Article

American Psychological Association

Review of General Psychology
2019, Vol. 23(3) 320–335

DOI: 10.1177/1089268019857936
journals.sagepub.com/home/rgp
SAGE

Feeling Hurt: Revisiting the Relationship Between Social and Physical Pain

Laura J. Ferris[1], Jolanda Jetten[1], Matthew J. Hornsey[1], and Brock Bastian[2]

Abstract

Pain overlap theory has generated decades of controversy and still receives considerable research attention. A major advance has been the revelation that social and physical pain activate similar neural regions, providing suggestive evidence of a "piggybacked" alarm system that coevolved to detect social exclusion. Recent developments, however, have brought neural evidence for pain overlap into question. We analyze these developments from a social psychological perspective and identify the need for a reformulated approach. To meet this need, we provide a framework that a priori predicts generalized overlap and specific divergence across a range of biopsychosocial domains. The framework points to a functional pattern for similarities and differences, which can be utilized to generate testable hypotheses so that the field can move forward. To demonstrate the utility and promise of the framework, we identify key hypotheses relating to attention, motivation, and responses to pain, and review research relevant to these hypotheses.

Keywords

social pain, pain overlap, functional signature, suffering, ostracism, rejection

The physical embodiment of emotional suffering is an enduring symbol. Describing emotional pain in physical terms confers tangibility and corporeality, and there are countless examples in philosophy, literature, and religion that bear witness to the association (see MacDonald & Leary, 2005, for review; Morris, 1991). The "heartache" we experience from the severance of a relationship is real, painful, and it *hurts*.

The idea that these two types of pain represent overlapping states of painfulness is an intuitively powerful progression on the theme. In the last decades, there has been a strong push to understand how social and physical pain are interconnected (see Eisenberger, 2012a, for a review). The resulting body of evidence has given weight to the promise of a mechanistic explanation for overlap (Panksepp, 2003), where social pain is mapped onto physical pain signaling systems and operates through shared neurochemistry and brain activation patterns (Eisenberger, 2012a, 2012b). Striking instances of functional crossover effects have been empirically described, including reports that conventional analgesics such as acetaminophen or opioids can reduce social pain (DeWall et al., 2010; Herman & Panksepp, 1978), and that social support can reduce physical pain (Brown, Sheffield, Leary, & Robinson, 2003; Master et al., 2009). Furthermore, trait sensitivity to physical pain is linked with sensitivity to social pain (Eisenberger, Jarcho, Lieberman, & Naliboff, 2006), and variations in pain receptors predict dispositional sensitivity to social pain (mu-opioid receptor polymorphism; Way, Taylor, & Eisenberger, 2009).

As a counterpoint, however, recent evidence indicates that gross anatomical neural overlap is nonspecific to core pain-processing brain regions (Cacioppo et al., 2013; Iannetti, Salomons, Moayedi, Mouraux, & Davis, 2013; Perini et al., 2018; Woo et al., 2014). In addition, the analgesic acetaminophen not only reduces the apprehension of negative stimuli such as social pain but also dampens positively valenced stimuli (Durso, Luttrell, & Way, 2015). Together, this implies that what may be shared between social and physical pain is salience, threat, or unpleasantness more generally, rather than anything specific to pain per se (cf. Eisenberger, 2015).

In response, Eisenberger (2015) identified the following priorities for future pain overlap research: investigating when social pain activates neural regions associated with

[1]The University of Queensland, St. Lucia, Queensland, Australia
[2]The University of Melbourne, Melbourne, Victoria, Australia

Corresponding Author:
Laura J. Ferris, School of Psychology, The University of Queensland, St. Lucia, Queensland 4072, Australia.
Email: l.ferris@uq.edu.au

the sensory component of pain and identifying boundary conditions for what other types of experiences activate pain-related neural regions. However, this is very different to the types of research we consider important in taking the field forward. This is because testing hypotheses around neural activation only adds to an understanding of the neural indices of pain. We argue that an expanded focus is required, if we are to explain the broader psychological and social dimensions and features of each pain—that is, if we seek a biopsychosocial understanding of pain.

In this article, we provide a framework for understanding the similarities and differences between physical and social pain, in terms of not just the biological components but also their social and psychological components. We describe the shared functions of social and physical pain, and also review examples of divergence that are fundamentally linked to the needs generated by each form of pain. These patterns—of generalized overlap combined with more specific divergences—are examined across three illustrative domains: (a) the role of pain in capturing attention, (b) the role of pain as a motivational state undermining self-integrity, and (c) the role of pain in promoting resource accumulation. Before doing so, however, we first review the development of pain overlap research over the last few decades, and, in particular, its focus on shared neural circuitry.

Physical and Social Pain Overlap: Reviewing the State of Play

Over time, comparison with physical pain has been conceptually influential in raising the profile of social exclusion, ostracism, and rejection. From an evolutionary perspective, the origin of overlap is founded on humans' fundamental need to belong (Baumeister & Leary, 1995) and the effectiveness of pain as a threat signal for directing attention and marshaling resources to cope (Eccleston & Crombez, 1999). Humans are social animals and rely on conspecifics and groups for satisfaction of direct and indirect survival needs such as food, shelter, attachment, and coalitional protection against predators and threats, as well as opportunities for mate selection and reproduction (Spoor & Williams, 2007; Wesselmann, Nairne, & Williams, 2012). Social exclusion means completion of these survival functions is denied or attenuated. Therefore, selection pressures favored predecessors who were able to detect, respond to, or prevent social exclusion, because these individuals carried a fitness advantage, in that they were arguably better positioned to avoid the risks to survival that rejection would bring (Spoor & Williams, 2007). Hurt feelings or social pain would, therefore, provide the signal and the impetus to appropriately respond to social injury and avoid *social death* (K. D. Williams, 2007a, 2007b), just as physical pain flags risks to physical integrity and drives responsive action to allay physical injury and death (A. D. Craig, 2003; Nesse, Bhatnagar, & Young, 2007). In turn, this gives an evolutionary explanation for why emotional suffering might be adaptive following exclusion, and for why physical and social pain would present as similarly hurtful.

The concept of overlap is consistent with contemporary "physical" pain theory (see Ferris, 2019, for a review), which posits pain as a subjective experience where nociception may be present but is not required (Melzack & Katz, 2013; A. C. de C. Williams & Craig, 2016). A two-component model of pain is now widely accepted in which pain sensation and pain affect are delineated (Fernandez & Turk, 1992), whereby pain is "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (International Association for the Study of Pain Taskforce on Taxonomy, 1994/2019, p. 209). In line with the two-component model of pain, MacDonald and Leary (2005) characterized social pain as pain affect, suggesting that ". . . the aversive emotional state of social pain is the same unpleasantness that is experienced in response to physical pain" (p. 203)—in short, the essence of overlap lies in pain's unpleasantness.

Neural Evidence of Pain Overlap

What then is the specific substrate or mechanism of pain overlap? With this question, the literature reaches a critical juncture. Over more than a decade, Eisenberger and colleagues provided theoretical and experimental support for a common neural substrate for social and physical pain, comprising dorsal anterior cingulate cortex, insula, and other key regions (Eisenberger, 2012a, 2015; Eisenberger & Lieberman, 2004; Eisenberger, Lieberman, & Williams, 2003; see also Kross, Berman, Mischel, Smith, & Wager, 2011). In its furthest extension, neural overlap was posited as a neat explanation for crossover modulation of the pain experience, because ". . . to the extent that physical and social pain rely on similar neural systems, factors, such as social support, that downregulate one type of pain (social pain) should also downregulate other types of pain (physical)" (Eisenberger, 2008, p. 189).

Following this period of consistent advocacy for neural pain overlap, a shift in the literature is underway. A comprehensive meta-analysis by Cacioppo et al. (2013) reexamined existing social pain and physical pain functional magnetic resonance imaging (fMRI) data, seeking to address concerns about small sample sizes, and failed to find support for the assertion that the experience of social pain (ostracism) mirrors the proposed physical pain signature. Iannetti et al. (2013) detailed concerns with the logical foundations of fMRI-based overlap, suggesting that the prevailing evidence of coactivation lacked the specificity to distinguish pain from other categories of stimuli (see also Poldrack, 2006), and, therefore, could not of itself provide evidence of shared

neural regions specific to pain. They suggested that the observed patterns of activation might not be exclusive to social or physical pain experiences but rather to multiple salient categories of stimuli, for instance, stimuli broadly pertaining to threat (see also Iannetti & Mouraux, 2011; Legrain, Iannetti, Plaghki, & Mouraux, 2011).

Furthermore, recent findings offer empirical evidence of separate neural representations of physical pain and social pain. Woo et al. (2014) used multivariate fMRI analysis techniques and drew on preexisting data sets from Kross et al. (2011) and Wager et al. (2013). They specifically tested for overlap in the activation of neuronal subpopulations within posited regions of broader anatomical overlap, and found distinct neural patterns of activation at this level of analysis. Woo and colleagues assert that previous findings on overlapping univariate fMRI activity are "...not anatomically specific enough to bear on the question of whether the underlying neural representations are similar" (p. 6).

Others have raised the question of whether the search for pain overlap has been overly narrative driven (Cacioppo et al., 2013; Iannetti et al., 2013). These findings give cause for reflection on the proposed nature of pain overlap, and further analysis and debate continue (Eisenberger, 2015; Lieberman & Eisenberger, 2015; Perini et al., 2018; Rotge et al., 2015; Salomons, Iannetti, Liang, & Wood, 2016).

Critically, reconsideration of the literature on physical–social pain overlap shows a preponderance of research focusing on shared neural circuitry and processes (Eisenberger, 2015). The proposed solutions also reflect this focus. Iannetti et al. (2013) raised the possibility that perceptual differences in the experiences of social and physical pain—the differences between hurt feelings and feeling hurt—could be better characterized with novel neuroimaging analysis techniques (e.g., Wager et al., 2013). Salomons et al. (2016) advocated that studies of human neural correlates of pain must be supplemented with other approaches that allow the making of causal inferences. To answer this call, these authors propose more experimental research in nonhuman species and cell populations, so that genetic and other factors can be manipulated; and more human studies involving individuals with lesions or genetic variants, so that causal inferences can more readily be drawn. However, this strategy in isolation continues to focus on the level of neural circuitry and biological substrates, and pays far less attention to psychological and social dimensions. In short, the continued emphasis on neural overlap has subsumed other lines of enquiry.

Taking a Broader View on Pain Overlap

In taking stock, thinking about pain overlap in terms of neural indices has produced novel conceptions of "hurt feelings," but recent developments show there is still more to learn in understanding how social and physical pain interrelate, and the substance of their proposed interconnectedness.

