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Why Does Social Exclusion Hurt? The Relationship Between Social and Physical Pain

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The authors forward the hypothesis that social exclusion is experienced as painful because reactions to rejection are mediated by aspects of the physical pain system. The authors begin by presenting the theory that overlap between social and physical pain was an evolutionary development to aid social animals in responding to threats to inclusion. The authors then review evidence showing that humans demonstrate convergence between the 2 types of pain in thought, emotion, and behavior, and demonstrate, primarily through nonhuman animal research, that social and physical pain share common physiological mechanisms. Finally, the authors explore the implications of social pain theory for rejection-elicited aggression and physical pain disorders.

> The physical pain alone was terrible. I always used to think the expression "a broken heart" was just a metaphor. But it felt as if I was having a heart attack.
>
> —Bob Geldof, on the end of his 19-year relationship

In a recent documentary about the death penalty, a camera crew was present in the home of a woman whose son was to be executed that day. Although she was not present at the execution itself, at the time the penalty was to be exacted she burst out of her front door and fell to the ground screaming and crying. Friends and family followed her outside and tried to help her up, as if her being on the ground was the problem. However, whenever people would try to touch her, she would scream at them with fury to keep away. Her behavior was akin to that of a wounded animal, scaring others away because her pain was so great.

In reflecting on the most agonizing moments in one's life, events involving severe physical pain (e.g., serious injuries, labor pain, kidney stones) quickly come to mind. But other events, such as the example above, may be as severely distressing, if not painful, despite the lack of any tangible threat to one's personal health or safety. Most people have experiences in which socially mediated pain is so great that they are not only in agony but are overwhelmed or incapacitated. In this article, we argue that referring to these responses to social exclusion, rejection, or loss as *pain* is more than just a metaphor. Because inclusion in social groups has been a key to survival for social animals deep into the past, we propose that threats to one's social connections are processed at a basic level as a severe threat to one's safety. In fact, we argue that such threats are partly mediated by the same system that processes physical pain because the pain system was already in place when social animals evolved adaptations for responding to social exclusion.

In this article, we use the term *social pain* to refer to a specific emotional reaction to the perception that one is being excluded from desired relationships or being devalued by desired relationship partners or groups. Exclusion may be a result of a number of factors, including rejection, death of a loved one, or forced separation. In everyday life, extreme social pain may be experienced as the deep aching of homesickness, grief, abandonment, or longing for a loved one. *Relational devaluation* refers to feeling less valued as a relational partner (e.g., friend, romantic partner, group member) than one desires (Leary & Springer, 2001). We argue that such devaluation is experienced as aversive because it signals an increased probability of ultimate exclusion. The acute emotional distress felt in response to relational devaluation is known as *hurt feelings* (Leary & Springer, 2001). However, other affective states such as embarrassment, shame, guilt, or jealousy can also serve as signs that one is not living up to the standards of valued others, and thus we consider these emotions to be aspects of social pain as well.

The concept of social pain was first suggested by Panksepp and colleagues. They provided evidence that the social attachment system was built up from more primitive regulation systems such as those involved in place attachment, thermoregulation, and physical pain (Panksepp, 1998). Herman and Panksepp (1978) suggested specifically that "it is conceivable that brain circuits for separation distress represent an evolutionary elaboration of an endorphin-based pain network" (p. 219), and Nelson and Panksepp (1998) stated, "The pain components made stronger contributions to the subcomponents which aroused emotional distress during social absence" (p. 438). In this article, we attempt to extend Panksepp's ideas with the goal of tying social pain more strongly to human reaction to perceived social exclusion and by considering the implications of social pain for the important problems of relationship aggression and pain disorders.

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We argue that the aversive emotional state of social pain is the same unpleasantness that is experienced in response to physical pain. Others before us have proposed the existence of nonphysical forms of pain such as "emotional pain," "mental pain," and "psychological pain." Thornhill and Thornhill (1989) proposed a theory of emotional pain, suggesting that its function is analogous to that of physical pain. That is, they proposed that such pain focuses attention on significant social events and promotes correction and avoidance of such events in the future. They further theorized that the causes of emotional pain would be circumstances that had influenced inclusive fitness in the environment of evolutionary adaptiveness such as the death of genetic relatives or close associates, loss of status, sexual jealousy, childlessness, and rape. In the current article, we restrict our analysis to a very specific evolutionary adaptation—the desire to avoid social exclusion. It is important to make clear that we are not suggesting that social pain is the only viable form of nonphysical pain. It is more accurate to suggest that social pain may be one form of emotional pain. In fact, in our analysis, it is most accurate to say that the affective responses to physical trauma usually described as physical pain are themselves a subcategory of emotional pain, albeit a fundamental one. Given Gray's (1971) suggestion that the same punishment mechanism underlies both fear and frustration, it seems reasonable to suggest that feelings of pain may be associated with a wide variety of stimuli that either lead to harm or block a highly desired goal. In this article, we do not claim to provide an exhaustive analysis of all possible forms of emotional pain but rather of one specific form—social pain.

To begin, we forward our theory of why social and physical pain overlap as they do. We argue that social animals require a system that punishes individuals who do not avoid social exclusion and motivates quick responses to signs of exclusion. In line with the work of Panksepp, we propose that at the point in evolutionary history when such a system developed, existing physical pain mechanisms provided its foundation. To support this hypothesis, we provide evidence that social and physical pain overlap in the attitudes, behaviors, and cognitions of humans, reviewing evidence that the two types of pain correlate similarly with factors such as extraversion, social support, anxiety, aggression, and depression. From there, we present physiological evidence that social and physical pain operate via shared mechanisms. Specifically, both types of pain have been shown to involve the anterior cingulate cortex and periaqueductal gray brain structures and the opioid and oxytocin neuroendocrine systems. We then move to discuss the implications of social pain theory, focusing on its implications for understanding rejection-elicited aggression such as violence in close relationships and pain disorders such as somatoform pain. We conclude by suggesting future directions for research on social pain.

Why Is Social Exclusion Painful?

> The pain of separation slams down, the guillotine.
> —Lucy Gwin, "Normal zone: You in or out?", *Adbusters: Journal of the Mental Environment,* 2002

Social pain theory is based on the idea that the possibility of being separated from important social entities posed a critical challenge to the survival of our ancestors, dating back at least to the earliest mammals (and likely beyond). For example, infants of highly socially integrated female baboons have been shown to be more likely to survive to 1 year of age than infants of less socially integrated mothers, even controlling for the mothers' dominance rank (Silk, Alberts, & Altmann, 2003). Further, vervets and rhesus monkeys who showed low interest in social contact (a result of receiving amygdala and other brain site lesions) after rerelease to the wild were excluded from the social group and died without the protection of their conspecifics (Kling, Lancaster, & Benitone, 1970). Such data support the premise that, over evolutionary time, social animals who formed strong relationships and were integrated most strongly into group living were most likely to survive, reproduce, and raise offspring to reproductive age (Baumeister & Leary, 1995). Phrased differently, for social animals, being socially excluded was often equivalent to death. As a result, the process of natural selection favored those who were motivated to be included, meaning such animals were more likely to leave viable descendants.

To adapt to changing conditions vis-à-vis social inclusion and exclusion, social animals required mechanisms that allowed them to recognize and react to threats of exclusion in an efficient manner. In particular, cues such as physical distance from important conspecifics may have been reliably correlated with eventual exclusion. In evolutionary terms, genetic mutations that provided learning mechanisms for associating such cues with response mechanisms that helped avoid exclusion would have facilitated survival (cf. Krebs, Stephens, & Sutherland, 1983). As a result, such mutations would have provided an important evolutionary advantage for social animals and would have been likely to be passed on to future generations. For early social animals, such cues would have included factors such as physical distance from important conspecifics or absence of those conspecifics. For example, social inclusion took on particular importance for mammals because they nurse their young, meaning parent–offspring interdependence is a critical survival issue. The mammalian infant's reliance on its mother for nourishment, as well as protection from predators and other dangers, means that any prolonged separation of an infant from its mother is potentially disastrous (MacLean, 1993).

This high degree of dependence on the mother set the stage for adaptations that maintained the infant–mother bond (Bowlby, 1973; Panksepp, 1998). Over time, some social animals gradually developed more complex cooperative social structures that eventually blossomed into high degrees of interdependence, making inclusion crucial for survival across the life span (Gilbert, 1992; MacLean, 1993; Whiten & Byrne, 1989). This increase in social complexity would have been accompanied by new cues of exclusion threat, such as averted eye gaze. Again, genetic mutations that tied such cues to appropriate warning and response mechanisms (or that facilitated the learning of such associations) would have conferred an important advantage, and thus would have been likely to be retained across generations. Because social exclusion has been such an important threat to survival from the earliest days of social speciation, it seems reasonable to suggest that exclusion cues recognized by modern humans have the potential to be processed as a basic and severe threat to existence in the same way as do other primitive threats (e.g., snakes or spiders; Öhman & Mineka, 2001).

The question, then, is what kind of warning and response mechanisms these cues of social distance came to trigger. Evolutionary theory suggests that such cues were likely to become associated with the activation of existing threat defense mecha-

nisms. Such "preadaptations" are considered to be a common means of responding quickly to new survival challenges, including social ones (D. C. Craig, Gilbert-MacLeod, & Lilley, 2000; Keverne, Nevison, & Martel, 1999; Öhman & Mineka, 2001; Panksepp, 1998; Rozin, Haidt, & McCauley, 1993). For example, the negative emotional and physical reaction provoked by moral offenses such as incest appears to tap the physical disgust response, leading to grimacing, flared nostrils, and nausea (Rozin et al., 1993). We propose that cues of social distance came to activate threat-defense responses that originally functioned to help organisms avoid physical danger, as such mechanisms predated the evolution of social animals. In particular, we propose that social exclusion cues accessed threat-defense responses by stimulating the same painful feelings associated with physical injury.

In the remainder of this section, we lay out our argument as to why pain would have provided an excellent mechanism for the regulation of social inclusion (Panksepp, 1998). In order to describe how social experience may have come to be mediated by feelings of pain, it is important to note that the experience of pain consists of two separate components—pain sensation and pain affect (Melzack & Wall, 1996; Price, 1999; Rainville, 2002). Pain sensation provides information about ongoing tissue damage, information that is gathered by the body's specialized pain receptors and transmitted to the brain for processing via the dorsal horn of the spinal cord (K. D. Craig, 1999; Melzack & Wall, 1965). We do not propose that social exclusion directly taps into this circuitry, although we do discuss the possibility of indirect influence later. Pain affect consists of the feelings of unpleasantness that are associated with pain sensation, as well as emotions associated with the future implications of those sensations (Price, 2000). It is this affective experience of pain that signals an aversive state and motivates behavior to terminate, reduce, or escape exposure to the source of the noxious stimulation (Melzack & Casey, 1968; Price, 1999). Because this affect component is separate from the sensation component, it is possible to experience painful feelings in the absence of a signal of tissue damage (Fields, 1999; Rainville, 2002). Thus, our suggestion is that social exclusion triggers these same painful feelings, leading to an emotional experience of pain without accompanying physical pain sensation.

We believe that pain affect came to underlie social regulation needs because it serves at least two functions crucial for the avoidance of social exclusion. First, learning that promotes avoidance of inclusion-threatening situations is needed to minimize the number of exclusion threats that one faces. Feelings of pain can provide a strong sense of aversiveness that, when paired with exclusion-threatening situations, can motivate avoidance of such situations. Second, quick action in response to exclusion warnings (e.g., ceasing an offending behavior) is needed to help sustain inclusionary status. Because of the strong relation between pain and threat-defense response mechanisms (Gray & McNaughton, 2000; Panksepp, 1998), pain affect should provide a pathway by which social exclusion cues could trigger quick, defensive reactions to regulate inclusionary status.

