.
Psychological versus physiological stress	Ambler et al., 2016; Klement et al., 2017; Sagarin et al., 2009	Salivary cortisol levels increase from pre- to post-BDSM activity. Despite heightened physiological stress, BDSM activity has been found to relieve psychological distress.

intersection of pain and pleasure with respect to autotelic pain is the experience of pain hurting in a way that is enjoyable. Sacrificial pain, or pain for a greater good, frames pain as a steadily undesirable sensation that the Bottom suffers in sacrifice (e.g., punishment and discipline). Investment pain is described as an "unpleasant stimulus that promises future rewards" (p. 402); reward is found as a result of the pain or from having withstood pain, instead of pleasure being taken from pain itself.

Similarly, Silva (2015) examined reasons for desiring pain in consensual BDSM, and found the top three reasons for receiving SM pain to be (1) pain enhances feelings of helplessness and submission; (2) pain creates sensation contrast so that it intensifies feelings of pleasure; and (3) pain is challenging, and the endurance of pain promotes feelings of achievement and pride. Other highly endorsed reasons reflected the functional utility of pain, including its ability to help participants forget the daily stresses of life and relieve emotional pain. An effect of gender also emerged, such that the most common reason for receiving pain among women was its ability to facilitate submission, versus its use to augment the experience of pleasure among men. Taken together, there are numerous reasons for seeking out physical pain in the context of consensual masochism, with the pleasurable component of pain often, but not always, serving as a central motivation. Additional motivations underlying sadomasochism, which are expanded on in the sections that follow, include its potential to enhance intimacy and social connection, augment sexual arousal, elicit an adrenaline rush, and produce altered states of consciousness.

Neurological and Physiological Processing of Pain As Pleasure

The association between pleasure and pain likely exists in part due to the neurological overlap in the networks that regulate pleasure and pain, which allow pleasure and pain to be experienced concurrently (Leknes & Tracey, 2008; Silva, 2015). In support of this, participants in a qualitative study discussed a neurophysiological component of SM, in which pain and arousal become linked (Taylor & Ussher, 2001).

Top-Down Processing

What processes are at work when a painful sensory stimulus is experienced as pleasurable or rewarding? To the authors' knowledge, there is no scientific evidence to provide a concrete and comprehensive description of what mechanisms underlie the pain–pleasure connection or transformation with respect to SM. We theorize, however, that the transformation of pain into pleasure likely occurs in the brain in the form of top-down processing. The area of the body from which sensations are being elicited sends signals that convey the nature of those sensations to the brain (bottom-up), and the brain, in turn, sends signals down the spinal cord to the nerve cells (top-down). In

top-down processing (Figure 1), the brain regulates the degree of pain it will experience through descending impulses that are mediated by endogenous endorphins (Ossipov, Dussor, & Porreca, 2010). The brain–spinal cord circuit is thus an opioid-sensitive circuit that acts as a pain volume control, with some painkilling circuits muting pain transmission through the activation of opioids and endorphins (Fields, Basbaum, & Heinricher, 2005). The descending pain modulatory circuit diminishes pain through net inhibition, with inhibitory signals "calming" the nerve cells at the appropriate section of the spinal cord (Ossipov et al., 2010). Certain neurotransmitters, including serotonin, norepinephrine, and dopamine, have been found to play a role in spinal descending inhibition of pain (Basbaum & Fields, 1978; Cui, Feng, McAdoo, & Willis, 1999; Wood, 2008). This natural painkilling pathway includes the prefrontal cortex (involved in executive function), the amygdala and hypothalamus (involved in emotional processing), and the deeper parts of the brain and spinal cord, where signals are sent to sensory nerve cells that are receiving sensory input (Ossipov et al., 2010). The brain–spinal pathways involved in the top-down modulation of pain shed light on how personal experience, emotional state, and societal beliefs have the potential to change the way pain is experienced (Ossipov et al., 2010).

It is possible that pain is consciously and immediately transformed in the brain after receiving the sensory input from nerve cells in the body, and is there interpreted as pleasure, which is then relayed from the brain back to the nerve cells that are being stimulated. Research has demonstrated that these brain–spinal circuits are influenced by psychological factors, such as emotions and context, that can modulate pain transmission (for a review, see Lumley et al., 2011). In the context of BDSM, the prospect of "pain" is often anticipated with excitement. Having a positive relationship with this kind of pain may impact the processing of painful sensations during BDSM activity. The Bottom may automatically register the emotional and ethical context that surrounds the infliction of SM pain, modifying the experience of pain (Newmahr, 2010).

Endogenous Opioids

Several authors have discussed the adrenaline high that can result from receiving painful stimulation without permanent harm or damage (e.g., Dietrich & McDaniel, 2004). In a qualitative study on motivations for engaging in BDSM, many participants identifying with the Bottom role emphasized the physical pleasure experienced from pain, particularly with reference to the endorphin rush that accompanies pain (Hébert & Weaver, 2015). This endorphin rush can be seen as analogous to the "runner's high" people can experience during intense athletic exertion (Dietrich & McDaniel, 2004). Research on exercise has found that the body produces endorphins—or endogenous opioids—during times of physical exertion (Figure 1). These endogenous opioids bind to opioid receptors in the brain, which can blunt physical pain by reducing pain sensitivity (Holden, Jeong, & Forrest, 2005). Endogenous opioids can also act upon areas of the brain involved in the processing of rewards, such as the nucleus accumbens and striatum. These neural processes promote the release of inhibitory transmitters involved in top-down processing and increase the release of dopamine, allowing for physical stress upon the body to be experienced as more pleasurable.

In addition to physical exertion, fear of an external stimulus can inhibit pain through the activation of endogenous opioids (Rhudy & Meagher, 2000). Fear akin to the anticipatory thrill that is often experienced prior to skydiving can be a key element of SM play. Indeed, the threat of pain often serves as the basis for fear play, a form of psychological SM. The physiological manifestation of fear mirrors that of sexual arousal so closely that fear and sexual arousal can be mistaken for each other, as well as compound each other. A prime example of this is Dutton and Aron's (1974) famous suspension bridge experiment, wherein participants rated a confederate as more attractive when standing on a high and rickety bridge compared to a low safe bridge; the physiological sensations of fear were mistaken for arousal, thus increasing attraction.

Endogenous Endocannabinoids

Exercise has also been shown to activate the endocannabinoid system, with physical exertion stimulating the production of endogenous cannabinoids, such as anandamide, which act upon the same cannabinoid receptors in the brain as marijuana (Figure 1). Endocannabinoids are densely expressed in brain networks responsible for reward, and are thought to be partly responsible for neurobiological responses to moderately intense exercise in humans (Raichlen, Foster, Gerdeman, Seillier, & Giuffrida, 2012). Anandamide levels have been found to increase with exercise in both mice (Fuss et al., 2015) and humans (Dietrich & McDaniel, 2004). In addition to motivating exercise endurance, endogenous endocannabinoids produced during physical stress exert central effects on the brain, such as improving mood, facilitating a sense of well-being, and reducing anxiety, as well as the peripheral effect of reduced pain sensitivity (Calignano, La Rana, Giuffrida, & Piomelli, 1998; Dietrich & McDaniel, 2004; Ogles & Masters, 2003; Sachs & Pargman, 1979; Watkins & Mayer, 1982). In Fuss and colleagues' (2015) study, mice appeared more relaxed and less sensitive to pain after running and had higher levels of endocannabinoids and endorphins. Mice were given blocking agents to examine the role of endorphins and endocannabinoids separately; the mice remained calmer and less sensitive to pain when endorphins were blocked but not when endocannabinoids were blocked. As endocannabinoids can pass through the blood–brain barrier, while endogenous opioids cannot, increased production of anandamide may be more responsible for the pain relief and euphoria

associated with exercise. As SM often entails physical exertion or physiological stress on the part of the Bottom (Morpheus, 2008, p. 118), it is likely that endogenous opioids and endocannabinoids play a role in experiencing seemingly painful stimuli as pleasurable. Both endogenous opioids and cannabinoids have been implicated in the descending modulatory inhibition of pain (top-down processing; Ossipov et al., 2010). Endocannabinoids also directly relate to gonadal hormones and sexual behaviors (e.g., Gorzalka, Hill, & Chang, 2010)—a notable association, given that sexual arousal can play an important role in processing pain as pleasure.

Nociceptors

The peripheral nervous system contains pain receptors, called nociceptors, that detect signals from damaged tissue or threat of damage (Figure 1). Mechanoreceptors respond to direct manipulation of the skin or intense mechanical stimulation (French & Torkkeli, 2009), and respond to play that elicits surface sensations (e.g., being bitten or pinched) or impact play (e.g., being hit with a paddle or whip). The four primary types of tactile mechanoreceptors follow:

1. Merkel's disks—slow-adapting nerve endings that respond to light touch
2. Meissner's corpuscles—rapidly adapting neurons that respond to low-frequency vibrations and fine touch
3. Ruffini endings—slow-adapting receptors that fire in response to stretching skin
4. Pacinian corpuscles—rapidly adapting receptors that respond to deep, transient pressure and high-frequency vibration

SM activity can elicit a wide array of tactile sensations, with the type of play and the tools used (e.g., cane, flogger, rope) differentially stimulating specific mechanoreceptors. Thermal nociceptors respond to stimuli that trigger mechanoreceptors in addition to thermal stimuli, such as hot candle wax. Chemical nociceptors respond only to chemical substances. Polymodal nociceptors respond to high-intensity stimuli from all three of the previously noted types of nociceptors. Silent nociceptors are located in the skin and deeper tissues; these tend not to respond to direct mechanical stimulation, and instead only respond to mechanical stimulation once the tissue is damaged or inflamed. Pain preferences among Bottoms vary, with such individuals often preferring certain kinds of pain to others (Wiseman, 1996, p. 170). Perhaps individual preferences are in some way tied to the stimulation of certain nociceptors.