To advance the field, the present analysis looks beyond the prevailing focus on neural overlap and other biological indices. All pain is aversive, captures attention, and motivates a response—and it follows that overlap in this set of processes can just as readily be examined through psychological and social lenses. Examining overlap through the prism of neural and other biological indices is just one approach. Indeed, MacDonald and Leary's (2005) original integrative perspective envisaged a range of domains for overlap and proposed future research exploring "convergence between the two types of pain in thought, emotion and behavior" (MacDonald & Leary, 2005, p. 202). This foundational work grounded the overlap argument not simply in shared brain mechanisms and the descriptive experience of pain but also across a range of psychosocial indicators, including threat responding, social support, anxiety, fear, depression, and aggression. This is also consistent with increasing acceptance of the concept of physical pain as having sensory, emotional, cognitive, and social elements (see A. C. de C. Williams & Craig, 2016, for a review), rather than as a unitary phenomenon analogous to nociception (Corns, 2013).

However, these opportunities have not been capitalized upon with reference to pain overlap. Questions of similarities and differences in psychosocial domains have been thoughtfully examined (see, for example, Chen, Williams, Fitness, & Newton, 2008; Riva, Wesselmann, Wirth, Carter-Sowell, & Williams, 2014; Riva, Williams, & Gallucci, 2014; Riva, Wirth, & Williams, 2011, discussed further below), but in the absence of an overarching framework, the approach has been less systematic. An integrative shift is needed to move the field forward. The present work aims to address this with a systematic framework to guide the next wave of enquiry into pain overlap.

A Framework for Comprehensive Investigation of Pain Overlap

In Figure 1, we describe a new framework that organizes the known characteristics of overlap, and which interrogates regions of overlap between social and physical pain across biological, psychological, and social domains. The constructs of social pain and physical pain are represented by overlapping ovals, and their simple tilted arrangement shows divergent features as well as convergence (i.e., overlap). Underpinning this arrangement lies an explicit acknowledgment of biological, psychological, and social domains in which similarities and differences may be found.

More specifically, this framework takes a different level of analysis to look at the functions of pain—what each pain *does* and why—as a way to make comparisons between

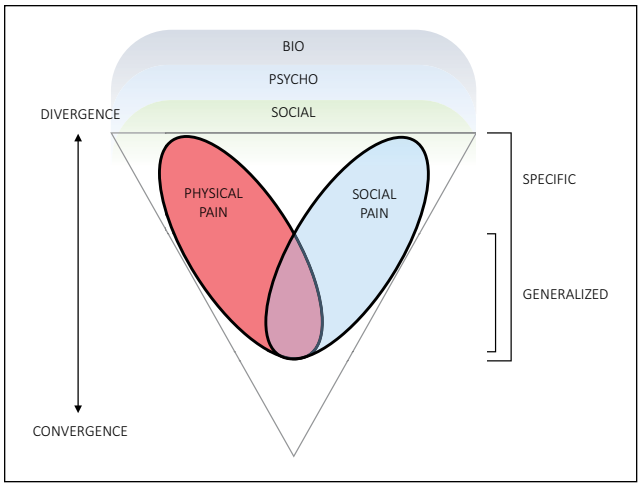

Figure 1. A framework of pain overlap that predicts a general–specific pattern on the basis on pain's functional signature.

social and physical pain, and to understand what unites them and what makes them different. The framework predicts a general–specific pattern of social–physical pain overlap on the basis of pain's function. It extends beyond the shared descriptive qualities of painfulness (or the *qualia*), and instead tracks the *functional signature* of pain.

The Functional Signature of Pain

The term *functional signature* has been used in other scientific domains to describe overlapping functional properties of divergent categories, such as shared functions across variant genes and shared clusters of phenotypic features among component species (see, for example, Ballouz & Gillis, 2017). In application to pain overlap, the term simply means looking at the shared functions of social and physical pain, that is, the psychological, social, and behavioral precursors and outputs of pain—*why* we feel pain, and what happens next when we feel pain. The functional signature of pain, therefore, considers pain comprehensively and *in its context*. With this approach, the framework focuses on pain's function rather than simply its description or its correlates.

Focusing on function also produces a predictive theory of overlap, consistent with original evolutionary explanations of overlap. Why we feel pain in the first place is, therefore, central to the framework logic. This is the locus of overlap—in the shared, generalized functional signature that characterizes how we anticipate, experience, and respond to both pains in life (see Figure 1, overlapping section). At its core, each type of pain captures attention and motivates a response (Eccleston & Crombez, 1999; K. D. Williams, 2007a). The putative function of pain is to signal imminent or actual harm, promote avoidance of painful stimuli and threats, and aid survival (Bateson, 1991; Eccleston & Crombez, 1999). Pain reduction or cessation functions as a form of negative reinforcement that aids the organism in escape, future avoidance, or other threat management strategies (Wiech & Tracey, 2013). Furthermore, pain expression and communication alert conspecifics to threats and enable access to support (Hadjistavropoulos et al., 2011; A. C. de C. Williams, 2002). As previously noted, on evolutionary grounds, social pain was thought to have co-opted or "piggybacked" onto the physical pain signaling system (Nelson & Panksepp, 1998; K. D. Williams, 2007a). Evidence for this includes pain's special capacity to snare attention, the quality of hurt feelings, and the presence of selection pressures that would favor those adept at detecting risks to social inclusion (Spoor & Williams, 2007; Wesselmann et al., 2012; K. D. Williams, 2007a).

From this functional perspective, the "piggybacking" explanation for pain overlap is a domain-general model of pain. The explanation implies there is an efficiency to be gained through the co-opting of physical pain neural circuitry for nonphysically derived pains such as social pain. Within this conceptualization, the experience of *hurt feelings* carries the same urgency as threats to the body, even though there are no specific social pain receptors in the periphery (Papini, Fuchs, & Torres, 2015). Hypothetically, this would represent a win against redundancy, a neat efficiency through biological economies of scale that is less costly from both metabolic and reproductive angles. This posit also aligns with early imaging studies: overlap in structure reflecting overlap in function. But as we have noted above, imaging techniques have advanced such that neural overlap seems evident only at a gross anatomical level, with general overlap clouding granular differences.

Moreover, given the critical importance of pain for survival, domain-*specific* mechanisms (see Figure 1, nonoverlapping sections) are likely to deliver the most adaptive solutions to these complex problems as a rule. The utility of a "piggybacked" signal relies on individuals having sufficient ability to sensitively distinguish pain signals to respond appropriately and adaptively to the corresponding threat. Selection pressures favor organisms that can avoid injury and death; therefore, sensitive and specific detection of pain assists in managing threats to survival. To the extent that overlap blurs these boundaries, overlap in pain signal essentially undercuts the utility of the threat calculus. This is relevant to both social and physical pain, given that failure to detect and respond appropriately to the pain signal is potentially fatal and, therefore, highly costly in evolutionary terms (Nagasako, Oaklander, & Dworkin, 2003; Spoor & Williams, 2007; Wesselmann et al., 2012; K. D. Williams, 2007b). Although selection pressures do not deliver "perfect designs" (Cosmides & Tooby, 1994, p. 88), the underlying threat to survival inherent in the pain signal means that overgeneralization to the detriment of signal specificity would be an adaptation likely to be precluded or

replaced (Haselton & Nettle, 2006). Indeed, humans have developed highly specialized nociceptors and accompanying perceptual, psychological, and linguistic architecture to differentiate types of pain (MacDonald & Leary, 2005; Melzack, 2005; Melzack & Torgerson, 1971; Schwarz & Meyer, 2005; Westlund, 2005). Over and above the efficiencies, the failure to promulgate sufficient cognitive architecture to functionally delineate social from physical pain seems unlikely. Social and physical pain both hurt, but one knows the difference between a breakup and a heart attack.

Therefore, our framework tracks the functional signature of pain. The broken heart is not broken, even though it hurts—and the difference matters in triggering attention and driving action and response. Critically, analyzing the functional signature provides a predictive approach to understanding when and why differences may be found.

Predicting convergence. Current evidence demonstrates convergence (overlap) in the broader functional signature of pain. Specifically, pain distracts from goals and drives attention toward site and source. Feelings of aversiveness threaten fundamental needs for physical and psychological integrity, and motivate general action to cease or reduce pain and restore equilibrium (A. D. Craig, 2003) observable across biological, psychological, and social domains. Together, this paints a picture of "pain" that leads the organism to avoid survival threats and seek out resources to cope in uncertain and demanding environments, and which triggers a broad range of responses in environments that contain threatening or even insurmountable challenges.

Predicting divergence. Meanwhile, consistent with the framework, current evidence points to divergence in the *specific* functional signature of each pain. The experience of pain focuses attention toward immediate *pain-relevant* information; for instance, while attention is captured by all pain, empirical evidence on attentional direction and biases associated with social and physical pain shows critical differences in reflexive and purposeful attentional direction (Bernstein, Sacco, Brown, Young, & Claypool, 2010; Bernstein, Young, Brown, Sacco, & Claypool, 2008; Moore, Keogh, & Eccleston, 2012, discussed further below). Such differences reflect the specific functionality of each pain as a distinct signal that motivates discrete kinds of action. Attention is galvanized, but along different trajectories depending on the nature of the pain. Existing theories of overlap quite rightly focused on understanding similarities, but differences were overlooked. Function provides a framework to understand both.

Biopsychosocial approach. Finally, the framework specifies the biopsychosocial model (Engel, 1977) as a theoretical foundation, because systematic incorporation of psychological and social constructs completes the picture. In application to pain overlap, the model implies that pain biologically defined is measurable, but incomplete, and, therefore, biological evidence that social exclusion *hurts* is only one part of the story. This aspect is particularly relevant to pain, because a major development in the physical pain field has been the idea that pain is more than biological nociception (Melzack & Katz, 2013), with an understanding of pain informed by its psychological and social context (see, for example, Fordyce et al., 1973; Gatchel, Peng, Peters, Fuchs, & Turk, 2007; Hadjistavropoulos et al., 2011; Melzack & Katz, 2013; Melzack & Wall, 1965; A. C. de C. Williams & Craig, 2016). Considering psychological and social constructs as complementary to biological indices provides a comprehensive psychological analysis of pain, and, therefore, of pain overlap.

Bringing It Together: Illustrating the Framework

In short, there is broad agreement that pain overlap is partial and not complete (Eisenberger, 2015). Prevailing debate centers on how much "area" is consumed by the overlapping sections and their boundaries—but this approach does not offer substantive guidance in terms of *which* domains should be examined, *why* some domains or processes would overlap more than others, or how the accrued body of knowledge might be integrated to provide a comprehensive understanding of pain. The objective of this new frame is to facilitate a priori predictions and to guide broad-based, systematic investigation of overlap and divergence between social and physical pain.