Aversiveness of Pain

The affective component of physical pain aids organisms in avoiding threats to their physical safety by serving as a source of punishment, and it functions to guide organisms toward safety by serving as a source of negative reinforcement. Increases in painful feelings motivate organisms to avoid dangerous stimuli, whereas decreases in painful feelings reward an organism for moving toward safety (i.e., away from danger and/or toward safety). Further, the aversiveness of pain can condition an organism to avoid situations in which a quick response is needed. After organisms learn to associate certain situational cues with pain, these cues trigger relevant approach/avoidance tendencies so that pain is avoided or minimized. As a result, the organism learns to fear not just pain itself but also cues that indicate the possibility of pain (Bowlby, 1973). For example, a child who is bitten by a dog may become fearful in the future upon seeing or hearing the dog, regardless of whether the dog actually bites the child again. This conditioned fear can motivate movement away from the fear-evoking stimulus and movement toward a helpful attachment figure, both of which have the potential to reduce the threat of a harmful stimulus.

We propose that painful feelings triggered by social exclusion also provide a mechanism useful for learning effective approach/avoidance regulation to avoid exclusion. People who reject, exclude, or ignore an individual are not likely to be safe or stable sources of support for that person and, in fact, may be inclined to cause harm to that person. Thus, experiencing painful emotions in connection with social exclusion guides an individual away from sources of rejection and toward sources of acceptance. Indeed, people are highly attuned to social cues indicating that social pain is likely and work to avoid social pain when such cues are detected. Just as a person is less likely to approach a dog who bit him or her, that person is also less likely to seek the company of an individual who has insulted, ostracized, or otherwise hurt him or her. Indeed, research has shown that people tend to distance themselves from others if they feel that rejection, and hence hurt feelings, is likely (Bourgeois & Leary, 2001; Feeney, Noller, & Roberts, 2001; Murray, Holmes, MacDonald, & Ellsworth, 1998; Vangelisti, 2001). For example, individuals who feel unsure of acceptance from a romantic partner often devalue the importance of the relationship as a means of protecting themselves from the hurt of rejection (Murray et al., 1998). Furthermore, social pain experienced in the context of a specific relationship can motivate people to seek support from trusted others or to pursue new relationships (Leary & Springer, 2001). Overall, both physical and social pain appear to serve a similar function in promoting adaptive approach and avoidance behavior in response to physical and social threats, respectively.

Another important point of overlap between social exclusion and physical pain relevant to learning is that certain early-life sensory experiences, particularly gentle touch, are involved in the alleviation of both physical pain and social separation. Physical touch provides the basis for attachment (Harlow, 1958). Human infants appear prepared to learn associations between attachment behaviors and parental responses as mediated by physical contact (Bowlby, 1973). When babies express physical discomfort (e.g., through crying), their distress can be alleviated through physical contact by the attachment figure such as holding or patting (Bowlby, 1973). In essence, this is the key to attachment theory; children learn about the reliability of social support from the attachment figure on the basis of that attachment figure's physical responsiveness to their distress. At a more basic level, however, the baby also learns that isolation and physical pain go hand in hand. Because the child learns that uncomfortable states such as hunger pangs and gas pain often continue until the attachment figure is in physical contact with the child, the association between

physical and social pain occurs at a very early age. (Interestingly, when we feel another person has helped us in a special, supportive way, we may say that we feel "touched.") All told, then, attachment regulation may have intertwined with pain mechanisms because these mechanisms would have already been highly responsive to the crucial cues of distress and physical touch.

Overall, we propose that social pain hurts because social inclusion was and is key for human survival. In accordance with this view, people do appear to take social pain very seriously. For example, Kaplan and Bratman (2000) showed that people judge doctor-assisted suicide as more moral and easier to understand when the patient is in emotional pain than in matched cases without emotional pain. This study also showed that participants viewed doctor-assisted suicide as more justifiable and understandable when both emotional and physical pain were present than when the patient experienced only physical pain. Thus, people realize that emotional pain can be excruciating. Further, K. D. Williams (1997) has observed that many people would prefer to be hit than ostracized, suggesting that the pain of social exclusion may be more aversive than the pain of physical injury in many instances. In fact, simply thinking about separation from close others has been shown to increase the accessibility of death-related thoughts (Florian, Mikulincer, & Hirschberger, 2002; Mikulincer & Florian, 2000; Mikulincer, Florian, Birnbaum, & Malishkevich, 2002), suggesting a strong link between attachment and a sense of physical safety. As MacLean (1993) aptly put it, "A sense of separation is a condition that makes being a mammal so painful" (p. 74).

Pain and Quick Reaction to Threat

Another benefit of tying social exclusion cues to pain is the ability to capitalize on the strong relation between pain and the threat-defense system (Gray & McNaughton, 2000; Panksepp, 1998). This way, social pain would not only lead to exclusion cues being perceived as aversive, but it would also promote timely response to such cues. As sketched by Gray and McNaughton (2000), the physical defense system regulates behavior in response to threat on the basis of the state of two key variables. The first variable, defensive distance, refers to the degree of perceived threat in a given situation (Blanchard & Blanchard, 1990). That is, the more threatening a stimulus is perceived to be to well-being, and the more imminent that threat is perceived to be, the more the defense system promotes active, self-protective behavior. The second variable, defensive direction, refers to whether motivation exists to approach a potentially dangerous stimulus (Gray & McNaughton, 2000). For example, a mouse may perceive moving onto an open field as threatening (as it would be exposed to predation), but it may need to do so to acquire food.

According to Gray and McNaughton's (2000) model, approaching a potentially threatening stimulus results in anxiety, promoting cautious approach behavior such as initially making brief forays onto the open field followed by quickly returning to a safe position. The intensity of anxious emotion and behavior should increase as defensive distance is reduced. When a potentially dangerous stimulus is detected and is not accompanied by a motivation to approach the stimulus, the resulting response is fearful avoidance of the stimulus when defensive distance is high (e.g., the faint odor of a predator is detected). However, when defensive distance is low (e.g., the presence of an immediate predator), a panic response promotes fight/flight/freezing behavior as a means of providing a quick route to safety. It is important to note that when we refer to *panic responses* throughout this article, we specifically mean the motivation for undirected escape from threat, or the fight/flight/freezing response. Such panic behavior can be highly reactive and relatively undirected as high levels of coordination and planning are sacrificed for a quick response to danger. The panic response is facilitated by a set of physiological changes designed to prepare an organism for urgent action such as increased heart rate, increased blood clotting factor, and analgesia (Gray & McNaughton, 2000). Factors that have been shown to trigger the panic response include immediate predators, high levels of carbon dioxide, and physical pain (Gray & McNaughton, 2000). Physical pain can be an important signal of immediate threat, as it often accompanies tissue damage. In this way, pain serves to activate and regulate avoidance responses including fight, flight, or freezing (Berkowitz, 1993; Berkowitz, Cochran, & Embree, 1981; Merskey, 2000).

Social relationships also require approach/avoidance regulation. Whereas the need to belong (Baumeister & Leary, 1995) and sexual desire provide approach motivation, the dangers of rejection and exclusion provide avoidance motivation. In fact, people often react to threats to social inclusion as if they were as important as threats to physical safety, if not more so (K. D. Williams, 1997). Perhaps not surprisingly, then, rejection appears to lead to responses consistent with Gray and McNaughton's (2000) model. For example, Vangelisti and Crumley (1998) asked participants to recall instances when their feelings had been hurt and to describe their responses to the incident. A factor analysis of participants' responses to feeling hurt classified these responses into three categories. The first, "acquiescent," consisted of behaviors such as apologizing that appear to facilitate safety from hurt via cautious approach. The second, labeled "invulnerable," consisted of behaviors such as ignoring the source of hurt that serve to help one avoid or withdraw from a hurtful exchange. Finally, the response labeled "active verbal" consisted of behaviors such as verbally attacking the source of hurt that seem to reflect more aggressive responses. These classes of responses appear to map well onto the anxiety, fear, and panic components of the physical defense system, respectively. As with physical pain, we believe that the panic response to perceived exclusion should occur only when defensive distance from exclusion is perceived to be low. That is, reactions to social stimuli should most resemble reactions to acute physical pain when strong relational devaluation by another is perceived, especially when there is a strong desire to maintain a relationship with the devaluation source (Leary & MacDonald, 2003; Leary, Springer, Negel, Ansell, & Evans, 1998).

Thus, like physical pain, social pain leads animals to approach friendly conspecifics, avoid threats to separation when possible, and attack unavoidable threats to separation (Alexander, 1986; Carter, 1998). Unlike physical pain, however, the emotional distress of social pain serves a protective function in social contexts (Baumeister & Tice, 1990; Leary & Springer, 2001; Miller & Leary, 1992; Thornhill & Thornhill, 1989; Vangelisti & Crumley, 1998). Because the need to belong is a fundamental aspect of human experience, a system to protect social well-being has great adaptive value for human beings (Baumeister & Leary, 1995; Baumeister & Tice, 1990; Leary, Tambor, Terdal, & Downs, 1995). In support of these ideas, separation from attachment figures in primates activates major behavioral and stress response

systems, according to a review of relevant literature (Mason & Mendoza, 1998). Such separation has been shown to lead to reactions similar to those seen in human beings, including increased anxiety and depression-like behavior (E. O. Johnson et al., 1996; Levine & Stanton, 1990), increased plasma cortisol (E. O. Johnson et al., 1996; Rilling et al., 2001), decreased norepinephrine (Kraemer, Ebert, Schmidt, & McKinney, 1991), and overt crying (E. O. Johnson et al., 1996; Panksepp, 1998). For example, marmosets placed in isolation for a 2-week period evidenced increases in plasma cortisol concentrations (a stress-related hormone involved in preparation for physical defense) and submissive crying, weight loss averaging 10% of body mass, and frequent crouching that the authors likened to freezing behavior in rats (E. O. Johnson et al., 1996). Social stressors have been shown to evoke similarly strong physiological responses in humans. A meta-analysis by Dickerson and Kemeny (2004) showed that the threat of social evaluation is unique among psychological stressors in stimulating the release of high levels of cortisol (this relation was particularly strong when stress was uncontrollable).

Further, separation from caregivers and isolation from conspecifics has been shown to lead to another aspect of the fight/flight/freezing response in nonhuman mammals—analgesia (or reduced pain sensitivity). Analgesia in response to short-term isolation has been demonstrated in rat pups (Kehoe & Blass, 1986a, 1986b; Naranjo & Fuentes, 1985; Spear, Enters, Aswad, & Louzan, 1985), mice (Konecka & Sroczynska, 1990), cows (Rushen, Boissy, Terlouw, & de Passillé, 1999), and chicks (Sufka & Hughes, 1990; Sufka & Weed, 1994). For example, as we discuss in more detail later, rat pups isolated from their mother (or "dam") and littermates have been shown to have longer response latencies to heat stimuli, suggesting a decreased sensitivity to pain (Kehoe & Blass, 1986b). Analogous results have been found with human participants. MacDonald, Kingsbury, and Shaw (in press) randomly assigned participants to be either included or excluded from an online ball-tossing game they believed they were playing with other participants (who were actually controlled by a computer schedule). Before the game, participants' proneness to experience hurt feelings (i.e., the ease with which an individual's feelings are hurt) was measured. Following the game, participants' physical pain sensitivity was tested by having them place an arm in cold water (the "cold pressor" task) and report how quickly they felt pain (i.e., pain threshold). The results showed that individuals whose feelings were more easily hurt and who were excluded from the game reported higher pain thresholds (i.e., slower onset of pain) than hurt-prone individuals included in the game. That is, individuals who were sensitive to rejection and who experienced social exclusion demonstrated an analgesic response to the cold water. Individuals less prone to hurt feelings did not differ across conditions. These data provide direct evidence that social exclusion can influence physical pain detection mechanisms. This supports the notion that reactions to social exclusion are regulated by a general threat-defense system that prepares an organism for potentially harmful situations and is responsive to "stimulation that is intense, *painful*, [italics added] or unexpected" (Mason & Mendoza, 1998, p. 771).