Research on cannabinoid-induced analgesia has shown that the stimulation of different types of nociceptors differentially activates the endocannabinoids system (Richardson, 2000; Richardson, Kilo, & Hargreaves, 1998). Indeed, there is evidence to suggest that pain stimulation to the skin is particularly effective in activating the endocannabinoids system and eliciting the pain-reducing effects of anandamide (Calignano et al., 2000; Richardson et al., 1998). Researchers have hypothesized that running stimulates the endocannabinoid system to a greater extent than other rhythmic endurance activities (e.g., swimming), due to the feet absorbing the impact of hitting the pavement (Dietrich & McDaniel, 2004). Impact play, which involves a Bottom consenting to being physically struck in a repeated, rhythmic fashion, is perhaps one of the most common forms of SM activity, and may stimulate the same nociceptors as running.

Nociceptors tend to become sensitized with prolonged stimulation, which leads them to respond to sensations that would not otherwise cause them to fire. It is possible that individual differences in nociceptor sensitization contribute to individual differences in the extent to which painful stimuli are experienced as pleasurable. For example, individuals with a greater nociceptor sensitization threshold might enjoy play of greater intensity or duration compared to individuals whose nociceptors are more easily sensitized.

Emotional Context and Pain

Observations of soldiers experiencing an extraordinary reduction of pain during combat provided early evidence for the modulation of pain by emotions, leading to the inference that strong emotions block pain (Beecher, 1946; Figure 1). The typical conceptualization of pain includes emotional distress; negative affect in relation to pain drives the understanding of pain as a form of suffering (Craig, 2003). The International Association for the Study of Pain defines pain as "an unpleasant sensory and emotional experience associated with actual or potential damage, or described in terms of such damage" (Merskey & Bogduk, 1994), indicating that pain is in part an emotional experience which coincides with a sensory experience. Emotions and pain share a bidirectional relationship, with pain shaping emotions and emotions influencing how pain is experienced. Negative emotions, such as depressed mood and anxiety, have been shown to augment pain (Rhudy & Meagher, 2000), while positive emotional states have been found to reduce pain—a phenomenon known as "affective analgesia" (Franklin, 1998). In-laboratory research has found that emotional valence, or positive/negative quality of pain, interacts with emotional intensity to determine the effect of emotions on pain; the more arousing or intense the negative or positive emotions are, the greater the degree to which pain is exacerbated or inhibited, respectively (Rhudy, Bartley, & Williams, 2010).

Laboratory research on the emotion–pain relationship has examined the physiological impact of emotion on pain processing and spinal nociception. One study examining the emotion–pain relationship used a picture-viewing paradigm with photos depicting emotively positive (food, erotica), negative (attack, loss/grief), and neutral images, while inducing noxious electric stimulation (Rhudy, Williams, McCabe,

Russell, & Maynard, 2008). In addition to subjective pain ratings, nociceptive reactions were assessed, including: nociceptive flexion reflex, skin conductance response, and heart rate acceleration. The pictures effectively manipulated emotional valence and emotional arousal, with erotic/food pictures eliciting the greatest pleasure, attack/loss pictures the lowest pleasure, and erotic/attack pictures eliciting the greatest arousal. An emotional valence-by-arousal interaction significantly predicted nociceptive reactions, with pleasant pictures inhibiting nociceptive reaction and unpleasant pictures enhancing nociceptive reactions. These findings indicate that emotional influence on nociceptive reactions is associated with a valence-by-arousal interaction. The authors suggested that emotional valence determines the direction of pain modulation and arousal determines the magnitude.

Another study examined the effect of emotions on pain perception by inducing emotions related to pain through hypnosis while subjecting participants to a pain stimulus (Rainville, Bao, & Chrétien, 2005). The induction of pain-related anger and sadness were found to elicit strong increases in pain, and corresponding increases in pain were associated with increased physiological arousal, negative affective valence, and a decrease in perceived control. This research shows that not only does pain influence emotion, but that negative pain-related emotions increase pain.

These findings are in line with research on women with provoked vestibulodynia (PVD), a chronic and distressing genital pain condition affecting between 8% and 16% of reproductive-age women (Harlow et al., 2014; Pukall & Cahill, 2014; Reed et al., 2012). Specifically, women with PVD tend to negatively anticipate the experience of genital pain, which has been shown to exacerbate pain (Brotto, Basson, et al., 2015; Sadownik, 2014); mindfulness-based treatments that emphasize noticing the physical qualities of pain instead of the anxious anticipation of pain lead to decreased levels of self-reported genital pain (Brotto, Basson, et al., 2015; Brotto, 2013). In the case of consensual masochism, noxious stimuli are presumably positively anticipated, potentially altering the fundamental experience of pain in sadomasochistic contexts.

Further support for the role of emotions in the processing of pain comes from brain-imaging research on neural activation in response to acute versus chronic pain. Acute pain, such as the pain experienced when a hot object is touched, activates the brain's sensory areas; whereas exacerbations of chronic pain activate the parts of the brain involved in processing emotions, reward, and motivation (Apkarian, Bushnell, Treede, & Zubieta, 2005). In such cases, the initial sensory signal of pain is supplanted by signals from brain areas that are emotionally associated with the experience of chronic pain. As chronic pain is experienced as aversive and distressing, the emotions elicited are those of suffering and reduced motivation. On the other hand, in BDSM, Bottoms report experiencing painful stimuli as pleasurable and rewarding, and typically develop preferences for certain kinds of stimulation that are sought out repeatedly over time. Perhaps the sensory signals here too are replaced by signals from parts of the brain involved in emotion, reward, and motivation, but with positive emotional connotations instead of the emotional duress elicited in chronic pain sufferers. This theory also has the potential to shed light on why Bottoms are motivated to continue engaging in SM activity. Of course, neural-imaging studies on BDSM practitioners would be needed to support this possibility.

One study compared masochists to nonmasochists in their brain responses (with functional magnetic resonance imaging [fMRI]) after they viewed painful stimuli paired with masochistic visual stimuli (Kamping et al., 2016). Emotionally neutral, positive, and negative pictures paired with and without painful stimuli were used as a control. Self-identified masochists reported lower pain intensity and pain unpleasantness ratings when painful stimuli was induced within a masochistic context, with the reduction in pain perception comparable to that of opioids (Furlan, Sandoval, Mailis-Gagnon, & Tunks, 2006). No difference in pain ratings between masochists and nonmasochistic controls emerged when other positive, negative, or neutral emotional context was present, indicating that differential pain ratings were exclusive to the masochistic context. Neurologically, the brain activation patterns of masochists observed when painful stimuli was paired with a visual masochistic context showed increased activity in the parietal operculum, which is involved in pain processing, as well as somatosensory and visual integration. Further, the parietal operculum is associated with Pavlovian nociceptive conditioning and emotional memories, suggesting that the neural patterns observed may be acquired, emerging as a result of emotional memories involving positive masochistic experiences (Sacco & Sacchetti, 2010). The parietal operculum also showed attenuated functional connectivity with the left and right insulae, the central operculum, and the supramarginal gyrus—brain regions involved in the affective-motivational aspects of pain processing. These findings demonstrate that the operculum serves as a key relay station for conveying somatosensory input to the limbic system, influencing the emotional-motivational aspects of pain in masochists.

This study also demonstrates the vital role of visual stimuli and the importance of context with respect to sadomasochism. As pictures of masochistic content were associated with reductions in perceived pain, being physically immersed in a sadomasochistic exchange may accomplish this to a greater extent. Visual and tactile senses may be augmented or accompanied by auditory and olfactory stimuli, while associated environmental and interpersonal contextual factors may also augment reductions in perceived pain. Sensory stimuli and context also play a central role in facilitating sexual arousal (Basson, 2008), which has been found to mitigate pain (Leknes & Tracey, 2008).

Social Connection and Interpersonal Relationships

Social-interpersonal factors likely also play an important role in the emotional modulation of pain as pleasure in the context of BDSM (Figure 1). Nichols (2006) outlined the

romantic and sexual benefits of BDSM, discussing its potential for enhancing intimacy, improving communication between partners, and building trust. Trust may define personal boundaries and limits with respect to BDSM activities, as well as facilitate the ability to "let go" during play. BDSM practitioners in a qualitative study suggested that BDSM both fosters and necessitates a high degree of trust between partners (Hébert & Weaver, 2015). Members of the BDSM community often relate how BDSM can bring people closer together very quickly as a result of the trust needed to safely engage in these activities. Some empirical support for this notion comes from a study by Sagarin, Cutler, Cutler, Lawler-Sagarin, and Matuszewich (2009), which found increased levels of emotional closeness reported by romantically partnered Tops and Bottoms following participation in a BDSM scene. Similarly, both Tops and Bottoms in Ambler et al.'s (2016) study reported increased self-other overlap from pre- to post-BDSM scene, a measure of relationship closeness. This is perhaps unsurprising, as one's emotional and physical safety may be placed in the hands of another in a BDSM exchange. When trust is absent or has not had the chance to form, the Bottom may be hypervigilant to error and the potential for unintentional harm during a scene. When playing with a trusted partner, the Bottom may be less cognitively distracted with worries about being hurt, which allows for a greater surrendering of control and further enables present-moment awareness. The receiver of stimulation is thus in a better position emotionally to handle more intense physical stimulation when engaged in play with a trusted partner compared to a less-familiar play partner.