To demonstrate the utility of the framework, we next show how the framework can be used to review and generate hypotheses on overlap and divergence, and consider evidence in support of our claims (see Table 1). The following areas and examples are not exhaustive and have been selected in light of the generalized function of pain we outlined earlier: that fundamentally, *pain attracts attention and motivates a response*. The aim is to step through some practical examples to illustrate the framework's capacity to generate hypotheses, to frame and resynthesize existing empirical research, and to also highlight where future research might be directed.

Attention

Pain's first utility as a signal is that it captures attention. Across both pain types, the experience of pain captures attention toward pain-relevant information. Physical pain induces swift disengagement from nonpain-related processing and goals, and a narrowing of attention toward the site and source of pain (Moore et al., 2012; Van Ryckeghem,

Table 1. Brief summary of the functions of social and physical pain with reference to attentional capture, fundamental needs, and resource accumulation.

		Specific Divergence	
Domain	Generalized Overlap	Physical Pain	Social Pain
Attention	Pain triggers bottom-up **attentional capture** and is selected for action	Attention is directed to the **body** and present moment	Attention is directed toward **social information** and actors
Motivation	Pain is **unpleasant** and undermines fundamental needs and survival goals	Integrity of the **physical self** is undermined	Integrity of the **social self** is undermined
Response	Pain motivates increased **resource accumulation**	Accumulation is directed toward **recuperative needs and physical recovery**: Social goals are subsidiary	Accumulation is geared toward **achievement or restoration of social recovery**: Social goals are primary

Note. Generalized overlap accompanied by specific divergence is described in these various domains. Bold text indicates key thematic clusters.

Crombez, Eccleston, Liefooghe, & Van Damme, 2012). Pain that is novel, intense, and threatening elicits bottom-up attentional capture (see for review, Eccleston & Crombez, 1999; Legrain et al., 2009), where pain is "selected for action from complex affective and motivational environments" (Eccleston & Crombez, 1999, p. 356).

Social pain similarly demands attention and action: Social damage threatens the fundamental human need to belong (Baumeister & Leary, 1995), and social pain's attentional pull distracts from other nonpain goals to leave the person in a "deconstructed state" (Baumeister, Brewer, Tice, & Twenge, 2007; Twenge, Catanese, & Baumeister, 2003). After social pain, people are cognitively diminished in a range of cognitive tasks, including intelligence batteries and other indices of cognitive performance, compared with nonexcluded controls (Baumeister, Twenge, & Nuss, 2002). This represents the shared attentional motif: pain distracts.

As we have argued, an *effective* threat calculus requires knowledge of where pain has come from, how it relates to prior experience, and other biopsychosocial factors that come into play in driving an adaptive response to pain. Therefore, we expect that there are differences in attentional capture that reflect these functional differences between social and physical pain. Empirical evidence supports this view. Specifically, physical pain captures attention with the physical state of the body in the present moment, where the object of attention is inside or inherent to the body, as the apprehension of an internal event mediated by interoception (Auvray, Myin, & Spence, 2010; A. D. Craig, 2002, 2003). Fundamentally, the cost of failing to attend to potential violation in bodily integrity is great—and accordingly, physical pain swings cognitive resources online to assess and meet these demands by first bringing attention swiftly to the state of the body. There are examples of top-down modulation of pain, for instance, where attending to the state of the body in pain is temporarily deferred to attend to superordinate goals (Auvray et al., 2010; Legrain et al., 2009; Villemure & Bushnell, 2002; Wiech & Tracey, 2013). However, our argument remains that primary function of physical pain is as an effective, interruptive bottom-up signal that demands attention to the body (Eccleston & Crombez, 1999), because ultimately, without adequate attention to the body following pain signals, organisms are exposed to excess injury and death, as in the case of congenital insensitivity to pain (Nagasako et al., 2003). Therefore, we suggest the primary phenomenon is for physical pain to bring attention to the body.

In contrast, social pain may be experienced interoceptively but does not necessarily implicate specific sites in the body for attentional focus (Papini et al., 2015). Rather, social pain distracts from nonpain goals such that people demonstrate reduced interoceptive accuracy (Durlik & Tsakiris, 2015) and report physical numbing and decreased responsiveness to physical pain (DeWall, 2006). This physical numbing phenomenon has been found both when social pain levels are high (Bernstein & Claypool, 2012) and when relatively mild (Borsook & MacDonald, 2010). Further research is warranted to clarify time course and boundary conditions in relation to *emotional* numbness after social pain, as meta-analysis has not provided consistent findings on whether the predominant response to social exclusion is low mood or emotional numbness (Baumeister, DeWall, & Vohs, 2009; Blackhart, Nelson, Knowles, & Baumeister, 2009; Gerber & Wheeler, 2009; Hartgerink, Van Beest, Wicherts, & Williams, 2015). Future research, particularly using designs with stronger ecological validity, may be able to address this issue by growing the evidence base of research involving real-life social pain experiences of social exclusion, and by more closely examining moderators such as culture (Uskul & Over, 2014). We would expect that conscious apprehension of the unpleasantness of social pain is an effective part of its function as a signal (just as for physical pain; Nesse et al., 2007), but that downstream responses that result in excessive or maladaptive introspection on one's own emotional distress over time would hamper efforts at reconnection (Riva, Wesselmann, et al., 2014).

Indeed, it appears that acute social pain prompts attentional redirection toward other social actors—and the net effect is reduced *self*-awareness and increased *other* awareness (Hess & Pickett, 2010; Twenge et al., 2003). For social pain, attentional resources appear particularly directed toward proaffiliative content. In an examination of responses to facial expressions following social pain, DeWall, Maner, and Rouby (2009) identified an attentional bias that favored smiling faces (i.e., shorter reaction times) over faces with neutral or negatively valenced expressions. This attentional focus on others may be the subject of temporal lag when rejection is chronic or stigma based (Smart Richman, Martin, & Guadagno, 2016), also referred to as resignation (Riva, Montali, Wirth, Curioni, & Williams, 2016; Riva, Wesselmann, et al., 2014). Relevant to our hypothesis, simply recalling prior social pain delivers an accuracy dividend in discriminating between real (Duchenne) smiles and fake smiles, compared with a no-pain control (Bernstein et al., 2008), and recalling a prior experience of social pain leads to a greater tendency to direct attention on the basis of others' gaze (Wilkowski, Robinson, & Friesen, 2009). Together, these attentional shifts position the recipient of social pain to take action to ameliorate social losses (Bolles & Fanselow, 1980; Hess & Pickett, 2010). Put simply, there is overlap in the basic phenomenon of attentional capture, but divergence in the direction of focus.

In sum, both pains grab our attention, and this forms part of a generalized pattern of bottom-up responding common to both social and physical pain. But the direction, content, and utility of this attentional diversion differs in functionally important ways, based on the features of the pain. Crucially, there are specific differences in how this attentional capture plays out: Pain distracts, but physical pain brings us into the body and into the present moment. Social pain draws our attentional resources toward the social world, with subsequent vigilance for socially relevant information and potential sources of future connection.

Motivation: Need Satisfaction, Physical Integrity, and Social Integrity

To serve its function as a signal, pain must not only capture attention but also motivate further action. Pain's unpleasantness provides motivation to bring pain to an end, and each pain signals potential or actual damage to the self. We suggest that both pains can undermine fundamental needs for self-integrity, thereby motivating action, in a pattern consistent with the notion of generalized overlap/specific divergence. We hypothesize that physical pain undermines bodily integrity, whereas social pain undermines the social self.

There is good reason to expect that fundamental needs are disrupted by the experience of pain, both social and physical, thereby motivating action. Effective responses to threat should focus the organism on fundamental needs, broadly construed, and the satisfaction of these needs (Lieberman & Eisenberger, 2009). Physical pain is unpleasant and motivates withdrawal or defensive behaviors to reduce or avoid further painfulness, which ultimately aid survival goals through avoidance of injury and death. Social inclusion and integrity of our social world is a precursor for the satisfaction of basic survival goals for which cooperation is necessary (Baumeister et al., 2007; MacDonald & Leary, 2005; Wesselmann et al., 2012; K. D. Williams, 2007a). Even when humans' food and shelter needs are met, social isolation represents a quantifiable mortality risk in its own right (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015). Unpleasantness creates the conditions to motivate action to make pain stop (A. D. Craig, 2003).

However, social and physical pain produce a different profile of psychological consequences. Riva et al. (2011) examined the effects of social and physical pain on self-reported fundamental needs satisfaction (self-esteem, belonging, control, and meaningful existence), as well as desire to aggress, negative affect, and feelings of ostracism (Study 2). Results showed that social and physical pain both decrease overall needs satisfaction, and increase desire to aggress, negative affect, and feelings of being ignored and excluded (compared with control treatments). However, much like neural evidence of pain overlap, divergence is evident on closer inspection. Direct comparison in the Riva et al. (2011) data showed that social and physical pain triggered a different profile of responses along these measures: Social pain was significantly more damaging than physical pain on overall fundamental needs satisfaction, sense of belonging, meaningful existence, and self-reported feelings of ostracism.

Finding differences here in the psychological consequences of social and physical pain is unsurprising, considering the close connection between physical pain and breaches of the physical corpus. Given that physical pain signals a physical breach (whether or not tissues are damaged), physical pain also signals the need to respond in ways that restore bodily integrity. In concrete terms, in acute physical pain, the physical self is protected through spinal reflex withdrawal, postural change, flight, and other defensive behaviors (Berkowitz, 1993; Ulrich & Azrin, 1962; Walsh, Eccleston, & Keogh, 2014; Weary & Fraser, 1995). These behaviors are ostensibly enacted to ameliorate pain's unpleasantness but also preserve the integrity of the affected area and marshal aid from conspecifics (see Hadjistavropoulos et al., 2011, for review). In chronic physical pain, motivated withdrawal from aversiveness is evident through patients' reduction in physical activity and avoidance of physical movements and tasks that could trigger more pain (Moseley & Butler, 2015).

Conversely, social pain is the appreciation of a shift in one's relational value in the eyes of others (Smart Richman & Leary, 2009), and the *social* dimension of social pain must be retained to make sense of it as a motivational state. By definition, to feel social pain, one must have a perception of the social context in which the relational transaction triggering distress has taken place. Social pain may be felt subjectively in the body as a percept, but fundamentally is a socially mediated phenomenon giving rise to social needs. Therefore, we can expect responses to social pain to respond more directly to damage of one's social integrity.