Shared Psychological Correlates of Social and Physical Pain

We now move to review evidence of the link between social and physical pain in the thoughts, feelings, and behavior of humans. The most obvious connection between the two is that similar words are used to describe both experiences. The phrase "I am hurt" could just as easily refer to the result of a physical injury as to one's reaction to a relationship dissolution. In fact, many of the terms used to describe social pain, if taken literally, would be great sources of physical pain. For example, people may say that they were "broken hearted," "cut to the core," or "emotionally scarred" by a rejection or other loss of social connection. Similarly, a person may say that being rejected "ripped out my heart" or was like a "slap in the face." More generally, people report feeling "crushed," "deeply hurt," or "wounded." It should be noted that counterexamples, where pain is used as a metaphor for positive social experience, can also be brought to mind, such as "having a crush on someone" or "getting a kick out of someone." However, unlike most other emotional states, the English language contains no direct synonym for the term *hurt feelings*, the emotion that accompanies perceived relational devaluation by other people (Leary & Springer, 2001). Thus, English speakers not only describe social pain using images connoting physical pain, but at least in the case of hurt feelings, they have constructed no other way to describe that common and important experience except with reference to pain. Further, as can be seen in Table 1, examples of a linguistic link between exclusion and pain can be found across a wide variety of languages and cultures.

Beyond these linguistic associations, if social and physical pain share a common psychological and/or physiological basis in humans, then both should be similarly related to a number of common factors. Because both types of pain serve to promote avoidance of pain-eliciting stimuli, both types of pain should be associated with higher degrees of caution and defensiveness. Furthermore, there should be evidence of crossover between the two types of pain. That is, higher degrees of physical pain should be associated with increased social caution or isolation and vice versa. In this section, we offer evidence supporting these two postulates from research on extraversion–introversion, social support, anxiety and fear, defensive aggression, and depression.

Table 1
International Terms for Hurt Feelings

Language	Native term	English translation
German	verletzt sein	hurt or wounded
French	blessé	hurt
Dutch	gekwetst	hurt
Spanish	sentirse herido	feel injured or harmed
Italian	ferito	hurt
Greek	pligomenos	hurt
Hebrew	he pag'ah baregashot shelo	she hit/damaged his feelings
Hungarian	megsertoedni	being hurt
Armenian	zkatsoumnires tsavtsoutsir	you hurt my feelings
Mandarin	shang liao kan ching	hurt feelings
Cantonese	siong sum	hurt heart
Tibetan	snying la phog	hit the heart
Bhutanese	sems lu phog	hit the mind
Inuktitut	anniqtuq	hurt by harsh words

Note. These terms were solicited from colleagues and friends with the following e-mail: "In English, we refer to a person's emotional reaction to being rejected as 'hurt feelings.' We are interested in what word or words native speakers of other languages use. We would appreciate it if you could tell me the expression used to describe the emotional reaction to rejection in any other language."

Extraversion and Introversion

Extraversion–introversion appears to have an important relation to both social and physical pain. Extraverts are more sociable and outgoing than introverts (Pervin, 1996), partly because they are less afraid of being rejected and hurt in social settings. Indeed, extraversion is negatively related to rejection sensitivity (Downey & Feldman, 1996). Further, extraversion is positively related to self-esteem (Halamandaris & Power, 1997; Kwan, Bond, & Singelis, 1997), a variable strongly tied to the belief that one is acceptable to other people (Leary & MacDonald, 2003).

Extraversion is also related to physical pain. A review of research by Phillips and Gatchel (2000) showed that extraverts demonstrated both higher pain thresholds (the point at which pain is detected) and higher pain tolerance (the degree of pain that can be withstood). It is interesting to note, however, that extraverts are more likely than introverts to express that they are in physical pain (Phillips & Gatchel, 2000; Wade & Price, 2000). If one considers that expressing injury could be taken as a sign of weakness, it appears that introverts, who are more wary of being rejected (Downey & Feldman, 1996), may want to hide their hurt. As a result, introverts may express less pain than extraverts even while experiencing it more intensely. In fact, as chronic pain continues over time, pain sufferers become more introverted (Phillips & Gatchel, 2000), demonstrating increased social anxiety and avoidance of social situations (Sharp & Harvey, 2001). In general, then, introverts appear to have a higher level of reactivity to both physical and social pain than extraverts, supporting the notion that the two types of pain operate via common mechanisms.

Social Support

The common-sense notion that meaningful support from close others is strongly tied to social pain and hurt feelings is supported by the literature (Leary, 1990; Leary, Koch, & Hechenbleikner, 2001). Indeed, we have defined social pain in terms of separation from valued others, and hurt feelings as a perception of suboptimal valuation by other people. In essence, then, a perceived lack of adequate social connections is the sine qua non of social pain. In support of this notion, hurt feelings have been shown to arise from the perception that one is less valued by another person or group than one wishes (Leary et al., 1998, 2001). For example, Leary et al. (1998) asked participants to recount instances when their feelings had been hurt and found that 99% of these instances involved relational devaluation. Further, the feeling of being valued that comes from meaningful social support helps to soothe social pain; people regularly derive a great deal of solace from other people when they are distressed (Buunk & Verhoeven, 1991; Finch, Okun, Pool, & Ruehlman, 1999; Haley, 1997; Schachter, 1959). For example, in a meta-analysis of relevant studies, Finch et al. (1999) found that both social support and negative social interaction had significant (and oppositely valenced) relations with psychological distress.

What is perhaps less intuitive is that social support is also related to physical pain. Research has shown that higher levels of social support are associated with lower levels of chronic pain (Phillips & Gatchel, 2000), labor pain (Klaus, Kennel, Robertson, & Sosa, 1986; Niven, 1985), cardiac pain (Chalmers, Wolman, Nikodem, Gulmezoglu, & Hofmeyer, 1995; Cogan & Spinnato, 1988), and postoperative pain (Lidderdale & Walsh, 1998). In addition, people who are socially alienated are more prone to physical ailments (Bockian, Meager, & Millon, 2000), and people experiencing marital dissatisfaction and conflict show poor adjustment to chronic pain (Robinson & Riley, 1999). The link between physical pain and social support has also been demonstrated experimentally. Brown, Sheffield, Leary, and Robinson (2003) tested pain sensitivity with the cold pressor task after randomly assigning participants to receive active social support (verbal support), passive social support (presence of other with no communication), distracting interaction (verbal interaction without support instructions), or no support. Relative to those with no support or distraction, those with active or passive social support reported less pain from the task. Social support, then, appears to play a role in buffering both social and physical pain.

The data reviewed here support the notion that perceptions of social support are associated with perceptions of reduced levels of physical pain. However, they also appear to be in conflict with research presented earlier suggesting that isolation leads to analgesia in nonhuman animals (e.g., Kehoe & Blass, 1986b) and that exclusion can lead to decreased pain sensitivity for hurt-prone humans (MacDonald et al., in press). Why would both inclusion and exclusion lead to decreased pain sensitivity? One answer may be that inclusion and exclusion affect different aspects of sensitivity to pain that follow different time courses. For example, in the Brown et al. (2003) study, socially supported participants did not begin reporting lower pain sensitivity until 1 min into the cold pressor task, an effect that remained significant for the duration of the task (the task stopped after 3 min). Correlational studies relating social support to lower pain sensitivity in human participants tend to encompass a relatively long time frame, with measures of social support tapping perceptions of long-term support.

On the other hand, excluded hurt-prone individuals in MacDonald et al.'s (in press) study reported initial pain less quickly than included hurt-prone individuals, but this effect did not last beyond the early stages of the cold pressor task. It is important to note that much of the work associating separation with analgesia in nonhuman animals has been conducted following relatively short-term isolation periods (e.g., separating a rat pup from its dam for 5 min).[1] Thus, measures of pain sensitivity in these studies are taken during a relatively short time span when analgesia is still active. Indeed, this short-term focus is consistent with the role of analgesia in response to physical injury as a mechanism that blocks attention to injury until safety is achieved. Analgesia that extended for long periods of time would be less functional, as injury would not be associated with the discomfort of pain and thus not promote avoidance learning. Further, it is unclear from these studies whether inclusion and exclusion were related to pain intensity, pain affect, or both, highlighting our limited knowledge about the mechanisms by which these studies found their effects. Finally, it seems potentially useful to test for a moderating role for hurt

[1] Some researchers have demonstrated reduced pain sensitivity in adult rats that were raised in isolation and thus experienced long-term social separation (Gentsch, Lichtsteiner, Frischknecht, Feer, & Siegfried, 1988; Schwandt, 1993). However, as these rats were raised from an early age without the presence of any conspecifics, it seems likely the analgesia demonstrated in these studies is related to developmental difficulties. Thus, we do not view these studies as comparable with the long-term social support data from correlational studies involving nondevelopmentally challenged human populations.

proneness in the support–analgesia link found by Brown et al. (2003), as the exclusion–analgesia effect found by MacDonald et al. (in press) was limited to hurt-prone individuals. Again, these data support a clear link between social exclusion and physical pain mechanisms, but clearly more research is needed to investigate the nature of this relationship and the mechanisms by which it operates.

Anxiety and Fear

Anxiety and fear are strongly tied to physical pain (Robinson & Riley, 1999; Turk & Flor, 1999; Weisberg & Keefe, 1999). For example, data from a survey of a representative sample of the population of the United States indicate that individuals experiencing the chronic pain of arthritis are more likely to experience anxiety and panic disorders, even when a wide range of sociodemographic variables and medical conditions were controlled (McWilliams, Cox, & Enns, 2003). Arthritis was also associated with social phobia in this study controlling for the sociodemographic variables, but this relation was nonsignificant when the other medical conditions were controlled. Further, people who score highly on measures of trait anxiety and neuroticism have lower thresholds for physical pain than those who are less anxious (Phillips & Gatchel, 2000; Wade & Price, 2000; D. A. Williams, 1999). Similarly, longitudinal research has shown that neuroticism predicts the experience of neck pain and migraine headaches 3 years later (Wade & Price, 2000). Chronic pain sufferers who fear abandonment from close others (i.e., have a more anxious attachment style) have been shown to experience their physical pain as more threatening and distressing than those with more secure attachment (Mikulincer & Florian, 1998). Not surprisingly, anxious attachment is related to neuroticism (Shaver & Brennan, 1992), and people who score high in neuroticism are more prone to death-related thoughts when they are reminded of their corporeal nature (Goldenberg, Pyszczynski, McCoy, Greenberg, & Solomon, 1999), suggesting that anxiousness is associated with more accessible cognitions related to threats to survival.