A hand-holding study examining the influence of contextual factors on the anticipation of pain subjected married women to the threat of noxious stimuli while holding their partner's hand, the hand of an anonymous male confederate, or no hand at all (Coan, Schaefer, & Davidson, 2006). Reported feelings of unpleasantness were significantly lower when holding their partner's hand compared to no hand-holding or holding the hand of a male confederate. Neuroimaging similarly showed less activation in regions of the brain associated with threat response when women held their partner's hand, and this effect varied by marital quality, with superior quality being associated with lower activation of brain areas involved in threat response. This study shows that the presence of a trusted partner has the potential to reduce anticipatory pain anxiety. Research on individuals with fibromyalgia, a chronic pain condition, found that pain ratings decreased while in the company of family and friends compared to pain ratings when alone (Montoya, Larbig, Braun, Preissl, & Birbaumer, 2004). These findings indicate that the experience of pain may be attenuated merely by the presence of loved ones.

Other research has shown that the promise of reward (such as benefit to muscles) can increase pain tolerance (Benedetti, Thoen, Blanchard, Vighetti, & Arduino, 2013). The prospect of pleasing or feeling more connected to one's partner may be rewarding to masochistic individuals and, in turn, mitigate the experience of pain. Benedetti and colleagues (2013) found the effect of reward on pain tolerance was partially impeded when participants were given opioid or cannabinoid antagonists, and completely impeded when given both antagonists. These findings indicate that the association between reward and pain is moderated by the coactivation of the opioid and cannabinoid systems discussed previously. Together, these studies suggest that pain can be experienced as rewarding if it occurs within certain contexts, and that the experience of pain can be altered by the presence of loved ones.

Although SM is a central element of BDSM, the larger practice of BDSM does not hinge on the giving and receiving of painful stimulation, or necessarily even involve pain at all. Qualitative research on BDSM practitioners has found that pain is not the main objective of play but is instead employed to achieve a certain emotional experience (Cross & Matheson, 2006). Power exchange—the appearance that one partner controls the other, a reciprocal give-and-take of dominance and submission (Weinberg, Williams, & Moser, 1984)—has been reported to be more important than pain in BDSM (Weinberg, 1987). Within the context of power exchange, pain may be used as a method to establish, maintain, or intensify the power differential between partners (Cross & Matheson, 2006; Langdridge & Butt, 2005; Newmahr, 2010). The vulnerability, both physically and emotionally, that can be elicited through the infliction of pain plays a role in its enjoyment. Several aspects of BDSM, such as psychological or emotional pain play, may not involve any physical stimulation (Barker et al., 2007). For some BDSM practitioners, it is not the experience of pain but the idea or threat of pain that is arousing (Moser & Kleinplatz, 2007). That Bottoms in qualitative studies have spoken about how their experience of pain is positively enhanced by the knowledge that they are pleasing their partners further speaks to the importance of interpersonal context in BDSM (Hébert & Weaver, 2015; Moser & Kleinplatz, 2007).

Volition and Control

The voluntary nature of pain experienced during BDSM activity likely plays an important role in the processing of pain as something other than "hurt" (Figure 1). This may seem paradoxical, as the Bottom will often, though certainly not always, find relief in the surrendering of control. Although power exchange represents a fundamental aspect of BDSM, dominance and submission ultimately rests on the illusion of power exchange. In reality, many BDSM practitioners feel that the Bottom partner has control equal to, if not greater than, the Dominant or Top in any given BDSM exchange (Easton & Hardy, 2001; Weinberg & Kamel, 1983). Although certain roles appear to occupy a position of greater power and control, BDSM interactions ideally represent a mutual, bidirectional exchange of power and control (Moser & Kleinplatz, 2007; Sagarin et al., 2009).

Bottoms are in control because they consented to BDSM play, and it is within their power to withdraw consent at any time. This knowledge of control, despite the suspension of disbelief with respect to surrendering control, may alter the quality of painful stimuli. The act of explicitly negotiating and consenting to mutually defined and agreed-upon activities may foster a greater sense of control and volition in consensual BDSM exchanges (Pitagora, 2013).

In-laboratory research suggests that pain, such as that delivered by a mild shock, is experienced as less painful when the individual receiving the pain is in control of eliciting the pain stimulus (Weisenberg, 1977). Although the giver of painful stimulation in the context of BDSM is typically another person, the Bottom has knowledge of having consented to the activity and the ability to stop at any point during the scene, and thus retains some degree of control. Similarly, pain that is not under an individual's control, such as back pain or pain from an injury, is rarely, if ever, experienced as pleasant. The consensual choice to experience pain in BDSM is qualitatively distinct from inflicted or accidental pain being experienced outside of an individual's control.

Pain Tolerance and Sexual Arousal

Research has found increases in self-reported sexual arousal in both Bottoms and Tops after taking part in a BDSM scene (Ambler et al., 2016). There is considerable research documenting a pleasure-related analgesic effect on the experience of pain (Figure 1); human and animal research has found pain to be mitigated by pleasant odors, images, pleasurable music, palatable food, and, more relevantly, sexual behavior (Leknes & Tracey, 2008). An in-lab study examining the association between pleasure and pain found that stimulation of the clitoris following masturbation was least painful when it was the most pleasurable (Paterson, Amsel, & Binik, 2013). This finding is consistent with the theory that pleasure and pain are mutually inhibitory (Leknes & Tracey, 2008) and suggests that improving the pleasure of genital sensations during sexual activity could decrease the likelihood of experiencing pain (Paterson et al., 2013). Prior research has also found vaginal self-stimulation in women to suppress experimentally induced finger pain, with pain thresholds elevated over 80% in the presence of sexual arousal (Komisaruk & Whipple, 1984; Whipple & Komisaruk, 1985, 1988). It is thus reasonable to conclude that sexual arousal, and the associated pleasure that arises with arousal, likely changes the perception of pain in the context of SM. In other words, sexual arousal can alter pain perception so that stimuli that would be experienced as unpleasant outside of an erotic context is experienced as pleasurable.

Sexual interaction activates certain dopamine neurons in the reward systems of the brain, and the activation of this system suppresses negative emotional reactions to pain (Kender, Harte, Munn, & Borszcz, 2008). The role of dopamine in modulating pain perception and natural analgesia via supraspinal regions in the brain is well documented in humans (e.g., Wood, 2008; Figure 1), and the associations between noxious stimuli, dopamine release, and increased sexual behavior have been demonstrated in rodents (Budygin et al., 2012; Lepton & Stewart, 1996). Experimental research has found reductions in pain through dopamine release and the activation of the pain–reward circuit in response to orgasm, as well as to viewing pictures of a romantic partner (Bianchi-Demicheli & Ortigue, 2007; Younger, Aron, Parke, Chatterjee, & Mackey, 2010). An inhibitory effect on the experience of experimental pain was also found in response to participants viewing arousing pictures of erotica (Rhudy et al., 2008). Endogenous opioids attenuate the pain response by acting on dopaminergic neurons; this is theorized to be especially true in the presence of competing motivations, such as the emotional and physical rewards associated with sex (Fields, 2007). Sexual arousal—a common component of SM—thus increases one's ability to withstand physical pain. Further, it is possible that the repeated pairing of physical pain and sexual arousal may also condition one to experience certain kinds of pain as pleasurable and arousing. Though there is no literature documenting this, community members have expressed that some Bottoms are capable of reaching orgasm purely in response to pain stimuli (e.g., Easton & Hardy, 2001, p. 121).

Given that intimacy and sexuality are often components of partnered SM practice, it is possible that oxytocin is released during scenes with romantic or sexual partners (Figure 1). Research has found oxytocin, a neuropeptide released by the pituitary gland, to be involved in sexual arousal and orgasm (Carmichael, DeGraff, Gazdar, Minna, & Mitchell, 1987; Carmichael, Warburton, Dixen, & Davidson, 1994), as well as pair-bonding and romantic love (Schneiderman, Zagoory-Sharon, Leckman, & Feldman, 2012). Further, oxytocin release has been shown to suppress nociception and promote analgesia in response to inflammatory pain (Eliava et al., 2016) and chronic pain (Goodin, Ness, & Robbins, 2015; Tracy, Georgiou-Karistianis, Gibson, & Giummarra, 2015). It has been proposed that oxytocin may have an analgesic effect through interacting with the central endogenous opioid system (Tracy et al., 2015) or by reducing the influence of stress and anxiety in nociceptive signaling of primary pain pathways (Tay & Yamamoto, 2016). Future research might investigate whether oxytocin is released during SM exchanges and, if so, how it might play a role in the experience or modulation of masochistic pain.

Although BDSM does not always involve sexual activity or even sexual arousal, it represents one of the various avenues by which pain is experienced as pleasurable. As in more conventional sexual situations, an array of factors contributes to the development and maintenance of sexual arousal. Basson's (2008) circular model of sexual response highlights several of these factors, including sexual stimuli, environmental and interpersonal contextual factors, as well

as the state of mind in terms of biological and psychological influences.