This brings attention to a major contrastive feature: Social pain represents a tear in our social fabric, where social or relational value, actual or perceived, has diminished. For social pain, the *social* damage (perceived or actual) defines the nature and extent of the hurt. Game-based laboratory experiments have suggested that social exclusion is universally immediate and intense in its painfulness (K. D. Williams, 2007b; K. D. Williams, Cheung, & Choi, 2000; K. D. Williams & Nida, 2011), even when the source of ostracism is a despised out-group (Gonsalkorale & Williams, 2007). However, more recent studies outside the laboratory show varying degrees of painfulness depending on the relative social importance of the source (Smart Richman & Leary, 2009), normative expectations of inclusion (Gerber & Wheeler, 2014), and cultural context (Over & Uskul, 2016; Uskul & Over, 2014, 2017). Altogether, this is consistent with the idea that the implications of social pain are principally experienced as negative and socially oriented, and relevant to our present argument, that social pain signals damage to the integrity of the social self, thereby motivating action.

In comparison, after physical pain, social or relational value may even be enhanced—for instance, where pain symbolizes heroic struggle or arises from great personal sacrifice. Physical pain signals a threat to bodily integrity, but need not give rise to immediate negative affect (Franklin, Lee, Hanna, & Prinstein, 2013) or lowered self-esteem, and instead, may serve to display and promote personal virtues that offer social advantages (Bastian, Jetten, Hornsey, & Leknes, 2014). Physical pain can give the opportunity for martyrdom, to transcend bodily limitations, and display self-mastery, patience, endurance, and efficacy (Bastian, Jetten, Hornsey, et al., 2014). Undergoing physical pain can lower one's guilt and blameworthiness in the eyes of others (Gray & Wegner, 2010, 2011) and can reduce feelings of guilt and restore moral balance for the person experiencing pain (Bastian, Jetten, & Fasoli, 2011; Bastian, Jetten, & Stewart, 2013).

There are exceptions to the rule, where perceived or actual social devaluation or loss may accompany physical pain, such as stigmatization of chronic pain (Eccleston, Williams, & Rogers, 1997) or medically unexplained pain (Jackson, 2005), or physical pain alongside humiliation (Mann, Feddes, Doosje, & Fischer, 2015). The key point is that physical pain signals a threat to bodily integrity, and there are many examples where it does not lead to social devaluation, especially the examples relating to acute pain we have outlined. In short, social pain represents damage to the social self, whereas in comparison, physical pain signals a threat of damage to the body.

Response: Resource Accumulation

In the next section, we examine motivated responses to pain. We propose that people respond to social and physical pain by seeking to accumulate resources, in an effort to better cope with the needs generated as a result of both pains. This analysis again identifies the generalized convergence and specific divergence pattern of overlap—a general motivation to accumulate resources per se, but functionally driven divergence according to pain type.

Resource accumulation is a strategy associated with effective proactive, anticipatory, and recuperative coping (Aspinwall & Taylor, 1997; Lazarus & Folkman, 1984; Rofé, 1984; Shilling & Brown, 2016). We define accumulation to include active *accrual* of resources, such as food, money, or social resources, or *preservation* of existing resources, through withdrawal or defensiveness. In humans and nonhuman mammals, increased glucose synthesis is elicited as part of the generalized stress response following pain (Nesse et al., 2007; Selye, 1936). This aids readiness to respond to threats and damage by increasing available energy to meet emergent demands, but ultimately generates a metabolic deficit. In the case of physical pain, classic animal studies in laboratory rats show increased eating (Siegel & Brantley, 1951) and drinking (Siegel & Siegel, 1949) following painful stimulation. In wild animals, accumulation of resources following pain is thought to be exhibited primarily in the form of energy preservation, such as avoiding demanding activities such as play, mating, or exploration, while balancing the need to eat, avoid predation, and maintain kinship ties (see A. C. de C. Williams, 2015, for review). For example, increased accumulation of calorific foods has been observed in physically impaired primates in Rwandan and Ugandan forests (Byrne & Stokes, 2002), where gorillas and chimpanzees with severe limb injuries were seen to adapt their leaf-processing techniques to achieve less effortful foraging to maintain survival. In humans, there is evidence of resource accumulation through active accrual of food, alongside energy preservation in the form of reduced physical activity. For instance, following experimentally induced acute physical pain, human participants are more likely to choose calorie-rich treats over nonfood rewards, in comparison with a no-pain control group (Bastian et al., 2013). Outside laboratory settings, persistent pain is also associated with increased caloric consumption and satiety dysregulation (Geha, deAraujo, Green, & Small, 2014).

Social pain also elicits accumulation of food (Gabriel & Valenti, 2016). In nonhuman animals such as primates, exclusion subsequently necessitates an increase in active accumulation following ostracism, because without coalitional support, additional effort must be expended toward securing food, water, and self-protection from predators, alongside restoring or reestablishing broken social ties (Lancaster, 1986). Research with human participants also shows increased resource accumulation, where "social surrogates" such as food are sought out after social pain (Gabriel & Valenti, 2016). Current evidence includes social–psychological studies involving low-intensity rejection manipulations or game paradigms, which provide experimental rigor but may exhibit poor face validity or lack ecological validity. Nevertheless, socially excluded participants appear to eat more foods than those who are not excluded within these paradigms. Baumeister, DeWall, Ciarocco, and Twenge (2005) reported that participants who were ostensibly rejected by their peers consumed more unhealthy cookies than control participants (Experiment 2). Oaten, Williams, Jones, and Zadro (2008) also found that ostracized participants consumed a greater quantity of palatable unhealthy biscuits than a nonostracized control group, and higher consumption continued over time for those participants high in social anxiety (i.e., those particularly vulnerable to the effects of ostracism). Beyond the laboratory, comfort eating following social exclusion or rejection is a familiar phenomenon (Troisi & Gabriel, 2011; Troisi, Gabriel, Derrick, & Geisler, 2015). Chronic exposure to social stressors is associated with subsequent caloric overconsumption, particularly for "stress eaters," and people experiencing chronic social distress are more likely to be overweight or obese (Tomiyama, Dallman, & Epel, 2011).[1] Together, these findings indicate that both social and physical pain increase accumulation of food, and in sum, there is evidence in support of a generalized resource accumulation response common to social and physical pain.

Consistent with the pattern of generalized overlap and specific divergence we identify in the framework, we find evidence of divergence between social and physical pain. Food accumulation responses are low-resolution strategies, in the sense that they promote short-term adaptation to pain (as well as a range of other stressors) by supplying or preserving energy needs, and may even offset the aversiveness of pain, but do not bring about the direct fitness gains of satisfying social and physical needs more proximately (Lea & Webley, 2006). To reconcile this, we use the framework to consider specific divergence in resource accumulation. We expect social and physical pain to instigate specific resource accumulation in a way that reflects the specific needs generated. On this basis, resource accumulation after physical pain should be geared toward physical recuperation and protecting against future physical risks—in line with its function of bringing attention to bodily integrity and its preservation—and less directed toward specific social dividends and goals. In contrast, we expect that resource accumulation following social pain is more likely to be geared toward these social ends: restoring one's sense of social self, nurturing future social prospects, or demonstrating social and relational value.

Indeed, specific social goals are likely to be secondary following physical pain. As summarized earlier, the classical response to physical pain is the activation of basic defensive and restorative behaviors such as reflex withdrawal from immediate nociceptive stimuli, guarded postures, retreat to recuperative safety (Berkowitz, 1993; Ulrich & Azrin, 1962; Walsh et al., 2014), along with pain expression and vocalizations, which communicate one's internal state to others (Hadjistavropoulos et al., 2011; A. C. de C. Williams, 2002). Endogenous opioids stave off intense pain to facilitate escape or attack; once they have subsided, physical pain resumes as a salient and unpleasant matter demanding response, overshadowing previous goals and objectives (Bolles & Fanselow, 1980). These are features of a prototypical physical pain response by which one can preserve basic physical resources. Certainly, being vulnerable may provide secondary social gains (see, for example, Gray & Wegner, 2011); at a basic level, credible signals of physical pain show others we need assistance and can generate empathy (K. D. Craig, 2009; K. D. Craig, Versloot, Goubert, Vervoort, & Crombez, 2010; Hadjistavropoulos et al., 2011; Steinkopf, 2016). Shared pain can bring people together (Bastian, Jetten, & Ferris, 2014), but nuanced sociorelational outcomes appear not to be the direct priority of resource accumulation activities after physical pain. In physical pain, we tend to care less about impression management, or social niceties—we are stripped back, raw (Scarry, 1985).

This disruption of ordinary social goals is also borne out in laboratory studies, in which social biases appear to be overshadowed following physical pain. For instance, van Leeuwen, Ashton-James, and Hamaker (2014) found that physical pain (recalled and experienced) attenuated the in-group favoritism effect. They found that for participants in the pain condition, support and helping toward out-group members was no different to in-group members. In contrast, the no-pain condition showed significantly more support and helping for in-group than out-group, consistent with in-group favoritism.

Altogether, this suggests that physical pain shifts priorities away from direct social goals, and toward physical preservation and recovery. The findings indicate that physical pain disrupts regular social priorities in ways that may be socially advantageous—but this is not the primary goal. After physical pain, we are vulnerable and priorities shift away from ordinary social objectives.

In contrast, after social pain, there is a range of evidence that *social* resource accumulation is prioritized. Experimental animal studies in social pain primarily examine maternal separation in neonates and juveniles (see, for example, Herman & Panksepp, 1978; Panksepp, Herman, Conner, Bishop, & Scott, 1978; Panksepp, Vilberg, Bean, Coy, & Kastin, 1978), in which separated pups signal their need for maternal proximity to be restored through cries and other acoustic signals. In human studies, responses to social pain are geared toward preservation and restoration of the social self and communicating relational value. Here, the behavioral outputs of such an orientation are not homogeneous—in terms of accessing social resources, social pain results in a complex suite of approach–withdraw–aggress responses (Wesselmann, Ren, & Williams, 2015) in which both proximity seeking and protective distancing may occur simultaneously (Sommer & Bernieri, 2014). For instance, social pain motivates inclusion- and proximity seeking (Chester, DeWall, & Pond, 2016; Maner, DeWall, Baumeister, & Schaller, 2007), also termed the "tend and befriend" response (Taylor, 2006; see also Mancini, 2019). However, other evidence also indicates people can become aggressive, even to unrelated others, by administering more hot sauce, noisier sound blasts, or by assigning undesirable tasks (Leary, Twenge, & Quinlivan, 2006; Twenge, Baumeister, DeWall, Ciarocco, & Bartels, 2007; Twenge, Baumeister, Tice, & Stucke, 2001), and especially when rejection is unexpected (Wesselmann, Butler, Williams, & Pickett, 2010). In addition, there is evidence that individuals withdraw from others following social pain (Ren, Wesselmann, & Williams, 2016), adopting a conservative prevention–motivation frame (Park & Baumeister, 2015). The field has attempted to reconcile the seemingly disparate findings on motivated responses to social pain, with mixed results (see, for example, Baumeister et al., 2009; Blackhart et al., 2009; Dickerson, Gruenewald, & Kemeny, 2009; Gerber & Wheeler, 2009; Hartgerink et al., 2015; Smart Richman & Leary, 2009). Several moderators have been identified, such as attachment style and trait pain sensitivity (Maner et al., 2007). We suggest that a functional frame assists in reconciling the various findings. Papini et al. (2015) make the point that in pursuit of biologically relevant rewards (such as food, shelter, or sex mates), most organisms show behavioral flexibility, and that this is consistent with selection pressures promoting the evolution of a range of adaptations to deal with complex problems and environments. Indeed, through ingratiation, strategic and salvageable social relations can be restored (Smart Richman & Leary, 2009). Through aggression, self-restorative emulation of dominance behaviors is on display for all to see (Price & Oxon, 1967; Ramírez, Bonniot-Cabanac, & Cabanac, 2005). Through withdrawal, depleted social capital can be reviewed and corralled, and additional pain avoided (Ren et al., 2016). One consistent theme runs through each of these profiles, which is dramatically heightened orientation to socially relevant information, social relations, and socially directed behavior (Smart Richman & Leary, 2009). Social pain makes social resources highly salient, and combined with evidence showing greater *other* focus, increased attention toward others' facial expressions, and a preference for prosocial others (Bernstein et al., 2010; Bernstein et al., 2008; Pickett & Gardner, 2005; Pickett, Gardner, & Knowles, 2004), this paints a picture of intensified *socially* focused action following social pain (K. D. Williams, 2007a). In short, after social pain, there is a generalized tendency to accumulate resources, but the focus remains on social ends.