Neuroticism is also related to the propensity to experience hurt feelings and other negative emotional reactions to social exclusion. People who are more neurotic are more prone to feel hurt when they do not feel valued (Leary & Springer, 2001) and are generally more rejection sensitive (Downey & Feldman, 1996; Downey, Feldman, & Ayduk, 2000). Individuals high in anxious attachment evidence higher levels of anxiety and distress in response to separation, conflict, and breakup in close relationships than those with more secure attachment (Feeney, 1999; Fraley & Shaver, 1999; Mikulincer & Florian, 1998; Rholes, Simpson, & Stevens, 1998). Those with higher levels of neuroticism are more likely to feel socially anxious and embarrassed when they become concerned about social approval and acceptance (Leary & Kowalski, 1993). In a survey of chronic pain patients and other community members, MacDonald et al. (in press) showed that the tendency to experience hurt feelings was associated with higher reports of physical pain and that both of these factors were related to higher levels of anxiety. In addition, physical pain reports partially mediated the relation between hurt feelings and anxiety, suggesting that one mechanism by which hurt feelings increase anxiety is through feelings of pain. Finally, in another study, MacDonald et al. (in press) presented individuals with video clips of painful and nonpainful events. When the ratings of the nonpainful clips were controlled, hurt feelings proneness was related to evaluating the painful clips as more aversive and less humorous, suggesting that hurt-prone individuals are relatively vigilant for physical threat.

Clearly, both physical pain and social exclusion are important correlates of anxiety. In fact, Baumeister and Tice (1990) proposed that all instances of anxiety arise from either the threat of physical pain or the threat of social exclusion. In both cases, anxiety signals a potentially dangerous stimulus or situation, necessitating cautious approach or avoidance of the stimulus (Gray & McNaughton, 2000; Frijda, 1986). However, there is a problematic aspect to a long-term avoidant response common to both social and physical pain. One common strategy for avoiding social pain in romantic relationships is described by Murray and Holmes's dependency regulation model (Murray, Holmes, & Griffin, 2000; Murray, Holmes, Griffin, Bellavia, & Rose, 2001; Murray et al., 1998). According to the model, individuals who fear rejection from intimate others tend to avoid creating situations where the expected rejection might materialize. Thus, such individuals will keep emotionally distant from their partners, limiting the risks they take to increase intimacy such as self-disclosure. As discussed earlier, such a self-protective stance can be functional in the short-term by limiting rejection. The problem with this approach is that by not exposing oneself to the potential for rejection, one's fears of rejection are never disconfirmed. The emotional distance motivated by these rejection fears undermines relationship closeness (Murray et al., 1998, 2000, 2001), often instigating the feared hurtful behavior from others (Ayduk, Downey, Testa, Yen, & Shoda, 1999; Murray, Holmes, & Griffin, 1996) and leading to eventual dissolution of the relationship (Karney & Bradbury, 1995; Kelly & Conley, 1987; Kurdek, 1997).

A similar process appears to occur for those with chronic physical pain. Chronic pain patients often decrease physical activity, especially activity that might increase pain in the affected somatic region (Sharp & Harvey, 2001; E. P. Simon & Folen, 2001). However, analogous to the results of dependency regulation, such inactivity means that individuals' beliefs about their pain are never tested, despite the fact that such activity may lead to no increase in pain or increased pain that is easily tolerable (Sharp & Harvey, 2001). Ultimately, decreased physical activity contributes to weakened muscle tissue and weight gain, both of which can exacerbate chronic pain (E. P. Simon & Folen, 2001). In both the cases of social and physical pain, then, an avoidant response may be functional for preventing short-term pain but dysfunctional for meeting long-term interpersonal and health goals. This sacrifice of long-term goals for short-term relief highlights the extremely aversive nature of both types of pain. More generally, the literature reviewed here suggests that both social exclusion and physical pain are related to the activation of emotional states related to cautious approach (anxiety) and avoidance (fear).

Defensive Aggression

Although fleeing physical harm often provides the best chance for an animal's survival, when escape is difficult or impossible, defensive aggression often minimizes the likelihood of injury or death. Physical pain is a primary elicitor of aggression (C. A. Anderson & Bushman, 2002; Berkowitz, 1993; Vernon, 1965) because pain frequently indicates a highly proximal threat that requires immediate action (Bowlby, 1973). Although it is unclear whether pain can directly prime aggressive tendencies or whether

this effect is mediated by cognition, what is clear is that pain frequently triggers defensive behavior that is quick and highly reactive (Berkowitz, 1993). In this way, aggression in response to pain is an important aspect of the fight response, aiding in rapid response to threats to safety. However, research with both animals and humans suggests that this highly defensive stance can lead to aggression against others who are not related to the cause of the pain (Berkowitz, 1993; Ulrich, Hutchinson, & Azrin, 1965). For example, fighting can be induced in rats by delivering electric footshock (e.g., O'Kelly & Steckle, 1939).

Social exclusion has also been shown to cause aggression (Buckley, Winkel, & Leary, 2003; Leary & Springer, 2001; Twenge, Baumeister, Tice, & Stucke, 2001; Vangelisti, 2001; Vangelisti & Crumley, 1998). Researchers who study aggression have long capitalized on the link between socially aversive, hurtful stimuli and aggression by using insults, criticism, slights, and other stimuli that connote exclusion to make participants angry (Berkowitz, 1993; Bushman, Baumeister, & Phillips, 2001; Donnerstein, Donnerstein, & Evans, 1975; Harmon-Jones & Sigelman, 2001; Scheier, 1976). In a series of studies, participants who were randomly assigned to receive feedback that they had been excluded by other participants or that they would have a lonely future exhibited higher levels of aggression such as administering unpleasant noise blasts to others than did those who did not receive exclusion feedback (Twenge et al., 2001). This was true even when the victim of aggression was not involved in the rejection episode in any way. This research suggests that, like physical pain, hurt feelings sometimes lead to aggression that is not limited to the source of threat. Although this pattern may seem interpersonally maladaptive (would not rejected individuals wish to foster relationships with other people rather than alienate them through aggression?), it parallels the findings regarding pain-elicited aggression. Overall, both physical and social pain appear to induce a general defensive stance that can lead to defensive aggression.

Depression

Both physical pain and hurt feelings are related to higher levels of sadness and depression (Fine & Olson, 1997; Leary et al., 2001). Physical pain and depression overlap significantly. According to a literature review of studies on the subject (Fishbain, Cutler, Rosomoff, & Rosomoff, 1997), higher levels of depression are related to a higher likelihood of experiencing pain, higher pain severity, and more frequent pain. In fact, responses to chronic pain and depression appear so similar that they are often confused by medical professionals (Weisberg, & Keefe, 1999; Seville & Robinson, 2000; Turk & Flor, 1999). Social pain is also often associated with sadness and depression (Allen & Badcock, 2003; Leary et al., 2001). For example, widows and widowers evidence rates of clinical depression twice that of base rates even 24 to 30 months after their partner has passed (Fraley & Shaver, 1999). Allen and Badcock (2003) argued that depression is a mechanism that decreases social risk when the likelihood of exclusion is perceived as high. These authors presented evidence from a review of the literature indicating that depression is associated with increased sensitivity to social threat, the instigation of support-eliciting behaviors, and a decrease in potentially risky social behaviors. Research on romantic relationship dissolution suggests that romantic rejection-related depression occurs mainly when individuals have been rejected by their partners but not when these individuals initiate the breakup themselves (Ayduk, Downey, & Kim, 2001). Thus, hurt feelings and depression appear related only as a result of *unwanted* separation. This point is important, given that emotional reactions to physical pain are different from the sensory experience of pain and depend heavily on the meaning or importance given to the painful stimulus (K. D. Craig, 1999; Engel, 1959). That is, emotional reactions to physical pain depend heavily on the implications of the injury. Although injury is typically associated with negative emotion, some injuries (e.g., a battlefield wound that earns a soldier the right to go home) may result in positive emotion. Analogously, then, social pain may only be emotionally distressing to the extent that the social bond being threatened is considered valuable. In MacDonald et al.'s (in press) research involving chronic pain patients and community members, both hurt feelings proneness and physical pain were significantly related to depression. As with anxiety, the relation between hurt feelings and depression was partially mediated by reports of physical pain. Again, it appears that one mechanism by which hurt feelings may influence depression is by leading to increased feelings of pain.

This review suggests that both physical and social pain can induce depression, depressed people have a lower threshold for experiencing both physical and social pain, and physical pain partially mediates the link between hurt feelings and depression. Overall, depression appears to be intimately related to physical and social pain, and it may be a mechanism to increase cautiousness or to downregulate behavior to reduce the risk of further injury or exclusion (Allen & Badcock, 2003).

Summary

Overall, social and physical pain correlate similarly with a number of important variables. Both types of pain are related to extraversion and perceptions of social support, providing evidence that social inclusion has a strong relation to sensitivity to physical pain. Further, both types of pain are related to emotional reactions indicative of increased caution and defensiveness such as anxiety and depression, suggesting that both exclusion and injury are related to general threat-defense mechanisms. These emotional reactions are consistent with Chapman's (1991) depiction of the emotional response of chronic pain patients to their malady, which he described as "an adaptation to loss" (p. 411). This characterization suggests that emotional reactions to both physical and social pain represent a kind of reorganization in response to the loss of vitally important personal assets—physical and social integrity, respectively.

There also appears to be ample evidence of overlap between the two types of pain: Extraverts are less sensitive to physical pain, and physical pain increases introversion, social anxiety, and avoidance of social situations (Phillips & Gatchel, 2000; Sharp & Harvey, 2001); people with low social support are more prone to physical pain (Phillips & Gatchel, 2000); research participants randomly assigned to receive social support experienced less experimental pain (Brown et al., 2003); fears of abandonment increase the distress of physical pain (Mikulincer & Florian, 1998); those more prone to hurt feelings find presentations of physically painful situations more aversive (MacDonald et al., in press); and physical harm is used in retaliation for rejection (Buckley et al., 2003; Twenge et al., 2001). Furthermore, the relation between hurt feelings and both anxiety and depression has been shown to be

partially mediated by reports of physical pain (MacDonald et al., in press). These findings support the notion that both social and physical pain are managed by similar psychological and physiological systems in humans.

Shared Physiological Mechanisms of Social and Physical Pain

On the face of it, the notion that reactions to physical harm and social rejection are mediated by a similar physiological system may seem odd because these two types of threats are typically encountered through different sensory modalities. That is, whereas physical pain is most frequently registered via direct touch, stimuli that create social pain typically come in the form of sights or sounds, often through stimuli with purely symbolic meaning (i.e., words, gestures, facial expressions). In this way, the two types of pain can seem quite different. At what point, then, do these different types of signals come to be processed and experienced in similar ways?

Panksepp (1998) has suggested that the physiology of the attachment system may be composed of two separate components: one component devoted to regulating reactions to social absence (what we call *social pain*), the other to regulating the pursuit of social engagement. As discussed, Panksepp proposed that this attachment system has been built up from older physiological systems including those that function to regulate basic needs such as energy balance, thermoregulation, place attachments, and pain perception. Indeed, there is reasonable evidence to suggest that an absence-regulation system is a part of mammalian physiology (Mason & Mendoza, 1998; Panksepp, 1998). In this section, we present evidence for physiological mechanisms that underlie the aversiveness and threat response aspects of both social and physical pain.

Anterior Cingulate Cortex (ACC)

The most direct evidence for the social pain hypothesis comes from work involving the ACC. The ACC has been well established as an important site for processing physical pain signals (Rainville, 2002). Specifically, pain affect, but not pain intensity (i.e., sensation), appears to be associated with activation in the ACC (Rainville, Carrier, Hofbauer, Bushnell, & Duncan, 1999; Rainville, Duncan, Price, Carrier, & Bushnell, 1997; Singer et al., 2004; Tölle et al., 1999). For example, Rainville et al. (1997) manipulated the unpleasantness of a painful sensation through hypnotic suggestion. Positron emission tomography (PET) revealed that activation in the ACC was associated with changes in perceived unpleasantness, but activity in other brain areas related to pain perception (i.e., primary and secondary somatosensory cortices and rostral insula) did not covary with unpleasantness ratings. Such data suggest that the ACC is involved in the processing of pain affect, although the correlational nature of PET data leaves open the question of whether pain affect is caused by ACC activation.