Altered States of Consciousness

Masochism can be viewed as a means of obtaining altered states of consciousness (Hennen, 2008; Landridge, 2007; Sagarin, Lee, & Klement, 2015; Figure 1). Pain can focus attention on the present moment and away from abstract high-level thought; in this way, pain may facilitate a temporary reprieve or escape from the burdensome responsibilities of adulthood, or "selfhood," as described by Baumeister (1988, 1997). The desire to escape from the burdens of daily life may motivate individuals to seek pleasant altered states of consciousness, such as those which can emerge from BDSM (Newmahr, 2010). Complementary to this notion, psychological release was listed as a primary theme in a qualitative study on BDSM practitioners (Hébert & Weaver, 2015), wherein participants explained that BDSM can be used as a tool to help deal with daily life stressors and frustrations, as well to gain feelings of freedom from day-to-day roles and responsibilities. Based on her therapeutic work with BDSM practitioners, Nichols (2006) listed the ability to obtain pleasurable altered states of consciousness as a healthy and straightforward reason for the appeal of BDSM to those who practice it. In a study involving interviews with 24 self-identified BDSM practitioners, Taylor and Ussher (2001) found that participant narratives generally reflected three positive motivations for engaging in BDSM, including sadomasochism as pleasure, escapism, and transcendence. Regarding escapism, participants described sadomasochism as a way to escape from the mundane ordinariness of day-to-day life. The theme of transcendence involved viewing sadomasochism either within a spiritual framework, as facilitating a heightened state of consciousness, or as an adrenaline rush. Westerfelhaus (2007) identified the role of pain in producing altered states of consciousness as a desirable spiritual experience in BDSM. Indeed, the altered states of consciousness sometimes obtained through sadomasochism may be comparable to those involved in the intense physical activity of extreme rituals (e.g., firewalking, body piercing) (Klement et al., 2017; Sagarin et al., 2015) and are likely facilitated by the release of endogenous opioids and cannabinoids. Pain in the context of BDSM thus has the potential to produce altered states of consciousness, the experience of which is proclaimed to be pleasurable (Hébert & Weaver, 2015).

Dietrich's (2003) transient hypofrontality hypothesis has been applied as the mechanism by which this form of physical pain can produce alerted states of consciousness similar to those which can arise from extreme exercise, meditation, and some drugs. Transient hypofrontality states that certain activities increase the need for additional blood flow in the brain, and that the brain compensates by redirecting blood flow away from currently less important areas to other areas of the brain in high demand. This downregulation can result in alterations to focused attention, time distortions, and social disinhibition. People thought to be experiencing transient hypofrontality have expressed short-term reductions to executive functioning, decreased pain, and increased present-moment awareness, as well as feelings of peacefulness and floating (Dietrich, 2003). Csikszentmihalyi's (1990) concept of flow has also been suggested to play a role in the altered states of consciousness that can be achieved through BDSM play (Newmahr, 2010). According to Newmahr (2010), flow is experienced by Bottoms through intense rhythmic sensation, sensation or pain itself, and a concentrated effort to endure a sensation. Consistent with this possibility is the numerous reports of BDSM practitioners, who use the term *subspace* to describe a pleasant state of altered consciousness experienced by the receiver of painful stimulation in a BDSM scene (Ambler et al., 2016).

Based on a phenomenological analysis of BDSM literature, Pitagora (2017) defined *subspace* as a "psychophysical" (i.e., reciprocally interactive psychological and physiological) state occurring within the context of a BDSM interaction. This state is often characterized by activation of the sympathetic nervous system, the release of epinephrine and endorphins, and a subsequent period of "non-verbal, deep relaxation" and "may include temporary feelings of depersonalization and derealization" (p. 46). Moreover, this altered state of consciousness has the potential to enhance connection and intimacy between partners (Pitagora, 2017; Sagarin et al., 2015).

Further evidence that BDSM facilitates altered states of consciousness comes from a study (Ambler et al., 2016) in which participants (n = 14) who identified as Switches[1] were randomly assigned to the Top or Bottom role for a BDSM scene. Individuals assigned to the Bottom role displayed temporary postscene reductions in executive functioning as measured by a Stroop test, which is consistent with transient hypofrontality and Baumeister's (1988) theory of self-escapism. Bottoms also reported higher levels of flow. Examination of flow dimensions showed that Bottoms endorsed experiencing a loss of self-consciousness, time transformation, pleasure, and engagement, but not the intentional performance characteristic of flow states.

That pain can concentrate attention on the present moment speaks to potential ties with mindfulness, which emphasizes a greater awareness and acceptance of moment-to-moment experiences. Being mindful entails an intentional shift toward observing one's present experience without altering it, a state of *being* instead of *doing*, in which thoughts freely enter conscious awareness and are then let go without reaction (Kurtz, 2005). In this way, the cognitive and emotional experience of pain can be "uncoupled" from the associated physical sensation of pain (Kabat-Zinn, 1982). Perhaps the flow state experienced by Bottoms in Ambler et al.'s (2016) study reflects an altered state of

[1] A Switch is a BDSM practitioner who enjoys both Topping and Bottoming, or playing the role of both Dominant and submissive.

consciousness, brought on by the contextual elements of SM and the production of endogenous opioids and cannabinoids, in turn altering pain perception.

Why might pain generate pleasurable altered states of consciousness in BDSM but not in other contexts? This phenomenon is likely tied to the environmental, psychological, and interpersonal contexts in which BDSM takes place. Figure 1 outlines how contextual factors, sexual arousal, the positive anticipation of pain, and the physiological response to pain may facilitate pleasurable altered states of consciousness within BDSM experiences. Conversely, the contextual factors involved in unwanted or accidental pain likely worsen the experience, and such pain tends to be negatively anticipated (if anticipated at all), as well as lack the presence of sexual arousal, consent, or control.

Pain and Mindfulness

Mindfulness can be thought of as a state of mind that emphasizes a nonjudgmental awareness and acceptance of emotions, thoughts, and physical sensations in the present moment. It has also been operationally defined as a "regulated, sustained attention to the moment-to-moment quality and character of sensory, emotional, and cognitive events" (Zeidan, Grant, Brown, McHaffie, & Coghill, 2012, p. 2). Mindfulness involves focused attention, which involves emotional detachment and augmented cognitive control (Lutz, Slagter, Dunne, & Davidson, 2008), as well as open monitoring, which involves a nonevaluative awareness of the present-moment experience (Wallace, 2006).

Mindfulness meditation has been associated with myriad positive mental and physical health outcomes, from improvements in anxiety (Kabat-Zinn et al., 1992) and depression (Barnhofer et al., 2009; Teasdale et al., 2000) to improved sexual function (Brotto & Basson, 2014; Brotto, Basson, & Luria, 2008; Brotto et al., 2012), including sexual arousal (Brotto et al., 2008). The link between pain and mindfulness was first documented by Kabat-Zinn in the 1970s when he adapted traditional Eastern meditation to a Western context of chronic debilitating pain conditions in patients who were otherwise resistant to traditional forms of pain management (Kabat-Zinn, 1982; Kabat-Zinn, Lipworth, & Burney, 1985). Mindfulness-Based Stress Reduction and Mindfulness-based Cognitive Therapy were born out of the success of this treatment and currently represent two of the most prominent psychological interventions for a wide variety of chronic pain conditions.

Mindfulness practice has been found to attenuate the subjective experience of pain, provide physical pain relief, decrease pain catastrophizing, and reduce pain-related brain activity (Brown & Jones, 2010; Garland et al., 2012; Grant & Rainville, 2009; Oshiro, Quevedo, McHaffie, Kraft, & Coghill, 2009; Zeidan, Gordon, Merchant, & Goolkasian, 2010; Figure 1). Training in mindfulness increases tolerance to experimental pain stimuli (Kingston, Chadwick, Meron, & Skinner, 2007) and attenuates the perceived unpleasantness of painful stimuli (Zeidan et al., 2011). Research has found that people who routinely practice mindfulness report less pain when given a painful stimulus than volunteers who receive the same stimulus and instructions (Grant & Rainville, 2009), suggesting that long-term meditators have higher pain tolerance or lower pain sensitivity compared to nonmeditators. This study found that long-term Zen meditators required higher temperatures to report moderate pain compared to meditation-naive controls and that the most experienced mindfulness practitioners experienced the largest reductions in pain. Another study found that practiced meditators reported lower pain unpleasantness but no difference in pain intensity compared to controls (Perlman, Salomons, Davidson, & Lutz, 2010). Anecdotally, BDSM practitioners sometimes use the term "intensity" to describe noxious sensations instead of "pain" (e.g., Morpheus, 2008, pp. 109, 118).

Corresponding neuroimaging research has shown that the brain areas involved in sensory processing are activated when mindfulness practitioners are given a painful stimulus, while the neural networks of nonpractitioners are centered on brain areas involved in evaluation, judgment, and emotion when given the same stimulus (Grant, Courtemanche, & Rainville, 2011). Mindfulness practitioners are thus more able to limit the experience of pain to physical sensations; nonpractitioners first experience the physical sensations of pain, and then reflexively experience an aversion to the physical sensations. Research has indicated that structural brain differences in somatomotor cortices among meditation practitioners may underlie the ability of meditators to focus on the sensory qualities of painful stimuli rather than the emotional cognitions that tend to immediately follow pain stimuli (Grant, Courtemanche, Duerden, Duncan, & Rainville, 2010; Grant et al., 2011). Mindfulness meditation has thus been found to attenuate pain through enhanced cognitive and emotional control, and through altering the contextual elements of noxious sensory stimuli (Zeidan et al., 2012).

Just how does focused attention mitigate pain? One study used fMRI to assess the neural mechanisms through which mindfulness meditation attenuates pain (Zeidan et al., 2011). After four days of mindfulness training, meditating while receiving a painful stimulus reduced pain intensity by 40% and unpleasantness by 57% compared to controls. Mindfulness-related decreases in pain intensity ratings coincided with increased anterior insula and anterior cingulate cortex activity (areas involved in pain processing and cognitive regulation, respectively). Decreases in pain unpleasantness ratings were associated with increased activity in the orbitofrontal cortex (an area involved in the contextual evaluation of physical sensations) and thalamic deactivation, which was postulated to reflect a modifying influence of the limbic system on the interaction between afferent input and brain areas involved in

executive function. These findings suggest that the subjective experience of pain is altered by multiple brain mechanisms during mindfulness meditation. Another neuroimaging study found that dispositional mindfulness in nonmeditators during pain induction was associated with more deactivation of the posterior cingulate cortex in the default mode network—an area involved in mind wandering and processing feelings of the self (Zeidan et al., 2015). The default mode network activates during task performance, suspending self-related thoughts and emotions. These findings indicate that mindful individuals may be less caught up in the experience of pain.