Conclusion

The preceding evidence spans a wide range of literature, but together shows how the framework can be used to understand divergence and convergence in the case of attention, motivation, and response. Attention is garnered by pain, and both social and physical pain undermine fundamental psychological needs. But each pain affects attention, body, and self in distinct ways, and while physical and social pain both motivate resource accumulation, these actions may be in service of different goals over time. This implies specific divergence in how people respond to social versus physical pain, consistent with the overlap framework we propose.

This is significant because it tells us about the functional basis of each instance of attentional capture, about the shared and divergent factors underlying need satisfaction, and about the nature of resource accumulation as a regulation strategy postpain. We have brought together evidence that for both pains, attention is galvanized by pain, fundamental psychological and survival needs are undermined, and the accumulation of food and other resources provides nourishment in a way that is broadly adaptive. Consistent with the framework, we also pinpoint evidence of specific divergence, such that physical pain captures attention to the body, whereas social pain brings our attention to social information; that each pain ruptures integrity of the self in distinct, pain-relevant ways; and that physical pain motivates resource accumulation in service of physical recuperation, whereas social goals are the principal motives following social pain.

Overall, our framework pinpoints functional overlap and draws out where social and physical pain diverge. It also presents a reasoned argument as to why—with reference to the nature of each pain as biopsychosocially defined. This framework offers an organizing structure to integrate existing research and guide future consideration of pain overlap. We have highlighted some opportunities through these illustrative examples above. This is with the aim of setting out broad domains for analysis, beyond neural overlap, when examining how social and physical pain are interrelated.

Reflecting on Pain Overlap

Acknowledging social pain as a construct that might share experiential qualities with physical pain expands our understanding of what pain is, and drives home some pressing definitional points. Nearly three decades ago, Morris (1991) shone a light on what he called the Myth of Two Pains, saying that

> [w]e live in an era when many people believe—as a basic, unexamined foundation of thought—that pain comes divided into separate types: physical and mental . . . Between these two different events we seem to imagine a gulf so wide that it might as well be filled by a sea that is impossible to navigate. (p. 9)

Research into pain overlap demonstrates that we have left the shore. By understanding pain as subjective, we validate pain experiences that lack a clear physical etiology. There is now greater acceptance of psychological explanations for physical pain phenomena, and of pain being more than nociception. However, a broader notion of pain brings new controversies about how to deal with what now attracts the misnomers of "mind pain" (hurt feelings) and "body pain" (feeling hurt). There is still scope to wonder whether social pain can correctly be denied the status of pain if it is experienced as hurtful, as *painful* (Biro, 2010).

Poetic hypotheses such as pain overlap hold a special place within the pantheon of scientific tradition, and there is now a substantial line of research and commentary seeking to unpack how social pain might mirror physical pain (Cacioppo et al., 2013; DeWall et al., 2010; Eisenberger, 2012a, 2012b; Eisenberger & Lieberman, 2004; Eisenberger et al., 2003; Iannetti et al., 2013; Lieberman & Eisenberger, 2009; MacDonald & Leary, 2005). Perhaps the subtext of the comparison is that when associated with physical pain, social pain is bolstered in its existential veracity; the "realness" of social pain is enhanced by association with physical pain, so that it might similarly deserve attention and remedy as physical pain does. Eisenberger (2015) directly articulates these hopes:

> Social pain is similarly conceptualized as being outside the purview of medical attention because it seems more psychological or emotional than physical. Focusing on treating the affective component of pain might serve to level this playing field, putting the need to treat various types of physical and social pains at the same level of importance and perhaps providing new avenues for treatment. (p. 623)

However, in developing a comprehensive psychology of pain, our own purview need not be confined to conventional medical conceptualizations or neural indices alone, to understand pain and bring attention to suffering.

Reconnecting to a Psychology of Pain

Recent advancements in our understanding of the neural overlap between physical and social pain suggest that key similarities may be nonspecific to pain, and instead explained by domain-general features of salience, threat, or conflict more broadly (Iannetti & Mouraux, 2010, 2011; Iannetti et al., 2013; Legrain et al., 2011). The framework encourages similar interrogation at the psychosocial level of analysis, and broader inquiry into whether points of contact between social and physical pain are specific to "pain" (social or physical) per se. By utilizing what is already known about each pain in the psychological areas we have identified, researchers can critically examine whether social and physical pain give rise to the same patterns and effects. As more is learned about the science of each pain, we can continue to query whether each phenomenon also holds for its counterpart, and whether it generalizes to other aversive experiences more broadly. We expect this cycle of reconceptualization will be an enduring and generative process, and one that psychological perspectives must inform. To set matters in perspective, while debate continues on the substance of neural overlap, evidence of functional pain-type crossover remains (e.g., Eisenberger et al., 2006; Way et al., 2009). Other features originally traced out by MacDonald and Leary (2005), such as a common language for social pain in physical terms across cultures, hold substantial empirical value. These foundations do support continued examination of pain overlap, but we have proposed some critical modifications and an expanded purview in terms of how this exercise should go forward.

Iannetti et al. (2013) describe the pain overlap story as a "glamorous marriage of metaphor and modern science." Indeed, there is considerable intellectual glamour where literary anecdote and science meet. However, beneath the surface, the benefits of the overlap metaphor must be balanced against the potential for information loss. Instead, we hope to guide greater intellectual contributions that can be made by situating pain of both types within the psychological and social world, and moving enquiry forward. Already, pain is "all in the mind": we simply need to contextualize it.

Acknowledgments

We thank Geoff MacDonald, Siri Leknes, Paolo Riva, and Kip Williams for thoughtful comments on earlier drafts.

Declaration of Conflicting Interests

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

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article:

This research was supported by a University of Queensland Postgraduate Research Scholarship and Graduate Student International Travel Award (Laura Ferris) and an Australian Research Council Discovery Grant (Brock Bastian and Jolanda Jetten, DP140103716).

Note

1. As an aside, when considering calorie consumption after social pain, findings have been couched in terms of a decrement in self-control rather than as a pain regulation strategy per se (Baumeister, Brewer, Tice, & Twenge, 2007; Baumeister, DeWall, Ciarocco, & Twenge, 2005; Nes, Carlson, Crofford, de Leeuw, & Segerstrom, 2010). We suggest an alternative explanation lies with resource accumulation. When conceptualized as motivated resource accrual, the consumption of palatable-rich foods arguably represents an active attempt to increase comfort through pleasurable inputs rather than failure to defend against latent desires.

References

Aspinwall, L. G., & Taylor, S. E. (1997). A stitch in time: Self-regulation and proactive coping. *Psychological Bulletin*, *121*, 417–436. doi:10.1037/0033-2909.121.3.417

Auvray, M., Myin, E., & Spence, C. (2010). The sensory-discriminative and affective-motivational aspects of pain. *Neuroscience & Biobehavioral Reviews*, *34*, 214–223. doi:10.1016/j.neubiorev.2008.07.008

Ballouz, S., & Gillis, J. (2017). Strength of functional signature correlates with effect size in autism. *Genome Medicine*, *9*, Article 64. doi:10.1186/s13073-017-0455-8

Bastian, B., Jetten, J., & Fasoli, F. (2011). Cleansing the soul by hurting the flesh: The guilt-reducing effect of pain. *Psychological Science*, *22*, 334–335. doi:0956797610397058

Bastian, B., Jetten, J., & Ferris, L. J. (2014). Pain as social glue: Shared pain increases cooperation. *Psychological Science*, *25*, 2079–2085. doi:10.1177/0956797614545886

Bastian, B., Jetten, J., Hornsey, M. J., & Leknes, S. (2014). The positive consequences of pain: A biopsychosocial approach. *Personality & Social Psychology Review*, *18*, 256–279. doi:10.1177/1088868314527831

Bastian, B., Jetten, J., & Stewart, E. (2013). Physical pain and guilty pleasures. *Social Psychological and Personality Science*, *4*, 215–219. doi:10.1177/1948550612451156

Bateson, P. (1991). Assessment of pain in animals. *Animal Behaviour*, *42*, 827–839. doi:10.1016/S0003-3472(05)80127-7

Baumeister, R. F., Brewer, L. E., Tice, D. M., & Twenge, J. M. (2007). Thwarting the need to belong: Understanding the interpersonal and inner effects of social exclusion. *Social and Personality Psychology Compass*, *1*, 506–520. doi:10.1111/j.1751-9004.2007.00020.x

Baumeister, R. F., DeWall, C. N., Ciarocco, N. J., & Twenge, J. M. (2005). Social exclusion impairs self-regulation. *Journal of Personality and Social Psychology*, *88*, 589–604. doi:10.1037/0022-3514.88.4.589

Baumeister, R. F., DeWall, C. N., & Vohs, K. D. (2009). Social rejection, control, numbness, and emotion: How not to be fooled by Gerber and Wheeler (2009). *Perspectives on Psychological Science*, *4*, 489–493. doi:10.1111/j.1745-6924.2009.01159.x

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, *117*, 497–529.

Baumeister, R. F., Twenge, J. M., & Nuss, C. K. (2002). Effects of social exclusion on cognitive processes: Anticipated aloneness reduces intelligent thought. *Journal of Personality and Social Psychology*, *83*, 817–827.