A functional magnetic resonance imaging study of participants experiencing social exclusion has shown the ACC to be active in response to social exclusion (Eisenberger, Lieberman, & Williams, 2003). In this study, participants were told they would be participating in an online ball-tossing game with 2 other participants. However, the other players were actually controlled by a computerized schedule. Participants were scanned first while watching others play the game (implicit exclusion), again while being included in a game (inclusion), and finally while being excluded by 2 other players who did not throw the ball to the participant (explicit exclusion). Heightened activity in the dorsal ACC was found when participants were either implicitly or explicitly excluded, relative to the inclusion condition. These researchers also found increased activation in the right ventral prefrontal cortex, a site associated with negative affect regulation, during explicit (though not implicit) exclusion. Eisenberger et al. (2003) described these reactions to social exclusion as "a pattern of activations very similar to those found in studies of physical pain" (p. 291). Like the PET data, the functional magnetic resonance imaging data are unable to shed light on whether ACC activation causes the experience of social pain. However, given the activation of the ACC in relation to the affective component of physical pain, this does provide evidence that reactions to both social and physical pain are related to similar neurologic components. Moreover, this evidence suggests that the ACC is a viable candidate to be involved particularly in processing the aversiveness of social pain.

The Periaqueductal Gray (PAG)

The PAG receives input from the body's injury detection mechanism, the nociceptive system (A. D. Craig & Dostrovsky, 1999), as well as from the ACC (An, Bandler, Öngür, & Price, 1998; Floyd, Price, Ferry, Keay, & Bandler, 2000), and has been shown to be active in connection with physical pain. For example, it has been linked to analgesia, as it is part of a circuit that controls nociceptive neurons in the dorsal horn of the spinal cord, with stimulation of the PAG inhibiting pain transmission by the dorsal horn via the release of endogenous opioids (Fields, 2000). Research with rat pups has shown that isolation from a dam and littermates can trigger such analgesia (Kehoe & Blass, 1986b; Spear et al., 1985). This effect appears to be mediated by the PAG. In one study, lesions to the lateral or ventrolateral PAG in rat pups were shown to disrupt the decreased pain sensitivity following social isolation that was demonstrated by pups assigned to a sham (or "placebo") lesion condition (Wiedenmayer, Goodwin, & Barr, 2000).

The PAG has also been shown to be related to bonding behavior. First, evidence suggests that the PAG is involved in regulating maternal behavior in rats such as kyphosis (optimal nursing posture), retrieval and transport of pups to the nest, and defense of the pups against outsiders (Lonstein, Simmons, & Stern, 1998; Miranda-Paiva, Ribeiro-Barbosa, Canteras, & Felicio, 2003; Stack, Balakrishnan, Numan, & Numan, 2002). For example, lesions to the caudal intercollicular PAG have been shown to disrupt the nursing posture of rat pup mothers, resulting in 10% less weight gain for the pups of lesioned as opposed to unlesioned dams (Lonstein et al., 1998). Second, the PAG has been shown to be involved in infant proximity-seeking behavior. During the first 2.5 weeks of life, rats have been shown to emit ultrasonic vocalizations when separated from their dam and littermates that can be reduced by reintroducing an anesthetized dam or littermate (Carden & Hofer, 1990a; Hofer & Shair, 1978; Kehoe & Blass, 1986b). These "separation distress" cries appear to serve the function of assisting in the reunification of a separated infant with its mother. Direct stimulation of the PAG can elicit these separation distress cries (Panksepp, 1998), and lesions to the PAG appear to decrease

such cries (Wiedenmayer et al., 2000). In fact, Panksepp (1998), on the basis of the physical proximity of PAG areas that can be stimulated to produce distress vocalizations and physical pain responses, suggested that separation distress emerged anatomically from more basic pain systems. He concluded that "this affirms that separation distress is related to perceptions of [physical] pain" (Panksepp, 1998, p. 267).

In general, the PAG is considered an important site for the integration of homeostatic control and limbic motor output in response to threats (Fanselow, 1991; Gray & McNaughton, 2000; Lonstein & Stern, 1998). Gray and McNaughton (2000) argued specifically that the PAG serves as the coordinator of the panic response and is thus at the base of the hierarchically organized neuroanatomical threat-defense system. That is, it is the structure at the lowest level of the defense system capable of coordinating a variety of physiological changes and behaviors to produce a relatively organized reaction to potential harm. Indeed, activation of the lateral PAG in nonhuman mammals (e.g., through injection of excitatory amino acids) leads to key aspects of the panic response, including defensive behavior, hypertension, tachycardia, and nonopioid analgesia (Bandler & Shipley, 1994). In particular, stimulation of the caudal lateral PAG appears to lead to preparation for flight through physiological mechanisms such as increased blood flow to the limbs and decreased blood flow to the face. Stimulation of the intermediate lateral PAG appears to lead to preparation for confrontational defense, through mechanisms such as decreased blood flow to the limbs and increased blood flow to the face (suggesting a possible link with blushing). Further, stimulation of the ventrolateral PAG appears to lead to reactions with similarities to responses to social defeat and depression, including quiescence and hyporeactivity (Bandler & Shipley, 1994). Overall, the PAG appears responsive to both separation cues and physical pain in nonhuman animals and appears to contribute to coordinated responses to both. In particular, these responses seem to be quick, reactive impulses such as defense, escape, and downregulation regardless of whether the initial input was social or physical in nature. Thus, at least for nonhuman animals, both social exclusion and physical pain appear intimately related to the most base level of the threat-defense system. This supports the notion that social exclusion is processed as a primal threat for animals who rely on interdependent relationships with conspecifics. Functionally, the PAG appears to provide at least one mechanism by which signals of social exclusion may facilitate quick action in response to inclusion threats.

Opioids

Another point of overlap between social and physical pain is the opioid neuroendocrine system (Panksepp, 1998; Taylor, Dickerson, & Klein, 2002). Endogenous opioids have long been recognized as an important regulator of physical pain, with exogenous forms such as morphine used to treat pain complaints (Panksepp, 1998; Smith, Stevens, & Caldwell, 1999). Research with both rats and mice suggests that opioids play an important role in isolation-induced analgesia (Kehoe & Blass, 1986a, 1986b; Konecka & Sroczynska, 1990; Naranjo & Fuentes, 1985; Spear et al., 1985). For example, Kehoe and Blass (1986b) measured the response latencies of 10-day-old rat pups when a paw was placed on a heated metal surface either immediately after isolation from the nest or 5 min after removal. Relative to pups tested immediately after removal from the nest, those removed for 5 min evidenced longer response latencies, indicating that separation prompted an analgesic response. Further, response latencies were reduced to baseline for pups treated with naltrexone (an opioid blocker) and exaggerated for pups treated with morphine, supporting the notion that opioids mediate the isolation–analgesia relation.

There is also strong evidence from animal research that opioids are involved in signaling the adequacy of social conditions. Low doses of morphine have been shown to reduce the separation distress cries of isolated rat pups (Carden, Hernandez, & Hofer, 1996; Carden & Hofer, 1990b; Kehoe & Blass, 1986b; Kehoe & Boylan, 1994; but see Winslow & Insel, 1991a). Similar results have been reported with other vertebrates including primates (Kalin, Shelton, & Barksdale, 1988), dogs (Panksepp, Herman, Conner, Bishop, & Scott, 1978), guinea pigs (Herman & Panksepp, 1978), and birds (Panksepp, Vilberg, Bean, Coy, & Kastin, 1978). Further, reductions in crying of isolated rat pups as a result of the introduction of a dam or littermate can be reversed by administration of opioid antagonists such as naltrexone (Carden et al., 1996; Carden & Hofer 1990a, 1990b), suggesting that drops in opioid levels may signal an unsatisfactory social environment. In particular, μ-opioid receptors (responsive to endorphins) and, to a lesser extent, δ-opioid receptors (responsive to enkephalins), both of which are powerfully related to reductions in pain, also appear to be generally effective in reducing separation distress vocalizations (Carden, Barr, & Hofer, 1991; Carden et al., 1996; Kehoe & Boylan, 1994; Panksepp, 1998). Administration of morphine has also been shown to reduce the pursuit of social interaction in primates (Keverne, Martensz, & Tuite, 1989; Martel, Nevison, Simpson, & Keverne, 1995), guinea pigs (Herman & Panksepp, 1978), and rats (Panksepp, Najam, & Soares, 1980). For example, young rhesus monkeys treated with naloxone (another opioid blocker) pursued more contact with their mothers, and mature naloxone-treated monkeys solicited and received more grooming from conspecifics (Martel et al., 1995). This again suggests that opioids may comprise one way the body regulates response to social distress, with low levels of opioids signaling an unsatisfactory social environment and motivating the pursuit of social interaction. It is important to note that such a withdrawal of opioid activity from μ- and δ-opioid receptors can create an aversive, painful state as in the case of withdrawal from opiate addiction (e.g., heroin addiction; Panksepp, 1998). Thus, another potential mechanism for the aversiveness of social pain is the reduction of opioid activity experienced during rejection, separation, or loss.

Oxytocin

The neuropeptide oxytocin provides a further link between social and physical pain. Oxytocin is perhaps most widely known for its roles in lactation and parent–child bonding. For example, administration of oxytocin has been shown to induce maternal behavior (e.g., following and cleaning young) in virgin rats (Pedersen, Ascher, Monroe, & Prange, 1982) and sheep (Kendrick, Keverne, & Baldwin, 1987). This peptide has also been shown to reduce distress vocalizations in rat pups isolated from their dam and littermates (Insel & Winslow, 1991). Oxytocin has also been tied to a wider range of social behaviors. One avenue of investigation has involved comparing two closely related species, the prairie vole and the montane vole. These two species are highly similar, except for their social behavior. The prairie vole tends to

be monogamous and affiliative and cares for its young, whereas the montane vole tends to be highly solitary (Carter, DeVries, & Getz, 1995). This difference has been partially attributed to the different distribution of oxytocin receptor sites in the brains of the two types of voles (Insel & Shapiro, 1992). In addition, administration of oxytocin has been shown to facilitate social contact and selective preference of mates in prairie voles, with oxytocin antagonists blocking such partner preferences (Cho, DeVries, Williams, & Carter, 1999; Insel & Hulihan, 1995; Witt, Carter, & Walton, 1990). For example, Cho et al. (1999) treated prairie voles with either oxytocin (1, 10, or 100 ng) or a placebo, then placed them with an opposite sex conspecific for 1 hr. Following this, the experimental voles were placed in a cage permitting access to either the familiar or an unfamiliar conspecific. Those treated with higher levels of oxytocin (100 ng) were significantly more likely to place themselves in contact with the familiar vole, suggesting that oxytocin positively reinforced time spent with a partner, thus promoting a partner preference. Oxytocin administration has also been shown to facilitate social behavior in rats (Witt, Winslow, & Insel, 1992) and squirrel monkeys (Winslow & Insel, 1991b), and gentle stroking has been shown to lead to the release of oxytocin in rats (Stock & Uvnäs-Moberg, 1988).