With respect to BDSM, the pleasurable altered state of consciousness sometimes obtained through bottoming allows one to focus attention on the here and now by observing physical sensations. A present moment focus may mitigate negative anticipatory anxiety of imminent pain, which has been shown to exacerbate the experience of pain (Ploghaus et al., 2001). This focused attention is necessary, as BDSM practitioners must be able to distinguish sensations that are pleasant or unpleasant but innocuous versus pain that signals the potential for real physical injury, a concept known as *hedonic tone* in mindfulness literature. In *How to be Kinky*, Morpheus (2008) highlighted the need to differentiate between safe pain and bad pain. The sensation of pins and needles or numbness, for example, can be indicative of nerve pain or compression, which is "the body's way of telling you that there is something seriously not right" and requires immediate intervention (p. 101). Focused attention on the present moment might better enable Bottoms to observe physical sensations of pain without negative evaluation or emotional reactivity. From these present-moment observations, practitioners can foster awareness of what type of activities they like or dislike, as well as differentiate safe pain from unsafe pain, which is crucial to communication and scene negotiation. Anecdotally, Bottoms often reference focusing on the breath during an SM scene (Easton & Hardy, 2001, p. 122), which is a core component of mindfulness practice.

Psychological versus Physiological Stress

A few studies provide experimental insight into the physiological and psychological effects of BDSM activities. These studies (Ambler et al., 2016; Klement et al., 2017; Sagarin et al., 2009) found increases in salivary cortisol levels (a hormone associated with physical stress) from pre- to post-BDSM scene engagement among Bottoms (Figure 1). Interestingly, Bottoms in the Ambler et al. (2016) study also reported significantly increased positive affect, decreased negative affect, and decreased psychological stress following participation in a BDSM scene. A study by Klement and colleagues (2017) yielded similar findings after administering surveys and collecting saliva samples from individuals participating in a ritual that involved temporary skin piercings known as a hook pull. Participants of the hook pull exhibited increased levels of salivary cortisol, as well as reductions in psychological stress and negative affect. This research showed increases in cortisol levels and decreases in negative affect and psychological stress during a BDSM ritual involving dance and temporary piercings with weights. Thus, despite the tendency to heighten physiological stress, BDSM activities have the potential to relieve psychological distress. The authors provided two possible explanations for the paradoxical increase in physical stress and decrease in psychological stress: (1) increases in cortisol may be attributed to the participant's bodies registering physical sensations of pain, while a subjective experience of pain was not experienced, and (2) the ritual itself could have moderated the association between physiological and psychological stress through the reduction of negative emotions that may have otherwise accompanied physical pain.

It is not uncommon for members of the BDSM community to desire the emotional release afforded by bottoming in times of emotional duress (e.g., Easton & Hardy, 2001, p. 86). That bottoming can reduce emotional distress and is sometimes used as a way to relieve negative affect is perhaps relevant to individuals who engage in nonsuicidal self-injury (NSSI). Specifically, the primary motive for engaging in NSSI is emotion regulation—to bring about a reduction in overwhelming negative affect. Although BDSM should not be confused with NSSI, the association between pain and improved emotional states for both of these populations may shed light on the pain–pleasure connection. Perhaps it is the release of endogenous opioids and endocannabinoids, or the ability of pain to focus attention on sensations in the present moment, that provides relief from psychological stress in both these populations. Whatever the mechanism, pain appears to have the paradoxical potential to reduce emotional stress in the face of physiological stress.

Bringing It All Together

As noted previously, Figure 1 depicts a visual representation of the various factors involved in the processing of pain as pleasure within the context of consensual masochism. Unlike contexts that involve accidental or unwanted pain, experiencing pain as pleasure begins with a positive headspace geared toward consensually receiving pain. Prior to the experience of pain, visual stimuli, environmental context, emotional state, interpersonal connection, memories, and, often, sexual arousal work together to create a desire for and receptivity to pain. That sadomasochistic pain is wanted and consensual also primes the individual for the experience of pain, with volition and the ability to withdraw from the scene at any time, creating a sense of safety and control that is absent in other pain-related contexts. An emotional sense of safety or ease may be compounded by the presence of

a loved one. Before noxious stimulation is delivered, these factors promote the positive anticipation of pain, rather than a negative anticipation of pain as in other contexts. Though there is no research on what neural networks are activated with the positive anticipation of pain among masochists, research shows that the negative anticipation of pain causes certain brain regions to fire and exacerbates pain once received. Perhaps a similar opposing process occurs in the positive anticipation of pain. For example, a Bottom may be in an environmental setting that stimulates arousal, which is further enhanced by the sight of preferred tools, the presence of a romantic partner, and evocative memories of previous sadomasochistic experiences. Such arousal may coincide with activity in the limbic and reward systems in the brain and trigger the release of dopamine and oxytocin. Thus, the neurological and physiological processing of pain as pleasure likely starts before noxious stimuli is even received.

Once nociceptors are stimulated, various physiological reactions work together in tandem to influence and maintain an individual's headspace and experience. Neurotransmitters and hormones, such as dopamine, oxytocin, and cortisol, are released alongside endogenous opioids and endocannabinoids to alter or complement the experience of pain. Sexual arousal may be present and augmented by the nociception, and orgasm may occur, all of which influence neural chemistry and emotional state. Tactile senses are accompanied by smells, sounds, and sights that harmoniously engage various neural networks to influence the moment-by-moment experience. Various brain areas fire in response to noxious stimuli and top-down processing occurs, influencing and being influenced by emotional and environmental factors that contribute to *set and setting*. The physiological, psychological, and interpersonal elements of a scene feed off one another to create an experience. With repeated stimulation, an altered state of consciousness may be achieved, whereby the individual becomes immersed in the present moment, mindfully focusing on observing each sense modality. This process has the potential to relieve psychological stress, allow the momentary suspension of the burdensome responsibilities of day-to-day life, and promote intimacy and connection between partners; all are powerful motivators to seek out such experiences again in the future.

Limitations

Though research on BDSM is gaining in popularity and improving in terms of study design and methodology, certain limitations must be considered. The sample sizes of studies on BDSM practitioners are often small or limited to a specific geographic region, which has implications for the generalizability of findings. Similarly, most studies on BDSM practitioners recruit from local BDSM communities and are thus limited to people who identify as BDSM community members. Replication of studies in different geographic settings is needed. Many BDSM studies utilize qualitative methodology, which is well suited for exploring the lived experiences of BDSM practitioners; however, such research lacks markers of validity and reliability characteristic of quantitative approaches. Finally, as with most studies using self-report, social desirability of responses may represent an issue, perhaps especially so due to the stigma often associated with such practices.

Conclusion

Pain is more than a physical sensation; it is also an emotion, built on past and present contextual and relational factors and memories. This is true of pain in all contexts, whether it represents accidental environmental pain, pain from medical procedures, or pain inflicted during consensual sadomasochism. In the case of consensual sadomasochism, neurological, psychological, environmental, and interpersonal elements come together to create a pleasurable or rewarding experience of pain.

From research on chronic and acute pain, we know that the experience of pain is influenced by thoughts about pain, the extent to which one perceives having control over pain, expectations about the cause of pain, whether the pain is anticipated or familiar, how pain is cognitively appraised, level of self-efficacy and pride in terms of believing one can take the pain, one's emotional state when pain is received, emotional associations with respect to the type of pain, and the feeling that one has control over the ending of pain. Though there is minimal research examining these variables within the context of sadomasochism, the important role of such factors on the sadomasochistic experience is not in doubt.

To the best of the authors' knowledge, this article is the first to comprehensively examine and combine the disparate factors involved in processing pain and relate them to processing pain as pleasure in the context of BDSM. While research investigating pain and its many correlates is abundant, research studying pain as a positive experience is scant. We know that the experience of pain is influenced by the presence of loved ones (Montoya et al., 2004), visual cues (Kamping et al., 2016), sexual arousal (Kender et al., 2008), emotions (Franklin, 1998), memories (Sacco & Sacchetti, 2010), and more; research examining the dynamic relationship among these factors in relation to pain among sadomasochists is needed. Existing research on pain lays the groundwork for novel and revolutionary research on the sadomasochistic pain experience. Research of this nature would not only further understanding of pain in relation to SM but potentially provide new insights into pain in and of itself. Examining the interactive and dynamic process of neurological, physical, psychological, emotional, and interpersonal factors involved in the pain–pleasure connection within the context of BDSM could feed back into the saturated body of literature on pain in traditional contexts.

Demystifying the overlap between pain and pleasure also has important clinical implications. For example, research

on the headspace of sadomasochists could provide insight into the psychological treatment of individuals struggling with acute or chronic pain. A better understanding of how certain kinds of pain can be processed as pleasure may also lessen the stigmatization of people who enjoy the experience of pain.