Berkowitz, L. (1993). Pain and aggression: Some findings and implications. *Motivation and Emotion*, *17*, 277–293. doi:10.1007/bf00992223

Bernstein, M. J., & Claypool, H. M. (2012). Social exclusion and pain sensitivity: Why exclusion sometimes hurts and sometimes numbs. *Personality and Social Psychology Bulletin*, *38*, 185–196. doi:10.1177/0146167211422449

Bernstein, M. J., Sacco, D. F., Brown, C. M., Young, S. G., & Claypool, H. M. (2010). A preference for genuine smiles following social exclusion. *Journal of Experimental Social Psychology*, *46*, 196–199.

Bernstein, M. J., Young, S. G., Brown, C. M., Sacco, D. F., & Claypool, H. M. (2008). Adaptive responses to social exclusion: Social rejection improves detection of real and fake smiles. *Psychological Science*, *19*, 981–983. doi:10.1111/j.1467-9280.2008.02187.x

Biro, D. (2010). Is there such a thing as psychological pain? And why it matters. *Culture, Medicine and Psychiatry*, *34*, 658–667.

Blackhart, G. C., Nelson, B. C., Knowles, M. L., & Baumeister, R. F. (2009). Rejection elicits emotional reactions but neither causes immediate distress nor lowers self-esteem: A meta-analytic review of 192 studies on social exclusion. *Personality & Social Psychology Review*, *13*, 269–309. doi:10.1177/1088868309346065

Bolles, R. C., & Fanselow, M. S. (1980). A perceptual-defensive-recuperative model of fear and pain. *Behavioral and Brain Sciences*, *3*, 291–323.

Borsook, T. K., & MacDonald, G. (2010). Mildly negative social encounters reduce physical pain sensitivity. *Pain*, *151*, 372–377. doi:10.1016/j.pain.2010.07.022

Brown, J. L., Sheffield, D., Leary, M. R., & Robinson, M. E. (2003). Social support and experimental pain. *Psychosomatic Medicine*, *65*, 276–283.

Byrne, R. W., & Stokes, E. J. (2002). Effects of manual disability on feeding skills in gorillas and chimpanzees. *International Journal of Primatology*, *23*, 539–554. doi:10.1023/a:1014917600198

Cacioppo, S., Frum, C., Asp, E., Weiss, R. M., Lewis, J. W., & Cacioppo, J. T. (2013). A quantitative meta-analysis of functional imaging studies of social rejection. *Scientific Reports*, *3*, Article 2027. doi:10.1038/srep02027

Chen, Z., Williams, K. D., Fitness, J., & Newton, N. C. (2008). When hurt will not heal. *Psychological Science*, *19*, 789–795. doi:10.1111/j.1467-9280.2008.02158.x

Chester, D. S., DeWall, C. N., & Pond, R. S. (2016). The push of social pain: Does rejection's sting motivate subsequent social reconnection? *Cognitive, Affective, & Behavioral Neuroscience*, *16*, 541–550. doi:10.3758/s13415-016-0412-9

Corns, J. (2013). The inadequacy of unitary characterizations of pain. *Philosophical Studies*, *169*, 355–378. doi:10.1007/s11098-013-0186-7

Cosmides, L., & Tooby, J. (1994). Origins of domain specificity: The evolution of functional organization. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind* (pp. 85–116). Cambridge, UK: Cambridge University Press.

Craig, A. D. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. *Nature Reviews Neuroscience*, *3*, 655–666.

Craig, A. D. (2003). A new view of pain as a homeostatic emotion. *Trends in Neurosciences*, *26*, 303–307.

Craig, K. D. (2009). The social communication model of pain. *Canadian Psychology/Psychologie canadienne*, *50*, 22–32. doi:10.1037/A0014772

Craig, K. D., Versloot, J., Goubert, L., Vervoort, T., & Crombez, G. (2010). Perceiving pain in others: Automatic and controlled mechanisms. *The Journal of Pain*, *11*, 101–108. doi:10.1016/j.jpain.2009.08.008

DeWall, C. N. (2006). *Alone but feeling no pain: Effects of social exclusion on physical pain tolerance and pain threshold, affective forecasting, and interpersonal empathy* (Master's thesis). Florida State University, Tallahassee.

DeWall, C. N., Macdonald, G., Webster, G. D., Masten, C. L., Baumeister, R. F., Powell, C., . . . Eisenberger, N. I. (2010). Acetaminophen reduces social pain: Behavioral and neural evidence. *Psychological Science*, *21*, 931–937. doi:10.1177/0956797610374741

DeWall, C. N., Maner, J. K., & Rouby, D. A. (2009). Social exclusion and early-stage interpersonal perception: Selective attention to signs of acceptance. *Journal of Personality and Social Psychology*, *96*, 729–741. doi:10.1037/a0014634

Dickerson, S. S., Gruenewald, T. L., & Kemeny, M. E. (2009). Psychobiological responses to social self threat: Functional or detrimental? *Self and Identity*, *8*, 270–285. doi:10.1080/15298860802505186

Durlik, C., & Tsakiris, M. (2015). Decreased interoceptive accuracy following social exclusion. *International Journal of Psychophysiology*, *96*, 57–63. doi:10.1016/j.ijpsycho.2015.02.020

Durso, G. R. O., Luttrell, A., & Way, B. M. (2015). Over-the-counter relief from pains and pleasures alike: Acetaminophen blunts evaluation sensitivity to both negative and positive stimuli. *Psychological Science*, *26*, 750–758. doi:10.1177/0956797615570366

Eccleston, C., & Crombez, G. (1999). Pain demands attention: A cognitive–affective model of the interruptive function of pain. *Psychological Bulletin*, *125*, 356–366. doi:10.1037/0033-2909.125.3.356

Eccleston, C., Williams, A. C., & Rogers, W. S. (1997). Patients' and professionals' understandings of the causes of chronic pain: Blame, responsibility and identity protection. *Social Science & Medicine*, *45*, 699–709. doi:10.1016/S0277-9536(96)00404-2

Eisenberger, N. I. (2008). Understanding the moderators of physical and emotional pain: A neural systems-based approach. *Psychological Inquiry*, *19*, 189–195.

Eisenberger, N. I. (2012a). Broken hearts and broken bones: A neural perspective on the similarities between social and physical pain. *Current Directions in Psychological Science*, *21*, 42–47. doi:10.1177/0963721411429455

Eisenberger, N. I. (2012b). The pain of social disconnection: Examining the shared neural underpinnings of physical and social pain. *Nature Reviews Neuroscience*, *13*, 421–434. doi:10.1038/nrn3231

Eisenberger, N. I. (2015). Social pain and the brain: Controversies, questions, and where to go from here. *Annual Review of Psychology*, *66*, 601–629. doi:10.1146/annurev-psych-010213-115146

Eisenberger, N. I., Jarcho, J. M., Lieberman, M. D., & Naliboff, B. D. (2006). An experimental study of shared sensitivity to physical pain and social rejection. *Pain*, *126*, 132–138. doi:10.1016/j.pain.2006.06.024

Eisenberger, N. I., & Lieberman, M. D. (2004). Why rejection hurts: A common neural alarm system for physical and social pain. *Trends in Cognitive Sciences*, *8*, 294–300.

Eisenberger, N. I., Lieberman, M. D., & Williams, K. D. (2003). Does rejection hurt? An fMRI study of social exclusion. *Science*, *302*, 290–292.

Engel, G. (1977). The need for a new medical model: A challenge for biomedicine. *Science*, *196*, 129–136. doi:10.1126/science.847460

Fernandez, E., & Turk, D. C. (1992). Sensory and affective components of pain: Separation and synthesis. *Psychological Bulletin*, *112*, 205–217.

Ferris, L. J. (2019). Hurt feelings: Physical pain, social exclusion, and the psychology of pain overlap. In S. Rudert, R. Greifeneder, & K. Williams (Eds.), *Current directions in ostracism, social exclusion, and rejection research*. New York, NY: Routledge.

Fordyce, W. E., Fowler, R. S., Jr., Lehmann, J. F., Delateur, B. J., Sand, P. L., & Trieschmann, R. B. (1973). Operant conditioning in the treatment of chronic pain. *Archives of Physical Medicine and Rehabilitation*, *54*, 399–408.

Franklin, J. C., Lee, K. M., Hanna, E. K., & Prinstein, M. J. (2013). Feeling worse to feel better: Pain-offset relief simultaneously stimulates positive affect and reduces negative affect. *Psychological Science*, *24*, 521–529. doi:10.1177/0956797612458805

Gabriel, S., & Valenti, J. (2016). Social surrogates and rejection: How reading, watching TV, and comfort food can ease the pain of social isolation. In K. D. Williams & S. A. Nida (Eds.), *Ostracism, exclusion, and rejection* (pp. 146–161). New York, NY: Routledge Psychology Press.

Gatchel, R. J., Peng, Y. B., Peters, M. L., Fuchs, P. N., & Turk, D. C. (2007). The biopsychosocial approach to chronic pain: Scientific advances and future directions. *Psychological Bulletin*, *133*, 581–624. doi:10.1037/0033-2909.133.4.581

Geha, P., deAraujo, I., Green, B., & Small, D. M. (2014). Decreased food pleasure and disrupted satiety signals in chronic low back pain. *Pain*, *155*, 712–722. doi:10.1016/j.pain.2013.12.027

Gerber, J. P., & Wheeler, L. (2009). On being rejected: A meta-analysis of experimental research on rejection. *Perspectives on Psychological Science*, *4*, 468–488. doi:10.1111/j.1745-6924.2009.01158.x

Gerber, J. P., & Wheeler, L. (2014). Clarifying the relationship between ostracism and relational devaluation. *Journal of Social Psychology*, *154*, 14–27. doi:10.1080/00224545.2013.826619

Gonsalkorale, K., & Williams, K. D. (2007). The KKK won't let me play: Ostracism even by a despised outgroup hurts. *European Journal of Social Psychology*, *37*, 1176–1186. doi:10.1002/ejsp.392

Gray, K., & Wegner, D. M. (2010). Torture and judgments of guilt. *Journal of Experimental Social Psychology*, *46*, 233–235. doi:10.1016/j.jesp.2009.10.003

Gray, K., & Wegner, D. M. (2011). To escape blame, don't be a hero—Be a victim. *Journal of Experimental Social Psychology*, *47*, 516–519. doi:10.1016/j.jesp.2010.12.012

Hadjistavropoulos, T., Craig, K. D., Duck, S., Cano, A., Goubert, L., Jackson, P. L., . . . Fitzgerald, T. D. (2011). A biopsychosocial formulation of pain communication. *Psychological Bulletin*, *137*, 910–939. doi:10.1037/a0023876

Hartgerink, C. H. J., Van Beest, I., Wicherts, J. M., & Williams, K. D. (2015). The ordinal effects of ostracism: A meta-analysis of 120 cyberball studies. *PLoS ONE*, *10*(5), e0127002. doi:10.1371/journal.pone.0127002

Haselton, M. G., & Nettle, D. (2006). The paranoid optimist: An integrative evolutionary model of cognitive biases. *Personality & Social Psychology Review*, *10*, 47–66. doi:10.1207/s15327957pspr1001_3

Herman, B. H., & Panksepp, J. (1978). Effects of morphine and naloxone on separation distress and approach attachment: Evidence for opiate mediation of social affect. *Pharmacology Biochemistry and Behavior*, *9*, 213–220.