Uvnäs-Moberg and colleagues have argued that oxytocin also functions to regulate physical pain. In a series of studies conducted with rats, administration of oxytocin was shown to reduce sensitivity to pain (Ågren, Lundeberg, Uvnäs-Moberg, & Sato, 1995; Lundeberg, Meister, Björkstrand, & Uvnäs-Moberg, 1993; Lundeberg, Uvnäs-Moberg, Ågren, & Bruzelius, 1994; Uvnäs-Moberg, Bruzelius, Alster, Bileviciute, & Lundeberg, 1992), whereas oxytocin antagonists, but not opioid antagonists, were shown to block this analgesic effect (Ågren et al., 1995; Lundeberg et al., 1994; Uvnäs-Moberg, Bruzelius, Alster, & Lundeberg, 1993; Uvnäs-Moberg et al., 1992). For example, Ågren et al. (1995) demonstrated that rats treated with oxytocin showed slower response latencies to thermal stimuli up to 90 min posttreatment, whereas rats treated with saline returned to baseline responses at 15 min. Rats treated with oxytocin antagonists demonstrated faster than baseline response latencies 45 and 75 min posttreatment. Thus, oxytocin appeared to promote analgesia, while hyperalgesia was demonstrated in rats whose oxytocin receptors had been blocked. Furthermore, oxitonergic neurons project from the paraventricular nucleus of the hypothalamus to a number of pain-related brain sites including the PAG and the dorsal horn of the spinal cord (Sawchenko & Swanson, 1982), suggesting a possible role for oxytocin in the regulation of pain. However, there is controversy over this conclusion, as not all researchers agree that oxytocin has true analgesic properties (e.g., Xu & Wiesenfeld-Hallin, 1994).

Summary

Overall, strong evidence for a physiological connection between responses to physical pain and social exclusion has been found across a variety of physiological markers. Our analysis suggests that the ACC, the PAG, opioids, and oxytocin may all underlie both physical pain and social behavior regulation. However, some caution must be taken in evaluating the applicability of the physiological evidence to human social behavior. Specifically, only the evidence relating to the ACC is derived from studies with human participants. Thus, the extent to which the PAG, opioids, and oxytocin are involved in human social pain is an open question. Social pain theory argues that physiological social pain mechanisms should be shared across a wide variety of social animals, as such mechanisms should date back to the early days of social speciation. However, there are also crucial differences between humans and other mammals. For example, more sophisticated processing ability in humans relative to other mammals allows for self-awareness and projection of the self into the future (Leary & Buttermore, 2003; Suddendorf, 1999). Thus, social exclusion can have implications for humans, not just in terms of their current social status, but also for beliefs about acceptability to others in the future. This may well influence how social pain is processed by humans. Further, although the nonhuman animal data are useful for investigating behavioral reactions to separation and injury, they are incapable of speaking to the phenomenological experience of pain in response to exclusion. Finally, much of the nonhuman animal research focuses on infants (e.g., rat pups), while social pain theory is concerned with regulation of social behavior across the life span. Nevertheless, the scant research on physiological reactions to rejection in humans conducted thus far appears consistent with the nonhuman animal data. Specifically, rejection has been shown to lead to ACC activation (Eisenberger et al., 2003), increased blood pressure and cortisol (Stroud, Tanofsky-Kraff, Wilfley, & Salovey, 2000), and analgesia for individuals prone to hurt feelings (MacDonald et al., in press). Clearly, significant work remains to be done to clarify physiological responses to social exclusion in humans. Nevertheless, future research examining whether such responses are mediated by the mechanisms listed in this review, and/or other mechanisms, seems warranted.

Implications of Social Pain Theory for Aggressive Behavior

> It is the denial of our intrinsic biological and psychological need for the "other" that may partly explain the length of time that it has taken to begin to understand the origins of human violence. (de Zulueta, 1996, p. 176)

In this section, we strive to demonstrate one important implication of conceptualizing social exclusion in terms of pain. Specifically, we propose that if exclusion is perceived as a serious, primal threat, then it should motivate an individual to adopt a highly defensive stance. Further, because the role of the panic response is to provide quick action in the face of any imminent threat, we propose that social pain should lead to a preparedness to defend against not just social, but physical threats as well. In line with the notion of fight/flight/freezing, such a stance should include a preparedness to escape and a preparedness to aggress. In fact, research has shown that excluded individuals exhibit many features of the panic response, including aggressiveness (Buckley et al., 2003; Twenge et al., 2001), analgesia (MacDonald et al., in press), high blood pressure and plasma cortisol concentrations (Stroud et al., 2000), and disruptions in higher order cognitive processing without accompanying disruptions in more automatic mental tasks (Baumeister, Twenge, & Nuss, 2002). These findings suggest that exclusion taps into relatively basic systems that are oriented toward response to generalized threat, rather than social threat in particular. The review that follows aims to demonstrate that both social and physical pain can prime aggressive action tendencies and that both types of pain-elicited aggression are moderated by perceptions of defensive distance. Overall, the goal

of this section is to provide a more comprehensive understanding of exclusion-elicited aggression by noting its similarities with defensive aggression provoked by physical pain.

Few people would be surprised to learn that those whose feelings are hurt often desire to inflict hurt in return (Leary & Springer, 2001). Research has confirmed this intuition; as discussed earlier, rejection often elicits aggressive behavior (Buckley et al., 2003; Twenge et al., 2001). In some instances, more forceful forms of behavior (i.e., assertiveness) in response to hurt feelings can be useful because actively confronting sources of hurt can help to resolve troubling relational issues (Fine & Olson, 1997; Vangelisti & Crumley, 1998). However, aggression, especially physical aggression, in response to hurt may be destructive and counterproductive by ultimately adding to the person's interpersonal problems and creating more, rather than less, social pain (Buckley et al., 2003; Twenge et al., 2001). Specifically, given that hurt feelings arise when people feel less relationally valued than they desire (Leary & Springer, 2001; Leary et al., 1998), aggression seems like an odd response. A person who feels devalued is unlikely to increase others' acceptance by insulting, abusing, or attacking them.[2] From an early age, children who aggress are rejected (Cantrell & Prinz, 1985; Dodge & Coie, 1987; McDougall, Hymel, Vaillancourt, & Mercer, 2001), suggesting that it is unlikely that rejected aggressors expect to win interpersonal acceptance from their victims. Furthermore, even if the experience of hurt feelings reduces individuals' desires to be accepted by the source of the hurt (Bourgeois & Leary, 2001; Leary et al., 1995), aggression still does not seem like an appropriate response. If you have given up on being accepted by someone, why not just walk away rather than risk the social, physical, and legal consequences of a verbal or physical attack?

We suggest that hurt feelings may contribute to aggressive behavior on the basis of our proposals that social pain can activate the generalized threat-defense system and that when ongoing rejection or high degrees of relational devaluation are perceived (i.e., when defensive distance is low), reactions are motivated by panic response mechanisms. Specifically, aggressive responses to rejection mimic behavior under conditions of physical pain. A great deal of research has demonstrated that physical pain reliably elicits aggression in both human beings and other animals (Berkowitz, 1989; Scott, 1966; Ulrich et al., 1965). When pain results from physical attack, a quick counterattack is often very effective in stopping the threat (Öhman & Mineka, 2001). In fact, some researchers have suggested that painful stimuli may automatically prime action tendencies associated with pain such as aggressive responding (C. A. Anderson & Bushman, 2002; Berkowitz, 1989; da Gloria, Pahlavan, Duda, & Bonnet, 1994). For example, Izard (1991) showed that 90% of infants aged 2 to 7 months displayed an angry facial expression after a painful inoculation. Indeed, pain signals have been shown to reach reflexive motor circuits before the pain is realized consciously (Panksepp, 1998), suggesting that pain-induced aggression may be difficult to control. Thus, to the extent that social exclusion taps into panic mechanisms, such exclusion may also prime a preparedness to aggress. The difficulty, however, is that such quick, aggressive reactions are likely to be much less functional in warding off social as opposed to physical threats. For example, hurt feelings from a lover's insult may lead to a quick counterattack, such as a shout, shove, or punch, triggered by a sense of threat. However, because the attacker in this instance likely has an interest in keeping the person who hurt his or her feelings proximal (as in the case of romantic couples or good friends), aggressive responses to social pain are likely to be interpersonally dysfunctional in the long run.[3]

Although it may be difficult to conceive of social exclusion eliciting automatic reactions such as aggression, there is one common automatic response to both exclusion and physical pain already known—crying (D. C. Craig et al., 2000; Vingerhoets, Cornelius, Van Heck, & Becht, 2000; Vangelisti & Crumley, 1998). Although crying can be controlled, or at least delayed (Leary et al., 1998), the urge to cry is often involuntary. As a result of its involuntary nature, crying is an expression that may elicit support from empathic onlookers without the individual needing to approach anyone or explicitly seek support (Gross, Fredrickson, & Levenson, 1994). This elicitation of support is obviously beneficial in the case of both physical injury and social loss.[4] Furthermore, its automatic nature is important given that people who are hurt may not approach others readily because their pain encourages them to take a defensive stance. We suggest, then, that aggression may be a relatively automatic response to both social exclusion and physical pain in much the same way as is crying.

Of course, social exclusion does not always result in aggressive behavior. An important question, then, is when social pain is most likely to trigger an aggressive response. In general, we expect that aggression would be especially likely when defensive distance from exclusion is low. Thus, aggression in response to social pain should be more likely when higher degrees of rejection or relational devaluation are perceived. However, as with physical pain, there are a number of cognitive moderators that can impact on

[2] Perhaps the saddest and clearest example of this paradox comes from the recent trend of school and work shootings that appear to be largely motivated by perceived rejection (Leary, Kowalski, Smith, & Phillips, 2003).

[3] This speculation on relatively automatic aggressive reactions to social pain is consistent with Twenge and her colleagues' studies that showed that self-reports of negative emotion did not mediate the rejection–aggression link (Twenge et al., 2001). If it is true that conscious negative feelings are not the proximal cause of rejection-elicited aggression, then automatically primed aggressive tendencies in response to social pain may be key. However, the Twenge et al. (2001) work is peculiar in that excluded individuals did not report more negative emotion than individuals who were not excluded (see also Twenge, Catanese, & Baumeister, 2003), despite the fact that exclusion has often been shown to evoke negative affective reactions (Baumeister & Tice, 1990; Leary et al., 2001). Thus, Twenge et al.'s (2001, 2003) failure to find mediation may reflect a more general difficulty with capturing self-reported negative affective reactions to exclusion in their studies. This issue is complicated by the finding that individuals high in proneness to hurt feelings may experience analgesia, or numbing, in response to rejection (MacDonald et al., in press; Twenge et al., 2003), suggesting negative affect may be blunted for some individuals. Overall, we consider there to be too little data currently to resolve the question of whether negative affect mediates the rejection–aggression link, but pursuit of this question should help shed light on the possible existence of automatic, aggressive reactions to social pain.

[4] The fact that crying also occurs in response to joyful feelings may be considered to weaken this argument. However, we suggest that crying may be a signal for the elicitation of closeness from others associated with both negative and positive affective states. Indeed, happy individuals desire closeness from others as a means of maintaining or enhancing positive affect, and closeness associated with joyful times may be a mechanism for cementing interpersonal bonds.

perceptions of defensive distance from exclusion. In this section, we explore these factors by reviewing commonalities between conditions that lead to physical pain-elicited aggression and social pain-elicited aggression. That is, we searched the literature to determine factors that make aggression especially likely as a result of physical pain and then looked for analogues in the realm of social pain. In particular, we draw heavily on the domestic violence literature to help elucidate our ideas regarding social pain and aggression.