References

Ambler, J. K., Lee, E. M., Klement, K. R., Loewald, T., Comber, E. M., Hanson, S. A., … Sagarin, B. J. (2016). Consensual BDSM facilitates role-specific altered states of consciousness: A preliminary study. *Psychology of Consciousness: Theory, Research, and Practice*, *4*, 75–91. doi:10.1037/cns0000097

Apkarian, A. V., Bushnell, M. C., Treede, R. D., & Zubieta, J. K. (2005). Human brain mechanisms of pain perception and regulation in health and disease. *European Journal of Pain*, *9*, 463–484. doi:10.1016/j/ejpain.2004.11.001

Barker, M., Iantaffi, A., & Gupta, C. (2007). Kinky clients, kinky counselling? The challenges and potentials of BDSM. In L. Moon (Ed.), *Feeling queer or queer feelings: Radical approaches to counselling sex, sexualities and genders* (pp. 106–124). London, UK: Routledge.

Barnhofer, T., Crane, C., Hargus, E., Amarasinghe, M., Winder, R., & Williams, J. M. G. (2009). Mindfulness-based cognitive therapy as a treatment for chronic depression: A preliminary study. *Behaviour Research and Therapy*, *47*, 366–373. doi:10.1016/j/brat.2009.01.019

Basbaum, A. I., & Fields, H. S. (1978). Endogenous pain control mechanisms: Review and hypotheses. *Annals of Neurology*, *4*, 451–462. doi:10.1002/ana.410040511

Basson, R. (2008). Women‘s sexual desire and arousal disorders. *Primary Psychiatry*, *15*, 72–81.

Baumeister, R. F. (1988). Masochism as escape from self. *Journal of Sex Research*, *25*, 28–59. doi:10.1080/00224498809551444

Baumeister, R. F. (1997). The enigmatic appeal of sexual masochism: Why people desire pain, bondage, and humiliation in sex. *Journal of Social and Clinical Psychology*, *16*, 133–150. doi:10.1521/jscp.1997.16.2.133

Beecher, H. K. (1946). Pain in men wounded in battle. *Annals of Surgery*, *123*, 96–105. doi:10.1097/00000658-194601000-00008

Benedetti, F., Thoen, W., Blanchard, C., Vighetti, S., & Arduino, C. (2013). Pain as a reward: Changing the meaning of pain from negative to positive co-activates opioid and cannabinoid systems. *Pain*, *154*, 361–367. doi:10.1016/j.pain.2012.11.007

Bianchi-Demicheli, F., & Ortigue, S. (2007). Toward an understanding of the cerebral substrates of woman‘s orgasm. *Neuropsychologia*, *45*, 2645–2659. doi:10.1016/j.neuropsychologia.2007.04.016

Brotto, L. A., & Basson, R. (2014). Group mindfulness-based therapy significantly improves sexual desire in women. *Behaviour Research and Therapy*, *57*, 43–54. doi:10.1016/j.brat.2014.04.001

Brotto, L. A., Basson, R., Carlson, M., & Zhu, C. (2013). Impact of an integrated mindfulness and cognitive behavioural treatment for provoked vestibulodynia (IMPROVED): A qualitative study. *Sexual and Relationship Therapy*, *28*(1–2), 3–19. doi:10.1080/14681994.2012.686661

Brotto, L. A., Basson, R., & Luria, M. (2008). A mindfulness-based group psychoeducational intervention targeting sexual arousal disorder in women. *Journal of Sexual Medicine*, *5*, 1646–1659. doi:10.1111/j.1743-6109.2008.00850.x

Brotto, L. A., Basson, R., Smith, K. B., Driscoll, M., & Sadownik, L. (2015). Mindfulness-based cognitive therapy for women with provoked vestibulodynia. *Mindfulness*, *6*, 417–432. doi:10.1007/s12671-013-0273-z

Brotto, L. A., Erskine, Y., Carey, M., Ehlen, T., Finlayson, S., Heywood, M., … Miller, D. (2012). A brief mindfulness-based cognitive behavioral intervention improves sexual functioning versus wait-list control in women treated for gynecologic cancer. *Gynecologic Oncology*, *125*, 320–325. doi:10.1016/j.ygyno.2012.01.035

Brown, C. A., & Jones, A. K. (2010). Meditation experience predicts less negative appraisal of pain: Electrophysiological evidence for the involvement of anticipatory neural responses. *Pain*, *150*, 428–438. doi:10.1016/j.neulet.2012.03.082

Budygin, E. A., Park, J., Bass, C. E., Grinevich, V. P., Bonin, K. D., & Wightman, R. M. (2012). Aversive stimulus differentially triggers subsecond dopamine release in reward regions. *Neuroscience*, *201*, 331–337. doi:10.1016/j.neuroscience.2011.10.056

Calignano, A., Katona, I., Desarnaud, F., Giuffrida, A., La Rana, G., Mackie, K., … Piomelli, D. (2000). Bidirectional control of airway responsiveness by endogenous cannabinoids. *Nature*, *408*, 96–101. doi:10.1038/35040576

Calignano, A., La Rana, G., Giuffrida, A., & Piomelli, D. (1998). Control of pain initiation by endogenous cannabinoids. *Nature*, *394*, 277–281. doi:10.1038/28393

Carmichael, J., DeGraff, W. G., Gazdar, A. F., Minna, J. D., & Mitchell, J. B. (1987). Evaluation of a tetrazolium-based semiautomated colorimetric assay: Assessment of chemosensitivity testing. *Cancer Research*, *47*, 936–942.

Carmichael, M. S., Warburton, V. L., Dixen, J., & Davidson, J. M. (1994). Relationships among cardiovascular, muscular, and oxytocin responses during human sexual activity. *Archives of Sexual Behavior*, *23*, 59–79. doi:10.1007/BF01541618

Coan, J. A., Schaefer, H. S., & Davidson, R. J. (2006). Lending a hand: Social regulation of the neural response to threat. *Psychological Science*, *17*, 1032–1039. doi:10.1111/j.1467-9280.2006.01832.x

Craig, A. D. (2003). A new view of pain as a homeostatic emotion. *Trends in Neurosciences*, *26*, 303–307. doi:10.1016/S0166-2236(03)00123-1

Cross, P. A., & Matheson, K. (2006). Understanding sadomasochism: An empirical examination of four perspectives. *Journal of Homosexuality*, *50*, 133–166. doi:10.1300/J082v50n02_07

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York, NY: Harper & Row.

Cui, M., Feng, Y., McAdoo, D. J., & Willis, W. D. (1999). Periaqueductal gray stimulation-induced inhibition of nociceptive dorsal horn neurons in rats is associated with the release of norepinephrine, serotonin, and amino acids. *Journal of Pharmacology and Experimental Therapeutics*, *289*, 868–876.

Defrin, R., Arad, M., Ben-Sasson, M. P., & Ginzburg, K. (2015). Attitudes and emotions towards pain and sensitivity to painful stimuli among people routinely engaging in masochistic behaviour. *European Journal of Pain*, *19*, 1321–1330. doi:10.1002/ejp.662

Dietrich, A. (2003). Functional neuroanatomy of altered states of consciousness: The transient hypofrontality hypothesis. *Consciousness and Cognition*, *12*, 231–256. doi:10.1016/S1053-8100(02)00046-6

Dietrich, A., & McDaniel, W. F. (2004). Endocannabinoids and exercise. *British Journal of Sports Medicine*, *38*, 536–541. doi:10.1136/bjsm.2004.011718

Dutton, D. G., & Aron, A. P. (1974). Some evidence for heightened sexual attraction under conditions of high anxiety. *Journal of Personality and Social Psychology*, *30*, 510–517. doi:10.1037/h0037031

Easton, D., & Hardy, J. W. (2001). *The new bottoming book*. Gardena, CA: Greenery Press.

Eliava, M., Melchior, M., Knobloch-Bollmann, H. S., Wahis, J., Da Silva Gouveia, M., Tang, Y., … Chavant, V. (2016). A new population of parvocellular oxytocin neurons controlling magnocellular neuron activity and inflammatory pain processing. *Neuron*, *89*, 1291–1304. doi:10.1016/j.neuron.2016.01.041

Fields, H. L. (2007). Understanding how opioids contribute to reward and analgesia. *Regional Anesthesia and Pain Medicine*, *32*, 242–246. doi:10.1016/j.rapm.2007.01.001

Fields, H. L., Basbaum, A. I., & Heinricher, M. M. (2005). Central nervous system mechanism of pain modulation. In S. McMahon & M. Koltzenburg (Eds.), *Textbook of pain* (5th ed., pp. 125–142). Burlington, MA: Elsevier Health Sciences.

Franklin, K. B. J. (1998). Analgesia and abuse potential: An accidental association or a common substrate? *Pharmacology Biochemistry and Behavior*, *59*, 993–1002. doi:10.1016/S0091-3057(97)00535-2

French, A. S., & Torkkeli, P. H. (2009). Reference module in neuroscience and biobehavioral psychology. In *Encyclopedia of Neuroscience* (pp. 689–695). Cambridge, MA: Academic Press.