Hess, Y. D., & Pickett, C. L. (2010). Social rejection and self- versus other-awareness. *Journal of Experimental Social Psychology*, *46*, 453–456. doi:10.1016/j.jesp.2009.12.004

Holt-Lunstad, J., Smith, T. B., Baker, M., Harris, T., & Stephenson, D. (2015). Loneliness and social isolation as risk factors for mortality. *Perspectives on Psychological Science*, *10*, 227–237. doi:10.1177/1745691614568352

Iannetti, G. D., & Mouraux, A. (2010). From the neuromatrix to the pain matrix (and back). *Experimental Brain Research*, *205*, 1–12. doi:10.1007/s00221-010-2340-1

Iannetti, G. D., & Mouraux, A. (2011). Can the functional MRI responses to physical pain really tell us why social rejection "hurts"? *Proceedings of the National Academy of Sciences*, *108*(30), E343.

Iannetti, G. D., Salomons, T. V., Moayedi, M., Mouraux, A., & Davis, K. D. (2013). Beyond metaphor: Contrasting mechanisms of social and physical pain. *Trends in Cognitive Sciences*, *17*, 371–378. doi:10.1016/j.tics.2013.06.002

International Association for the Study of Pain Taskforce on Taxonomy. (2019). Part III: Pain terms, a current list with definitions and notes on usage. In H. Merskey & N. Bogduk (Eds.), *Classification of chronic pain* (2nd ed., pp. 209–214). Seattle, WA: International Association for the Study of Pain Press. (Original work published 1994)

Jackson, J. E. (2005). Stigma, liminality, and chronic pain: Mind–body borderlands. *American Ethnologist*, *32*, 332–353. doi:10.1525/ae.2005.32.3.332

Kross, E., Berman, M. G., Mischel, W., Smith, E. E., & Wager, T. D. (2011). Social rejection shares somatosensory representations with physical pain. *Proceedings of the National Academy of Sciences*, *108*, 6270–6275. doi:10.1073/pnas.1102693108

Lancaster, J. B. (1986). Primate social behavior and ostracism. *Ethology and Sociobiology*, *7*, 215–225. doi:10.1016/0162-3095(86)90049-X

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal and coping*. New York, NY: Springer.

Lea, S. E., & Webley, P. (2006). Money as tool, money as drug: The biological psychology of a strong incentive. *Behavioral and Brain Sciences*, *29*, 161–176. doi:10.1017/s0140525x06009046

Leary, M. R., Twenge, J. M., & Quinlivan, E. (2006). Interpersonal rejection as a determinant of anger and aggression. *Personality and Social Psychology Review*, *10*, 111–132. doi:10.1207/s15327957pspr1002_2

Legrain, V., Damme, S. V., Eccleston, C., Davis, K. D., Seminowicz, D. A., & Crombez, G. (2009). A neurocognitive model of attention to pain: Behavioral and neuroimaging evidence. *Pain*, *144*, 230–232. doi:10.1016/j.pain.2009.03.020

Legrain, V., Iannetti, G. D., Plaghki, L., & Mouraux, A. (2011). The pain matrix reloaded: A salience detection system for the body. *Progress in Neurobiology*, *93*, 111–124. doi:10.1016/j.pneurobio.2010.10.005

Lieberman, M. D., & Eisenberger, N. I. (2009). Pains and pleasures of social life. *Science*, *323*, 890–891. doi:10.1126/science.1170008

Lieberman, M. D., & Eisenberger, N. I. (2015). The dorsal anterior cingulate cortex is selective for pain: Results from large-scale reverse inference. *Proceedings of the National Academy of Sciences*, *112*, 15250–15255. doi:10.1073/pnas.1515083112

MacDonald, G., & Leary, M. R. (2005). Why does social exclusion hurt? The relationship between social and physical pain. *Psychological Bulletin*, *131*, 202–223.

Mancini, A. D. (2019). When acute adversity improves psychological health: A social-contextual framework. *Psychological Review*. Advance online publication. doi: 10.1037/rev0000144

Maner, J. K., DeWall, C. N., Baumeister, R. F., & Schaller, M. (2007). Does social exclusion motivate interpersonal reconnection? Resolving the "porcupine problem." *Journal of Personality and Social Psychology*, *92*, 42–55. doi:10.1037/0022-3514.92.1.42

Mann, L., Feddes, A. R., Doosje, B., & Fischer, A. H. (2015). Withdraw or affiliate? The role of humiliation during initiation rituals. *Cognition and Emotion*, *30*, 80–100. doi:10.1080/02699931.2015.1050358

Master, S. L., Eisenberger, N. I., Taylor, S. E., Naliboff, B. D., Shirinyan, D., & Lieberman, M. D. (2009). A picture's worth: Partner photographs reduce experimentally induced pain. *Psychological Science*, *20*, 1316–1318. doi:10.1111/j.1467-9280.2009.02444.x

Melzack, R. (2005). The McGill Pain Questionnaire: From description to measurement. *Anesthesiology*, *103*, 199–202.

Melzack, R., & Katz, J. (2013). Pain. *Wiley Interdisciplinary Reviews: Cognitive Science*, *4*, 1–15. doi:10.1002/wcs.1201

Melzack, R., & Torgerson, W. S. (1971). On the language of pain. *Anesthesiology*, *34*(1), 50–59.

Melzack, R., & Wall, P. D. (1965). Pain mechanisms: A new theory. *Science*, *150*, 971–979.

Moore, D. J., Keogh, E., & Eccleston, C. (2012). The interruptive effect of pain on attention. *Quarterly Journal of Experimental Psychology*, *65*, 565–586. doi:10.1080/17470218.2011.626865

Morris, D. B. (1991). *The culture of pain*. Berkeley: University of California Press.

Moseley, G. L., & Butler, D. S. (2015). Fifteen years of explaining pain: The past, present, and future. *The Journal of Pain*, *16*, 807–813. doi:10.1016/j.jpain.2015.05.005

Nagasako, E. M., Oaklander, A. L., & Dworkin, R. H. (2003). Congenital insensitivity to pain: An update. *Pain*, *101*, 213–219.

Nelson, E. E., & Panksepp, J. (1998). Brain substrates of infant-mother attachment: Contributions of opioids, oxytocin, and norepinephrine. *Neuroscience & Biobehavioral Reviews*, *22*, 437–452. doi:10.1016/S0149-7634(97)00052-3

Nes, L. S., Carlson, C. R., Crofford, L. J., de Leeuw, R., & Segerstrom, S. C. (2010). Self-regulatory deficits in fibromyalgia and temporomandibular disorders. *Pain*, *151*, 37–44. doi:10.1016/j.pain.2010.05.009

Nesse, R. M., Bhatnagar, S., & Young, E. A. (2007). Evolutionary origins and functions of the stress response. In G. Fink (Eds.), *Encyclopedia of stress* (2nd ed., *Vol. 1*, pp. 965–970). Amsterdam, The Netherlands: Elsevier.

Oaten, M., Williams, K. D., Jones, A., & Zadro, L. (2008). The effects of ostracism on self-regulation in the socially anxious. *Journal of Social & Clinical Psychology*, *27*, 471–504.

Over, H., & Uskul, A. K. (2016). Culture moderates children's responses to ostracism situations. *Journal of Personality and Social Psychology*, *110*, 710–724. doi:10.1037/pspi0000050

Panksepp, J. (2003). Feeling the pain of social loss. *Science*, *302*, 237–239.

Panksepp, J., Herman, B. H., Conner, R., Bishop, P., & Scott, J. P. (1978). The biology of social attachments: Opiates alleviate separation distress. *Biological Psychiatry*, *13*, 607–618.

Panksepp, J., Vilberg, T., Bean, N. J., Coy, D. H., & Kastin, A. J. (1978). Reduction of distress vocalization in chicks by opiate-like peptides. *Brain Research Bulletin*, *3*, 663–667. doi:10.1016/0361-9230(78)90014-X

Papini, M. R., Fuchs, P. N., & Torres, C. (2015). Behavioral neuroscience of psychological pain. *Neuroscience & Biobehavioral Reviews*, *48*, 53–69. doi:10.1016/j.neubiorev.2014.11.012

Park, J., & Baumeister, R. F. (2015). Social exclusion causes a shift toward prevention motivation. *Journal of Experimental Social Psychology*, *56*, 153–159. doi:10.1016/j.jesp.2014.09.011

Perini, I., Gustafsson, P. A., Hamilton, J. P., Kämpe, R., Zetterqvist, M., & Heilig, M. (2018). The salience of self, not social pain, is encoded by dorsal anterior cingulate and insula. *Scientific Reports*, *8*, Article 6165. doi:10.1038/s41598-018-24658-8

Pickett, C. L., & Gardner, W. L. (2005). The social monitoring system: Enhanced sensitivity to social cues and information as an adaptive response to social exclusion and belonging need. In K. D. Williams, J. P. Forgas, & W. von Hippel (Eds.), *The social outcast: Ostracism, social exclusion, rejection, and bullying* (pp. 213–226). New York, NY: Psychology Press.