Partner abuse is an important topic in the consideration of a hurt–aggression link for two reasons. First, it is well known that hurt feelings can lead to violence (Leary & Springer, 2001), and the highly interdependent nature of close relationships provides a fertile breeding ground for such hurt (Levitt, Silver, & Franco, 1996; Vangelisti & Maguire, 2002). Indeed, there is a wide range of evidence suggesting that partner abuse may largely stem from abusers' perceptions or fears of rejection. Literature reviews indicate that abusers report higher fears of rejection and abandonment (Dutton, 2002; Holtzworth-Munroe, Bates, Smutzler, & Sandin, 1997), attribute more negative intentions to their partners (Eckhardt & Dye, 2000; Holtzworth-Munroe, Bates, et al., 1997), experience more jealousy and less secure attachment (Dutton, 2002; Holtzworth-Munroe, Smutzler, & Bates, 1997; Schumacher, Smith Slep, & Heyman, 2001), have their demandingness met with withdrawal or ostracism (Holtzworth-Munroe, Smutzler, & Bates, 1997; Schumacher et al., 2001), report higher levels of depression and anxiety (Gleason, 1997; Holtzworth-Munroe, Smutzler, & Bates, 1997; Schumacher et al., 2001), and are more likely to have been rejected by their parents (Schumacher et al., 2001). Further, those individuals who kill their spouses usually do so during periods of perceived or actual abandonment (Dutton, 2002).

Second, aggression in relationships is depressingly common, with estimates of the incidence of violence in relationships ranging from 12% to 57% (Arriaga & Oskamp, 1998). Figures this high suggest that such violence is too common to attribute its cause simply to some "abnormality" in abusers. Thus, understanding family violence is an important research goal in its own right. In fact, one would hope that if people could restrain aggressive impulses against any target, it would be their relationship partners, but too often this is not the case. Instead, family violence appears to be a poignant example of an area in which aggressive responses to rejection not only create tremendous trauma for the victim of aggression but also make further rejection of the aggressor more likely.

Because of the extensive literature on family violence, we were able to examine parallels between such violence and aggression resulting from physical pain in some detail. This review highlights the fact that both social pain-elicited aggression and physical pain-elicited aggression appear to stem from difficult-to-control impulses that arise quickly, possibly automatically, from painful feelings. We suggest that the relatively rapid activation of social pain-elicited aggression is a result of the strong sense of threat that social pain evokes. That is, evolution has equated exclusion with extinction, meaning rejection may be treated as a mortal danger at the motivational level. This high level of perceived threat should lead individuals to adopt a protective posture, bypassing complex cognitive processing in favor of efficient, defensive behavior. We note further that both types of aggression are moderated by a strikingly similar constellation of cognitive moderators. In general, we suggest that factors that decrease perceptions of defensive distance (from injury or exclusion) increase the risk of aggression.

Situation Appraisal and Reappraisal

According to C. A. Anderson and Bushman's (2002) general aggression model, aggressive behavior can be based either on a relatively automatic appraisal of whether the situation calls for aggression or on a more deliberate reappraisal of one's initial action tendency. Appraisal of a stressful situation, such as the experience of pain, changes according to an individual's perceptions of the consequences of the experience, the extent to which one's well-being is threatened, and the resources available for coping with the threat (Weisenberg, 1999). As discussed earlier, we propose that social exclusion can lead to aggression because such exclusion is processed at a basic level as a primal threat to one's well-being. For example, K. D. Williams, Case, and Govan (in press) demonstrated that participants who were ostracized during an online ball-toss game evidenced higher levels of implicit racial prejudice, as measured by a reaction time task, than those who were not ostracized (self-reports of prejudice were not affected). This suggests that exclusion may prime an automatic defensive stance against perceived threat, even if such defensiveness is not recognized consciously. Thus, social exclusion may lead to an initial situation appraisal that indicates a high degree of threat, possibly priming an aggressive response.

C. A. Anderson and Bushman (2002) argued that a reappraisal of such a situation will occur only if two conditions are met: (a) there are sufficient cognitive resources to permit reappraisal and (b) the outcome of the initial appraisal is both important and unsatisfying. Both social and physical pain may place pressure on reappraisal efforts because a strong perception of threat can shift an individual into a more defensive, reactive mode. Such a reactive stance is likely to augment the importance of automatic as opposed to controlled processing, limiting the cognitive resources available for reappraisal. Literature reviews suggest that physical pain disrupts cognitive functioning, particularly decreasing attentional capacity and processing speed (Eccleston & Crombez, 1999; Hart, Martelli, & Zasler, 2000). Response to social exclusion appears to have a similar effect. Baumeister et al. (2002) randomly assigned participants to receive feedback that they would have a lonely future or that they would have an accident-prone future. Participants told they would be lonely scored lower on IQ and Graduate Record Examination tests, but did not differ from control participants on more automatic tasks such as memory recall. These results suggest that threats to social inclusion interfere with higher order cognitive functioning, possibly indicating a bias toward more automatic processing under these circumstances. Thus, one response to social or physical pain appears to be a heavier reliance on more automatic cognitive processing, suggesting that both types of pain are treated as highly threatening, requiring a quick response.

Given the possibility that defensive aggression may be an automatic response to social exclusion, such a decrease in higher cognitive functioning means that exclusion should be especially likely to lead to aggression when further burdens are placed on processing capacity. Research on relationship aggression backs up this notion. Higher risk of abuse has been connected with a number of variables related to deficits in cognitive capacity and impulse control such as alcohol consumption (Gleason, 1997; Leonard &

Senchak, 1996; MacDonald, Zanna, & Holmes, 2000) and head injury (Holtzworth-Munroe, Bates, et al., 1997). Further, male abusers asked to imagine themselves in scenarios in which they are rejected by their wives react with more irrational ideas than nonabusers (Eckhardt & Dye, 2000; Schumacher et al., 2001). That is, abusers in this research exhibited a less sophisticated cognitive response to rejection than nonabusers, suggesting they may be less able to control aggressive action tendencies spurred by exclusion.

Attributions

If sufficient cognitive resources are available for more complex processing, attributing causality for physical pain to a specific source can either reduce or exacerbate aggressiveness (Berkowitz, 1993). Specifically, attributions that decrease defensive distance (i.e., increase perception of threat) should more strongly prime aggressive impulses. For example, if an individual determines that a coworker spilled hot coffee on him or her intentionally instead of accidentally, an aggressive response is more likely. In this case, the incident signals a greater threat of future harm than if the act was accidental and thus warrants a more hostile response. Reviews of the partner abuse literature suggest that attributions of causality also play an important role in partner abuse, as abusers tend to attribute more hostile intentions and traits to their partners (Eckhardt & Dye, 2000; Holtzworth-Munroe, Bates, et al., 1997). Thus, abusers may be aggressive, in part, because their negative attributions indicate to them a higher degree of rejection and an increased likelihood of future pain.

Control

Another important factor in both physical and social pain is control. Literature reviews suggest that perceiving that one has control over physical pain, particularly that one can terminate the painful stimulus, is related to a lower subjective experience of pain and increased pain tolerance (Arntz & Schmidt, 1989; Seville & Robinson, 2000). Thus, perceptions of control appear to decrease aggressiveness by increasing defensive distance from threat. Feelings of lost control over painful stimuli may be especially painful. In one study (Staub, Tursky, & Schwartz, 1971), some participants were given control over the administration of an initial regimen of electric shocks they were to receive, then lost that control during a second regimen. The other participants in the study were not given control during either the first or second set of shocks but were yoked to the "in-control" participants such that they received shocks of the same intensity and temporal sequence. Relative to those who never had control, those who lost control were quicker to report discomfort as shock intensity increased and ended the shock regimen after a smaller number of shocks.

Given the relationship between control and perceived pain, a potentially useful way of explaining pain-induced aggression is as a behavioral tendency that can be helpful in increasing control over a potentially threatening stimulus. In the case of physical pain, achieving such control may be relatively straightforward. However, by definition, a source of social pain is some social entity. Thus, exerting control over the source of hurt feelings or other social pain may mean attempting to control another person. Aggression is certainly one way to exert such power and control (Tedeschi & Felson, 1994), and reviews of the literature suggest that relationship aggressors tend to demonstrate higher needs for power and control (Dutton, 2002; Jackson, 1999; Schumacher et al., 2001). This point is especially important in light of the aforementioned meta-analysis showing that the combination of social evaluative stressors and lack of control is strongly predictive of cortisol release (Dickerson & Kemeny, 2004). As those who more strongly desire control are more likely to perceive unsatisfactory levels of control in a given situation, such individuals may be especially reactive when perceiving rejection.

The notion that relationship aggression involves attempts at control is not new. K. D. Williams et al. (in press) suggested that social exclusion can induce a need to regain control of the situation that motivates behavior to gain the attention of the excluder, whether that behavior (including aggression) is prosocial or not. Further, some arguments from the feminist tradition suggest that relationship aggression may represent men's efforts to exert the power granted them by a patriarchal society (Renfrew, 1997), although feminist scholars also point to other control motives (M. P. Johnson & Ferraro, 2000). The latter point is important, given a recent review suggesting that women are aggressive in relationships as often (though not as severely) as men (Archer, 2000). Our theory of social pain suggests that control-oriented aggression may reflect a basic motive to increase defensive distance and reduce the sense of threat signaled by social pain. In this way, our theory of social pain suggests that control-oriented aggression may not be limited to those whom society grants power. However, this is not to say that issues such as patriarchy are irrelevant to aggression. As a loss of control may be related to increased pain (Staub et al., 1971), men who believe in patriarchal structure may experience the threat of social pain especially acutely in relationships if they feel their "rightful" control is slipping.

Feeling Trapped

Aggression is more likely if individuals feel trapped in a painful situation. For example, animals generally prefer to avoid physical conflict when possible but will fight in response to physical pain when no escape is available and a threat is perceived as imminent (Blanchard & Blanchard, 1990; Gray & McNaughton, 2000; Ulrich et al., 1965). Thus, we would expect hurt feelings to be more likely to result in aggression when the hurt individual believes that significant barriers to exiting a relationship exist. Phrased differently, when hurt feelings signal a threat and the individual feels trapped in that situation, the likelihood of aggression may be higher than when the individual feels free to walk away. Like the different sources of physical and social pain, being physically trapped appears on the surface to be much different from being emotionally trapped. However, one commonality between the two is a lack of control in that escape from pain seems impossible. When physically trapped, inaction in response to threat inevitably leads to physical harm. When emotionally dependent on another, withdrawal of the other inevitably leads to social pain (Panksepp, 1998). Indeed, a review of the spousal violence literature suggests that relationship aggression is more likely when the aggressor feels dependent on the relationship (Holtzworth-Munroe, Bates, et al., 1997). Further, violence often follows increases in commitment to the relationship such as marriage (Henton, Cate, Koval, Lloyd, & Christopher, 1983; Rounsaville, 1978), times when increased dependence is highly salient. Finally, in a review of spousal homicide literature, Dutton (2002) suggested that a large percentage of

perpetrators of spousal homicide experience a catathymic crisis, or aversive emotional tension that is perceived as *inescapable* and caused by the spouse. Thus, aggression against romantic partners by individuals who are emotionally dependent on the relationship may be motivated by a desire for control similar to that demonstrated with physical pain-elicited aggression.

Hostility

Hostility, or trait anger, is an important personality variable influencing the likelihood of aggression in response to pain. Angry and aggressive thoughts and feelings can be primed by exposure to physical pain (C. A. Anderson & Bushman, 2002; Berkowitz et al., 1981), especially for those with generally hostile dispositions (K. B. Anderson, Anderson, Dill, & Deuser, 1998). Participants in a study by K. B. Anderson et al. (1998) were randomly assigned to hold their arm in either a painful or comfortable position while evaluating the similarity between pairs of words. Some of these words were explicitly related to aggression (e.g., *choke*), while others were more ambiguously related to aggression (e.g., *stick*). Participants high in hostility who were experiencing pain evaluated the ambiguous-aggressive and aggressive-aggressive word pairs as highly similar, suggesting that aggressive thoughts were highly accessible for these individuals. Reviews of the domestic violence literature suggest that trait hostility is also a strong correlate of domestic violence (Gleason, 1997; Holtzworth-Munroe, Bates, et al., 1997; Schumacher et al., 2001). Thus, people with hostile personalities appear to be under a relatively chronic state of threat, perceiving defensive distance from both injury and rejection as low. As a result, hostile individuals appear to react to both physical and social pain cues with more aggressive thoughts and behavior.