Furlan, A. D., Sandoval, J. A., Mailis-Gagnon, A., & Tunks, E. (2006). Opioids for chronic noncancer pain: A meta-analysis of effectiveness and side effects. *Canadian Medical Association Journal*, *174*, 1589–1594. doi:10.1503/cmaj.051528

Fuss, J., Steinle, J., Bindila, L., Auer, M. K., Kirchherr, H., Lutz, B., & Gass, P. (2015). A runner's high depends on cannabinoid receptors in mice. *Proceedings of the National Academy of Sciences*, *112*, 13105–13108. doi:10.1073/pnas.1514996112

Garland, E. L., Gaylord, S. A., Palsson, O., Faurot, K., Mann, J. D., & Whitehead, W. E. (2012). Therapeutic mechanisms of a mindfulness-based treatment for IBS: Effects on visceral sensitivity, catastrophizing, and affective processing of pain sensations. *Journal of Behavioral Medicine*, *35*, 591–602. doi:10.1007/s10865-011-9391-z

Goodin, B. R. J., Ness, T. J., & Robbins, M. T. (2015). Oxytocin - a multifunc tional analgesic for chronic deep tissue pain. *Current Pharmaceutical Design*, *21*, 906–913. doi:10.2174/1381612820666141027111843

Gorzalka, B. B., Hill, M. N., & Chang, S. C. (2010). Male–female differences in the effects of cannabinoids on sexual behavior and gonadal hormone function. *Hormones and Behavior*, *58*, 91–99. doi:10.1016/j.yhbeh.2009.08.009

Grant, J. A., Courtemanche, J., Duerden, E. G., Duncan, G. H., & Rainville, P. (2010). Cortical thickness and pain sensitivity in Zen meditators. *Emotion*, *10*, 43–53. doi:10.1037/a0018334

Grant, J. A., Courtemanche, J., & Rainville, P. (2011). A non-elaborative mental stance and decoupling of executive and pain-related cortices predicts low pain sensitivity in Zen meditators. *Pain*, *152*, 150–156. doi:10.1016/j.pain.2010.10.006

Grant, J. A., & Rainville, P. (2009). Pain sensitivity and analgesic effects of mindful states in Zen meditators: A cross-sectional study. *Psychosomatic Medicine*, *71*, 106–114. doi:10.1097/PSY.0b013e31818f52ee

Harlow, B. L., Kunitz, C. G., Nguyen, R. H., Rydell, S. A., Turner, R. M., & MacLehose, R. F. (2014). Prevalence of symptoms consistent with a diagnosis of vulvodynia: Population-based estimates from 2 geographic regions. *American Journal of Obstetrics and Gynecology*, *210*, 40.e1–40.e8. doi:10.1016/j.ajog.2013.09.033

Hébert, A., & Weaver, A. (2014). An examination of personality characteristics associated with BDSM orientations. *The Canadian Journal of Human Sexuality*, *23*, 106–115. doi:10.3138/cjhs.2467

Hébert, A., & Weaver, A. (2015). Perks, problems, and the people who play: A qualitative exploration of dominant and submissive BDSM roles. *The Canadian Journal of Human Sexuality*, *24*, 49–62. doi:10.3138/cjhs.2467

Hennen, P. (2008). *Faeries, bears, and leathermen: Men in community queering the masculine*. Chicago, IL: University of Chicago Press.

Holden, J. E., Jeong, Y., & Forrest, J. M. (2005). The endogenous opioid system and clinical pain management. *AACN Advanced Critical Care*, *16*, 291–301. doi:10.1097/00044067-200507000-00003

Holt, K. (2016). Blacklisted: Boundaries, violations, and retaliatory behavior in the BDSM community. *Deviant Behavior*, *37*, 1–14. doi:10.1080/01639625.2016.1156982

Kabat-Zinn, J. (1982). An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation: Theoretical considerations and preliminary results. *General Hospital Psychiatry*, *4*, 33–47. doi:10.1016/0163-8343(82)90026-3

Kabat-Zinn, J., Lipworth, L., & Burney, R. (1985). The clinical use of mindfulness meditation for the self-regulation of chronic pain. *Journal of Behavioral Medicine*, *8*, 163–190. doi:10.1007/bf00845519

Kabat-Zinn, J., Massion, A. O., Kristeller, J., Peterson, L. G., Fletcher, K. E., Pbert, L., … Santorelli, S. F. (1992). Effectiveness of a meditation-based stress reduction program in the treatment of anxiety disorders. *American Journal of Psychiatry*, *149*, 936–943. doi:10.1176/ajp.149.7.936

Kamping, S., Andoh, J., Bomba, I. C., Diers, M., Diesch, E., & Flor, H. (2016). Contextual modulation of pain in masochists: Involvement of the parietal operculum and insula. *Pain*, *157*, 445–455. doi:10.1097/j.pain.0000000000000390

Kender, R. G., Harte, S. E., Munn, E. M., & Borszcz, G. S. (2008). Affective analgesia following muscarinic activation of the ventral tegmental area in rats. *The Journal of Pain*, *9*, 597–605. doi:10.1016/j.jpain.2008.01.334

Kingston, J., Chadwick, P., Meron, D., & Skinner, T. C. (2007). A pilot randomized control trial investigating the effect of mindfulness practice on pain tolerance, psychological well-being, and physiological activity. *Journal of Psychosomatic Research*, *62*, 297–300. doi:10.1016/j.jpsychores.2006.10.007

Klement, K. R., Lee, E. M., Ambler, J. K., Hanson, S. A., Comber, E., Wietting, D., … Reid, E. (2017). Extreme rituals in a BDSM context: The physiological and psychological effects of the 'dance of souls'. *Culture, Health & Sexuality*, *19*, 453–469. doi:10.1080/13691058.2016.1234648

Komisaruk, B. R., & Whipple, B. (1984). Evidence that vaginal self-stimulation in women suppresses experimentally-induced finger pain. *Society for Neuroscience Abstracts*, *10*, 675.

Kurtz, R. (2005). *Body centered psychotherapy: The Hakomi method*. Mendocino, CA: LifeRhythm.

Landridge, D. (2007). *Phenomenological psychology: Theory, research and method*. London, UK: Pearson Education.

Langdridge, D., & Butt, T. (2005). The erotic construction of power exchange. *Journal of Constructivist Psychology*, *18*, 65–73. doi:10.1080/10720530590523099

Leknes, S., & Tracey, I. (2008). A common neurobiology for pain and pleasure. *Nature Reviews Neuroscience*, *9*, 314–320. doi:10.1038/nrn2333

Lepton, M., & Stewart, J. (1996). Acute and repeated activation of male sexual behavior by tail pinch: Opioid and dopaminergic mechanisms. *Physiology & Behavior*, *60*, 77–85. doi:10.1016/0031-9384(95)02270-8

Lumley, M. A., Cohen, J. L., Borszcz, G. S., Cano, A., Radcliffe, A. M., Porter, L. S., … Keefe, F. J. (2011). Pain and emotion: A biopsychosocial review of recent research. *Journal of Clinical Psychology*, *67*, 942–968. doi:10.1002/jclp.20816

Lutz, A., Slagter, H. A., Dunne, J. D., & Davidson, R. J. (2008). Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences*, *12*, 163–169. doi:10.1016/j.tics.2008.01.005

Meredith, P. J., Strong, J., & Feeney, J. A. (2006). The relationship of adult attachment to emotion, catastrophizing, control, threshold and tolerance, in experimentally-induced pain. *Pain*, *120*, 44–52. doi:10.1016/j.pain.2005.10.008

Merskey, H., & Bogduk, N. (1994). *Classification of chronic pain, IASP task force on taxonomy*. Seattle, WA: International Association for the Study of Pain Press.

Montoya, P., Larbig, W., Braun, C., Preissl, H., & Birbaumer, N. (2004). Influence of social support and emotional context on pain processing and magnetic brain responses in fibromyalgia. *Arthritis & Rheumatism*, *50*, 4035–4044. doi:10.1002/art.20660

Morpheus. (2008). *How to be kinky: A beginner's guide to BDSM*. San Francisco, CA: Green Candy Press.

Moser, C., & Kleinplatz, P. J. (2007). Themes of SM expression. In A. Moore (Ed.), *Safe, sane, and consensual: Contemporary perspectives on sadomasochism* (pp. 35–54). London, UK: Palgrave Macmillan.

Newmahr, S. (2010). Rethinking kink: Sadomasochism as serious leisure. *Qualitative Sociology*, *33*, 313–331. doi:10.1007/s11133-010-9158-9

Nichols, M. (2006). Psychotherapeutic issues with "kinky" clients: Clinical problems, yours and theirs. *Journal of Homosexuality*, *50*, 281–300. doi:10.1300/J082v50n02_14

Ogles, B. M., & Masters, K. S. (2003). A typology of marathon runners based on cluster analysis of motivations. *Journal of Sport Behavior*, *26*, 69–85.

Oshiro, Y., Quevedo, A. S., McHaffie, J. G., Kraft, R. A., & Coghill, R. C. (2009). Brain mechanisms supporting discrimination of sensory

features of pain: A new model. *Journal of Neuroscience*, *29*, 14924–14931. doi:10.1523/JNEUROSCI.5538-08.2009

Ossipov, M. H., Dussor, G. O., & Porreca, F. (2010). Central modulation of pain. *The Journal of Clinical Investigation*, *120*, 3779–3787. doi:10.1172/JCI43766

Paterson, L. Q., Amsel, R., & Binik, Y. M. (2013). Pleasure and pain: The effect of (almost) having an orgasm on genital and nongenital sensitivity. *Journal of Sexual Medicine*, *10*, 1531–1544. doi:10.1111/jsm.12144

Perlman, D. M., Salomons, T. V., Davidson, R. J., & Lutz, A. (2010). Differential effects on pain intensity and unpleasantness of two meditation practices. *Emotion*, *10*, 65–71. doi:10.1037/a0018440

Pitagora, D. (2013). Consent vs. coercion: BDSM interactions highlight a fine but immutable line. *The New School Psychology Bulletin*, *10*, 27–36.

Pitagora, D. (2017). No pain, no gain? Therapeutic and relational benefits of subspace in BDSM contexts. *Journal of Positive Sexuality*, *3*, 44–54.