Pickett, C. L., Gardner, W. L., & Knowles, M. (2004). Getting a cue: The need to belong and enhanced sensitivity to social cues. *Personality and Social Psychology Bulletin*, *30*, 1095–1107. doi:10.1177/0146167203262085

Poldrack, R. A. (2006). Can cognitive processes be inferred from neuroimaging data? *Trends in Cognitive Science*, *10*(2), 59–63. doi:10.1016/j.tics.2005.12.004

Price, J. B. M., & Oxon, D. P. M. (1967). The dominance hierarchy and the evolution of mental illness. *The Lancet*, *290*, 243–246. doi:10.1016/S0140-6736(67)92306-9

Ramírez, J. M., Bonniot-Cabanac, M.-C., & Cabanac, M. (2005). Can aggression provide pleasure? *European Psychologist*, *10*, 136–145. doi:10.1027/1016-9040.10.2.136

Ren, D., Wesselmann, E., & Williams, K. D. (2016). Evidence for another response to ostracism: Solitude seeking. *Social Psychological & Personality Science*, *7*, 204–212. doi:10.1177/1948550615616169

Riva, P., Montali, L., Wirth, J. H., Curioni, S., & Williams, K. D. (2016). Chronic social exclusion and evidence for the resignation stage: An empirical investigation. *Journal of Social and Personal Relationships*, *34*, 541–564. doi:10.1177/0265407516644348

Riva, P., Wesselmann, E. D., Wirth, J. H., Carter-Sowell, A. R., & Williams, K. D. (2014). When pain does not heal: The common antecedents and consequences of chronic social and physical pain. *Basic and Applied Social Psychology*, *36*, 329–346. doi:10.1080/01973533.2014.917975

Riva, P., Williams, K. D., & Gallucci, M. (2014). The relationship between fear of social and physical threat and its effect on social distress and physical pain perception. *Pain*, *155*, 485–493. doi:10.1016/j.pain.2013.11.006

Riva, P., Wirth, J. H., & Williams, K. D. (2011). The consequences of pain: The social and physical pain overlap on psychological responses. *European Journal of Social Psychology*, *41*, 681–687. doi:10.1002/ejsp.837

Rofé, Y. (1984). Stress and affiliation: A utility theory. *Psychological Review*, *91*, 235–250. doi:10.1037/0033-295x.91.2.235

Rotge, J. Y., Lemogne, C., Hinfray, S., Huguet, P., Grynszpan, O., Tartour, E., . . . Fossati, P. (2015). A meta-analysis of the anterior cingulate contribution to social pain. *Social Cognitive and Affective Neuroscience*, *10*, 19–27. doi:10.1093/scan/nsu110

Salomons, T. V., Iannetti, G., Liang, M., & Wood, J. N. (2016). The "pain matrix" in pain-free individuals. *JAMA Neurology*, *73*, 755–756. doi:10.1001/jamaneurol.2016.0653

Scarry, E. (1985). *The body in pain: The making and unmaking of the world*. Oxford, UK: Oxford University Press.

Schwarz, J. P., & Meyer, R. A. (2005). Nociceptors and pain: Correlation of electrophysiology in animals to pain perceptions in humans. In M. Pappagallo (Ed.), *The neurological basis of pain* (pp. 21–30). New York, NY: McGraw-Hill Medical Publishing Division.

Selye, H. (1936). A syndrome produced by diverse nocuous agents. *Nature*, *138*, 32.

Shilling, A. A., & Brown, C. M. (2016). Goal-driven resource redistribution: An adaptive response to social exclusion. *Evolutionary Behavioral Sciences*, *10*, 149–167. doi:10.1037/ebs0000062

Siegel, P. S., & Brantley, J. J. (1951). The relationship of emotionality to the consummatory response of eating. *Journal of Experimental Psychology*, *42*, 304–306. doi:10.1037/h0058402

Siegel, P. S., & Siegel, H. S. (1949). The effect of emotionality on the water intake of the rat. *Journal of Comparative and Physiological Psychology*, *42*, 12–16. doi:10.1037/h0054752

Smart Richman, L., & Leary, M. R. (2009). Reactions to discrimination, stigmatization, ostracism, and other forms of interpersonal rejection: A multimotive model. *Psychological Review*, *116*, 365–383. doi:10.1037/a0015250

Smart Richman, L., Martin, J., & Guadagno, J. (2016). Stigma-based rejection and the detection of signs of acceptance.

Social Psychological and Personality Science, *7*, 53–60. doi:10.1177/1948550615598376

Sommer, K. L., & Bernieri, F. (2014). Minimizing the pain and probability of rejection. *Social Psychological and Personality Science*, *6*, 131–139. doi:10.1177/1948550614549384

Spoor, J. R., & Williams, K. D. (2007). The evolution of an ostracism detection system. In J. P. Forgas, M. G. Haselton, & W. von Hippel (Eds.), *Evolution and the social mind: Evolutionary psychology and social cognition* (pp. 279–292). New York, NY: Psychology Press.

Steinkopf, L. (2016). An evolutionary perspective on pain communication. *Evolutionary Psychology*, *14*(2). doi:10.1177/1474704916653964

Taylor, S. E. (2006). Tend and befriend: Biobehavioral bases of affiliation under stress. *Current Directions in Psychological Science*, *15*, 273–277. doi:10.2307/20183134

Tomiyama, A. J., Dallman, M. F., & Epel, E. S. (2011). Comfort food is comforting to those most stressed: Evidence of the chronic stress response network in high stress women. *Psychoneuroendocrinology*, *36*, 1513–1519. doi:10.1016/j.psyneuen.2011.04.005

Troisi, J. D., & Gabriel, S. (2011). Chicken soup really is good for the soul: "Comfort food" fulfills the need to belong. *Psychological Science*, *22*, 747–753. doi:10.1177/0956797611407931

Troisi, J. D., Gabriel, S., Derrick, J. L., & Geisler, A. (2015). Threatened belonging and preference for comfort food among the securely attached. *Appetite*, *90*, 58–64. doi:10.1016/j.appet.2015.02.029

Twenge, J. M., Baumeister, R. F., DeWall, C. N., Ciarocco, N. J., & Bartels, J. M. (2007). Social exclusion decreases prosocial behavior. *Journal of Personality and Social Psychology*, *92*, 56–66.

Twenge, J. M., Baumeister, R. F., Tice, D. M., & Stucke, T. S. (2001). If you can't join them, beat them: Effects of social exclusion on aggressive behavior. *Journal of Personality and Social Psychology*, *81*, 1058–1069.

Twenge, J. M., Catanese, K. R., & Baumeister, R. F. (2003). Social exclusion and the deconstructed state: Time perception, meaninglessness, lethargy, lack of emotion, and self-awareness. *Journal of Personality and Social Psychology*, *85*, 409–423. doi:10.1037/0022-3514.85.3.409

Ulrich, R. E., & Azrin, N. H. (1962). Reflexive fighting in response to aversive stimulation. *Journal of the Experimental Analysis of Behavior*, *5*, 511–520. doi:10.1901/jeab.1962.5-511

Uskul, A. K., & Over, H. (2014). Responses to social exclusion in cultural context: Evidence from farming and herding communities. *Journal of Personality and Social Psychology*, *106*, 752–771. doi:10.1037/a0035810

Uskul, A. K., & Over, H. (2017). Culture, social interdependence, and ostracism. *Current Directions in Psychological Science*, *26*, 371–376. doi:10.1177/0963721417699300

van Leeuwen, E., Ashton-James, C., & Hamaker, R. J. (2014). Pain reduces discrimination in helping. *European Journal of Social Psychology*, *44*, 602–611. doi:10.1002/ejsp.2045

Van Ryckeghem, D. M., Crombez, G., Eccleston, C., Liefooghe, B., & Van Damme, S. (2012). The interruptive effect of pain in a multitask environment: An experimental investigation. *Journal of Pain*, *13*, 131–138. doi:10.1016/j.jpain.2011.09.003

Villemure, C., & Bushnell, M. C. (2002). Cognitive modulation of pain: How do attention and emotion influence pain processing? *Pain*, *95*, 195–199.

Wager, T. D., Atlas, L. Y., Lindquist, M. A., Roy, M., Woo, C.-W., & Kross, E. (2013). An fMRI-based neurologic signature of physical pain. *New England Journal of Medicine*, *368*, 1388–1397. doi:10.1056/NEJMoa1204471

Walsh, J., Eccleston, C., & Keogh, E. (2014). Pain communication through body posture: The development and validation of a stimulus set. *Pain*, *155*, 2282–2290. doi:10.1016/j.pain.2014.08.019

Way, B. M., Taylor, S. E., & Eisenberger, N. I. (2009). Variation in the mu-opioid receptor gene (OPRM1) is associated with dispositional and neural sensitivity to social rejection. *Proceedings of the National Academy of Sciences*, *106*, 15079–15084.

Weary, D. M., & Fraser, D. (1995). Signalling need: Costly signals and animal welfare assessment. *Applied Animal Behaviour Science*, *44*, 159–169. doi:10.1016/0168-1591(95)00611-U

Wesselmann, E. D., Butler, F. A., Williams, K. D., & Pickett, C. L. (2010). Adding injury to insult: Unexpected rejection leads to more aggressive responses. *Aggressive Behavior*, *36*, 232–237. doi:10.1002/ab.20347

Wesselmann, E. D., Nairne, J. S., & Williams, K. D. (2012). An evolutionary social psychological approach to studying the effects of ostracism. *Journal of Social, Evolutionary, and Cultural Psychology*, *6*, 309–328. doi:10.1037/h0099249

Wesselmann, E. D., Ren, D., & Williams, K. D. (2015). Motivations for responses to ostracism. *Frontiers in Psychology*, *6*, Article 40. doi:10.3389/fpsyg.2015.00040

Westlund, K. N. (2005). Neurophysiology of nociception. In M. Pappagallo (Ed.), *The neurological basis of pain* (pp. 3–19). New York, NY: McGraw-Hill Medical Publishing Division.

Wiech, K., & Tracey, I. (2013). Pain, decisions, and actions: A motivational perspective. *Frontiers in Neuroscience*, *7*, Article 46. doi:10.3389/fnins.2013.00046

Wilkowski, B. M., Robinson, M. D., & Friesen, C. K. (2009). Gaze-triggered orienting as a tool of the belongingness self-regulation system. *Psychological Science*, *20*, 495–501. doi:10.1111/j.1467-9280.2009.02321.x

Williams, A. C. de C. (2002). Facial expression of pain: An evolutionary account. *Behavioral and Brain Sciences*, *25*, 439–455.

Williams, A. C. de C. (2015). What can evolutionary theory tell us about chronic pain? *Pain*, *157*, 788–790. doi:10.1097/j.pain.0000000000000464

Williams, A. C. de C., & Craig, K. D. (2016). Updating the definition of pain. *Pain*, *157*, 2420–2423. doi:10.1097/j.pain.0000000000000613

Williams, K. D. (2007a). Ostracism. *Annual Review of Psychology*, *58*, 425–452. doi:10.1146/annurev.psych.58.110405.085641

Williams, K. D. (2007b). Ostracism: The kiss of social death. *Social and Personality Psychology Compass*, *1*, 236–247. doi:10.1111/j.1751-9004.2007.00004.x

Williams, K. D., Cheung, C. K., & Choi, W. (2000). Cyberostracism: Effects of being ignored over the internet. *Journal of Personality and Social Psychology*, *79*, 748–762.

Williams, K. D., & Nida, S. A. (2011). Ostracism: Consequences and coping. *Current Directions in Psychological Science*, *20*, 71–75. doi:10.1177/0963721411402480

Woo, C.-W., Koban, L., Kross, E., Lindquist, M. A., Banich, M. T., Ruzic, L., . . . Wager, T. D. (2014). Separate neural representations for physical pain and social rejection. *Nature Communications*, *5*, Article 5380. doi:10.1038/ncomms6380