Anticipation of Pain

Expecting a stimulus to be physically painful has been associated with an increase in felt pain and more aggression in response to that pain (Berkowitz & Thome, 1987; Leventhal, Brown, Shacham, & Engquist, 1979). For example, Berkowitz and Thome (1987) instructed participants to place an arm in water, telling some to expect the water to be painful while others did not receive this information. Half of those told to expect pain placed their arm in uncomfortably cold water, whereas the other half placed their arm in more comfortable room temperature water. All participants not told to expect pain placed their arm in cold water. Participants were then asked to deliver rewards (nickels) and punishments (noise blasts) based on the performance of a "worker" (a confederate). Relative to those not expecting the cold water to be painful, those in the cold water condition who did expect pain reported the water to be more painful, unpleasant, and annoying. In addition, those expecting and experiencing pain delivered fewer rewards and more noise blasts relative to the other two groups. These data suggest that those expecting to experience pain may exhibit the confirmation bias, selectively searching for and attending to threatening pain cues (Sharp & Harvey, 2001), thus increasing their experience of pain, decreasing defensive distance, and enhancing aggressive action tendencies. Analogously, people with insecure attachment styles are highly wary of rejection from close others and thus tend to be highly sensitive to cues that may signal the potential for hurt feelings (Downey & Feldman, 1996). It is not surprising, then, that reviews of the literature indicate that insecure attachment is a common aspect of those who abuse their romantic partners (Holtzworth-Munroe, Bates, et al., 1997; Roberts & Noller, 1998; Schumacher et al., 2001). That is, those who closely attend to cues connoting the threat of social pain are likely to experience that pain more intensely, decreasing defensive distance and increasing the possibility of rejection-elicited aggression.

Summary

The literature reviewed in this section supports the usefulness of conceptualizing social pain-elicited aggression as a reaction to low perceived defensive distance from rejection. Such a relation appears analogous to physical pain-elicited aggression that stems from low perceived defensive distance from injury. Further, this review suggests that cognitive factors that influence perceptions of defensive distance including appraisals, attributions, perceived control, hostility, and pain expectancies moderate the likelihood of aggressive responses to both social and physical threats. This analysis helps to resolve the question of why aggression is a frequent response to rejection, despite the fact that such aggression appears to be nonfunctional in winning acceptance. Particularly, if rejection is indeed a primal threat, then the panic motivation spurred by low defensive distance may lead to defensive aggression that is functional in physical threat contexts but less functional in social threat contexts. Of course, some caution is warranted in accepting this conclusion. Whereas much of the physical pain-related data comes from experimental research, much of the domestic violence literature reviewed is based on correlational work. Thus, although we have drawn parallels between the two it is difficult to be certain that the results are directly comparable. Nevertheless, it is striking that results from these two very different approaches share these parallels. It is our belief that social pain theory provides a parsimonious framework through which to view the commonalities between aggression provoked by social and physical threat.

Implications of Social Pain for Chronic Pain and Pain Disorders

Our contention that social pain stems from the same emotional unpleasantness associated with physical pain implies that feelings of exclusion and relational devaluation may contribute to pain-related disorders. Indeed, clinical views of somatoform pain disorder (pain complaints that cannot be adequately explained by a known medical disorder) suggest that drawing a distinct line between physical and social pain is inaccurate and potentially harmful (Roth, 2000; G. E. Simon, 1998; Sullivan, 2000). Like other forms of physical pain, somatoform pain is strongly related to both anxiety and depression, and treatments for anxiety and depression, including cognitive–behavioral therapy and tricyclic antidepressants, help to alleviate somatoform pain (Fishbain, Cutler, Rosomoff, & Rosomoff, 1998; G. E. Simon, 1998; Sullivan, 2000).

Social pain theory may be useful in understanding aspects of somatoform pain and other pain disorders. For example, individuals who experience any type of chronic pain are prone to feelings of embarrassment resulting from conflict with others who do not understand their pain, including medical professionals (Chapman, 1991; E. P. Simon & Folen, 2001). Given that such social pain may

lead to activation of pain circuits in the ACC and right ventral prefrontal cortex (Eisenberger et al., 2003), perceived relational devaluation resulting from a pain disorder might add directly to an individual's suffering. Further, individuals who perceive rejection readily may find their body's pain management systems taxed. For example, chronic activation of analgesia in response to social threat (MacDonald et al., in press) may lead to the depletion of resources over time, leaving rejection-sensitive individuals vulnerable to increased pain. Indeed, low levels of opioids create a higher level of vulnerability to physical pain because of opioids' importance in regulating physical discomfort (Panksepp, 1998). This notion may help account for the fact that individuals with low social support are more pain sensitive (Phillips & Gatchel, 2000).

Thus, encouraging feelings of social acceptance may help to alleviate pain complaints (Brown et al., 2003). Along these lines, an important aspect of current treatment for somatoform pain is support and validation that the pain is real (G. E. Simon, 1998), and treatment for chronic pain often involves family members in the therapeutic process (Chapman, 1991). Such affirmation may help to break a cycle in which feelings of exclusion contribute to inexplicable pain, the expression of which alienates the pain sufferer from others and leads to increased exclusion that then exacerbates the pain further (Sullivan, 2000).

Research Directions

Although the evidence reviewed in this article has clearly drawn a link between social and physical pain, it has also highlighted some apparent discrepancies that require further research attention. As discussed earlier, some work suggests that social exclusion is related to decreased pain sensitivity, whereas other work suggests that social inclusion is related to decreased pain sensitivity. Clearly, future research is needed both to replicate the experimental results with human participants and to help understand the mechanisms by which perceptions of social standing can influence sensitivity to pain. One consideration that may be important for future research is the notion of framing inclusion and exclusion as separate factors rather than as opposite ends of a continuum. As discussed, the pursuit of social relationships involves both an approach and an avoidance component. Comfort with closeness in relationships is relatively weakly related to the fear of rejection (Feeney, Noller, & Hanrahan, 1994), suggesting that motivation for inclusion may be tied to the behavioral approach system whereas concerns over exclusion may be tied to the avoidance (defense) system. Given that analgesia can be achieved through a variety of mechanisms (Panksepp, 1998), it is possible that the mechanisms through which inclusion (approach) relates to analgesia may be different than the mechanisms through which exclusion (avoidance) relates to analgesia. Thus, it seems potentially important for future research to compare the effects of both inclusion and exclusion against a neutral control condition.

Further, investigating the specific mechanisms by which social conditions influence pain sensitivity is also of importance. For example, the work of Eisenberger et al. (2003) mapping brain areas active in response to social exclusion is an extremely important contribution. Future research should continue to investigate which pain-related brain areas are active in response to exclusion, and which are not, in order to help determine what aspects of pain are involved in the experience of rejection. Our review suggests the PAG as one brain site deserving of attention. It is important that future research in this vein also feature control groups in which participants experience noxious but nonexclusion-related stimuli. For example, participants could be exposed to socially disgusting stimuli to test whether brain areas involved in pain processing are independent of this type of aversive social stimulus. This analysis also suggests that research investigating the neuroendocrine basis of reactions to exclusion in humans would be valuable.

Despite the fact that much of this article focuses on pain in response to social exclusion, its focus on the role of the general threat-defense system in responding to social conditions is equally important. We believe that future research examining what conditions lead to particular physiological reactions to social exclusion is needed to determine with increased clarity the role of the defense system. Given that fight/flight/freezing appear to underlie response to exclusion, it becomes increasingly important to understand what the human analogue of these three reactions are in social situations. At least on the surface, fight and flight responses seem relatively easy to understand. Social fight motivation appears to manifest in assertiveness and aggression, and social flight motivation in withdrawal from interactions. Although the freezing response in humans appears less intuitive, it may well be represented by depressive affect and behavior. An important follow-up question is under what conditions social threat will lead to each of the three responses. In physical contexts, flight is the preferred option in response to threat and is instigated if an escape route from the threatening stimulus is available (Gray & McNaughton, 2000). Freezing occurs when escape is impossible but the threat can be avoided by becoming motionless. Fight is the least preferred option but is selected when escape is not possible and a threat is actively manifested. Considering these factors in a social context provokes questions such as: What leads to a perception that a social threat cannot be avoided? How is an "escape route" perceived in social space? Is fight also the least preferred option in social interaction? In general, it is not entirely clear how the situational cues highlighted in analyses of response to physical threat map onto a social context. This question is important, as answering it should help in understanding why some individuals aggress in response to rejection while others pursue other courses of behavior. More generally, research is needed to investigate physiological reactions to exclusion, as this would help in understanding the relation of the panic response to exclusion experiences. For example, physical pain puts large demands on attention (Eccleston & Crombez, 1999), suggesting that exclusion may also have a similar effect. In general, we suggest that viewing exclusion, not just as a generic stressor, but as a major threat to perceptions of safety will help researchers understand the seemingly extreme reactions that exclusion can provoke.

More generally, although the focus of this article has been to make a case for social pain, it is important to reemphasize our belief that social pain is only one aspect of a more general emotional pain mechanism. Given that our analysis suggests that pain affect is the key mechanism behind social pain, it seems likely that pain affect may be experienced in many situations other than those connoting physical or social injury. An important question, then, is how to determine what other forms of behavior regulation may involve pain affect. One approach, suggested by our linguistic analysis, is to consider the possibility that usage of terms such as *hurt* and *pain* in noninjury contexts may, to some degree, accurately reflect the activation of pain affect. Thus, an examination of

what situations most consistently evoke the use of pain terms across cultures may provide important clues as to where else pain affect operates to regulate behavior. Another approach is suggested by our analysis of why pain came to underlie reactions to exclusion: Specifically, it is our position that social exclusion became associated with pain affect because inclusion is highly important for survival and requires quick responses. Thus, other survival threats that require quick action might also have co-opted pain as a preadaptive mechanism and could involve emotional pain as an important part of behavior regulation. Such work would help clarify the nature of emotional pain in general and allow for better understanding of the relation of social pain to other forms of emotional pain.

Just as exclusion is likely not the only form of nonphysical pain, pain is likely not the only physical safety mechanism underlying reaction to exclusion. As noted, Panksepp (1998) has suggested a role for a number of other systems including those that regulate energy balance, thermoregulation, and place attachments. For example, it is common to refer to agreeable individuals as "warm," and disagreeable individuals as "cold." The broad point made by social pain theory is that mechanisms for social regulation followed the development of a series of complex mechanisms that aided in survival against physical threats. Future research specifying what other physical safety mechanisms, if any, are related to perceptions of exclusion has the potential to provide important insight into the nature of human social behavior.

Summary and Conclusion

Evidence from a wide range of psychological disciplines converges to suggest that physical and social pain operate via common mechanisms. Both were necessary to promote the survival of social animals, functioning to guide animals away from threats and toward helpful others. Both motivate quick, defensive behavior and are extremely emotionally aversive. Both types of pain share common psychological correlates and physiological pathways. Finally, both appear to prime generalized threat-response mechanisms.

In general, we believe this review contributes to the emerging notion that people's social and physical worlds are deeply entangled. We have focused specifically on how individuals' feelings for other people may stem in part from the same pain that keeps them physically safe. We also believe that social pain theory helps emphasize the vital role of connection with others in human behavior. Those of us living in individualistic societies are inundated with messages trumpeting autonomy and individuality. Yet, a picture is emerging that people are so vitally important to each other that social needs are ingrained in our very biology. We hold social pain to be one such example of our deep, physical need for each other.

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