Ploghaus, A., Narain, C., Beckmann, C. F., Clare, S., Bantick, S., Wise, R., … Tracey, I. (2001). Exacerbation of pain by anxiety is associated with activity in a hippocampal network. *Journal of Neuroscience*, *21*, 9896–9903. doi:10.1523/JNEUROSCI.21-24-09896.2001

Ploghaus, A., Tracey, I., Gati, J. S., Clare, S., Menon, R. S., Matthews, P. M., & Rawlins, J. N. P. (1999). Dissociating pain from its anticipation in the human brain. *Science*, *284*, 1979–1981. doi:10.1126/science.284.5422.1979

Pukall, C. F., & Cahill, C. M. (2014). New developments in the pathophysiology of genital pain: Role of central sensitization. *Current Sexual Health Reports*, *6*, 11–19. doi:10.1007/s11930-013-0007-1

Raichlen, D. A., Foster, A. D., Gerdeman, G. L., Seillier, A., & Giuffrida, A. (2012). Wired to run: Exercise-induced endocannabinoid signaling in humans and cursorial mammals with implications for the 'runner's high'. *Journal of Experimental Biology*, *215*, 1331–1336. doi:10.1242/jeb.063677

Rainville, P., Bao, Q. V. H., & Chrétien, P. (2005). Pain-related emotions modulate experimental pain perception and autonomic responses. *Pain*, *118*, 306–318. doi:10.1016/j.pain.2005.08.022

Reed, B. D., Harlow, S. D., Sen, A., Edwards, R. M., Chen, D., & Haefner, H. K. (2012). Relationship between vulvodynia and chronic comorbid pain conditions. *Obstetrics and Gynecology*, *120*, 145–151. doi:10.1097/AOG.0b013e31825957cf

Rhudy, J. L., Bartley, E. J., & Williams, A. E. (2010). Habituation, sensitization, and emotional valence modulation of pain responses. *Pain*, *148*, 320–327. doi:10.1016/j.pain.2009.11.018

Rhudy, J. L., & Meagher, M. W. (2000). Fear and anxiety: Divergent effects on human pain thresholds. *Pain*, *84*, 65–75. doi:10.1016/j.pain.2005.08.022

Rhudy, J. L., Williams, A. E., McCabe, K. M., Russell, J. L., & Maynard, L. J. (2008). Emotional control of nociceptive reactions (ECON): Do affective valence and arousal play a role? *Pain*, *136*, 250–261. doi:10.1016/j.pain.2007.06.031

Richardson, J. D. (2000). Cannabinoids modulate pain by multiple mechanisms of action. *The Journal of Pain*, *1*, 2–14. doi:10.1016/S1526-5900(00)90082-8

Richardson, J. D., Kilo, S., & Hargreaves, K. M. (1998). Cannabinoids reduce hyperalgesia and inflammation via interaction with peripheral CB 1 receptors. *Pain*, *75*, 111–119. doi:10.1016/S0304-3959(97)00213-3

Sacco, T., & Sacchetti, B. (2010). Role of secondary sensory cortices in emotional memory storage and retrieval in rats. *Science*, *329*, 649–656. doi:10.1126/science.1183165

Sachs, M. L., & Pargman, D. (1979). Running addiction: A depth interview examination. *Journal of Sport Behavior*, *2*, 143–155.

Sadownik, L. A. (2014). Etiology, diagnosis, and clinical management of vulvodynia. *International Journal of Women'S Health*, *6*, 437–449. doi:10.2147/IJWH.S37660

Sagarin, B. J., Cutler, B., Cutler, N., Lawler-Sagarin, K. A., & Matuszewich, L. (2009). Hormonal changes and couple bonding in consensual sadomasochistic activity. *Archives of Sexual Behavior*, *38*, 186–200. doi:10.1007/s10508-008-9374-5

Sagarin, B. J., Lee, E. M., & Klement, K. R. (2015). Sadomasochism without sex? Exploring the parallels between BDSM and extreme rituals. *Journal of Positive Sexuality*, *1*, 32–36.

Sandnabba, N. K., Santtila, P., Alison, L., & Nordling, N. (2002). Demographics, sexual behaviour, family background and abuse experiences of practitioners of sadomasochistic sex: A review of recent research. *Sexual and Relationship Therapy*, *17*, 39–55. doi:10.1080/14681990220108018

Schneiderman, I., Zagoory-Sharon, O., Leckman, J. F., & Feldman, R. (2012). Oxytocin during the initial stages of romantic attachment: Relations to couples' interactive reciprocity. *Psychoneuroendocrinology*, *37*, 1277–1285. doi:10.1016/j.psyneuen.2011.12.021

Scott, G. G. (1983). *Erotic power: An exploration of dominance and submission*. Secaucus, NJ: Citadel Press.

Silva, A. D. (2015). *Through pain, more gain? A survey into the psychosocial benefits of sadomasochism* (Master's thesis). Retrieved from https://www.duo.uio.no/handle/10852/48652

Tay, J. Y., & Yamamoto, C. K. (2016). Oxytocin: A new painkiller? *Journal of Pain Relief*, *4*, 1. doi:10.4172/2167-0846.S4-001

Taylor, G. W., & Ussher, J. M. (2001). Making sense of S&M: A discourse analytic account. *Sexualities*, *4*, 293–314. doi:10.1177/136346001004003002

Teasdale, J. D., Segal, Z. V., Williams, J. M. G., Ridgeway, V. A., Soulsby, J. M., & Lau, M. A. (2000). Prevention of relapse/recurrence in major depression by mindfulness-based cognitive therapy. *Journal of Consulting and Clinical Psychology*, *68*, 615–623. doi:10.1037/0022-006X.68.4.615

Tracy, L., Georgiou-Karistianis, N., Gibson, S., & Giummarra, M. (2015). Oxytocin and the modulation of pain experience: Implications for chronic pain management. *Neuroscience & Biobehavioral Reviews*, *55*, 53–67. doi:10.1016/j.neubiorev.2015.04.013

Wall, P. D. (1999). *Pain: The science of suffering*. London, UK: Weidenfeld & Nicolson.

Wallace, B. A. (2006). *The attention revolution: Unlocking the power of the focused mind*. Somerville, MA: Wisdom Publications.

Watkins, L. R., & Mayer, D. J. (1982). Organization of endogenous opiate and nonopiate pain control systems. *Science*, *216*, 1185–1192. doi:10.1126/science.6281891

Weinberg, T. S. (1987). Sadomasochism in the United States: A review of recent sociological literature. *Journal of Sex Research*, *23*, 50–69. doi:10.1080/00224498709551341

Weinberg, T. S., & Kamel, G. W. L. (Eds.). (1983). *S and M: Studies in sadomasochism*. New York, NY: Prometheus Books.

Weinberg, T. S., Williams, C. J., & Moser, C. (1984). The social constituents of sadomasochism. *Social Problems*, *31*, 379–389. doi:10.2307/800385

Weisenberg, M. (1977). Pain and pain control. *Psychological Bulletin*, *84*, 1008–1044. doi:10.1037/0033-2909.84.5.1008

Westerfelhaus, R. G. (2007). The spirituality of sex and the sexuality of the spirit: BDSM erotic play as soulwork and social critique. In K. E. Lovaas & M. M. Jenkins (Eds.), *Sexualities and communication in everyday life: A reader* (pp. 265–277). Thousand Oaks, CA: Sage.

Whipple, B., & Komisaruk, B. R. (1985). Elevation of pain threshold by vaginal stimulation in women. *Pain*, *21*, 357–367. doi:10.1016/0304-3959(85)90164-2

Whipple, B., & Komisaruk, B. R. (1988). Analgesia produced in women by genital self-stimulation. *Journal of Sex Research*, *24*, 130–140. doi:10.1080/00224498809551403

Williams, A. C. (2002). Facial expression of pain: An evolutionary account. *Behavioural and Brain Sciences*, *25*, 439–488. doi:10.1017/S0140525X02000080

Wiseman, J. (1996). *SM 101: A realistic introduction*. Emeryville, CA: Greenery Press.

Wood, P. B. (2008). Role of central dopamine in pain and analgesia. *Expert Review of Neurotherapeutics*, *8*, 781–797. doi:10.1586/14737175.8.5.781

Younger, J., Aron, A., Parke, S., Chatterjee, N., & Mackey, S. (2010). Viewing pictures of a romantic partner reduces experimental pain: Involvement of neural reward systems. *PLoS One*, *5*, e13309. doi:10.1371/journal.pone.0013309

Zeidan, F., Emerson, N. M., Farris, S. R., Ray, J. N., Jung, Y., McHaffie, J. G., & Coghill, R. C. (2015). Mindfulness meditation-based pain relief employs different neural mechanisms than placebo and sham mindfulness meditation-induced analgesia. *Journal of Neuroscience*, *35*, 15307–15325. doi:10.1523/JNEUROSCI.2542-15.2015

Zeidan, F., Gordon, N. S., Merchant, J., & Goolkasian, P. (2010). The effects of brief mindfulness meditation training on experimentally induced pain. *The Journal of Pain*, *11*, 199–209. doi:10.1016/j.jpain.2009.07.015

Zeidan, F., Grant, J. A., Brown, C. A., McHaffie, J. G., & Coghill, R. C. (2012). Mindfulness meditation-related pain relief: Evidence for unique brain mechanisms in the regulation of pain. *Neuroscience Letters*, *520*, 165–173. doi:10.1016/j.neulet.2012.03.082

Zeidan, F., Martucci, K. T., Kraft, R. A., Gordon, N. S., McHaffie, J. G., & Coghill, R. C. (2011). Brain mechanisms supporting the modulation of pain by mindfulness meditation. *Journal of Neuroscience*, *31*, 5540–5548. doi:10.1523/JNEUROSCI.5791-10.2011