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The pains and pleasures of social life: A social cognitive neuroscience approach

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Imagine business partners, Gil and Sarah, who have always split the work and the resulting rewards, evenly, right down the middle. Gil lines up three new clients, one of whom will be an easy client both because he is personable and because Gil and Sarah have amassed great expertise in handling his needs. Each of the other two clients will be more difficult. One is known for being a bit of a bully who seems to change what he wants as a client as his whims change. The second is easy enough to get along with but has demands that really stretch Gil and Sarah's existing expertise. Because Gil has brought in the clients, he feels it is his perogative to divide the work between them. He chooses to take the first client for himself and assign the two difficult clients to Sarah.

Naturally, Sarah finds this arrangement unfair. She is annoyed at just how much more work she is going to have to do than Gil. She also feels insulted that Gil thought it was acceptable to treat her in this way. Her anger at the situation mounts and she must figure out how to respond. Should she bring this up overtly with Gil and potentially jeopardize their collegial relationship? Should she find a way to respond in kind? Or should she just try to "suck it up" and accept what has happened?

Psychologically, this scenario raises a number of interesting questions. How do common psychological processes determine what one would feel and do in Sarah's position? How does she weigh the costs and benefits of lashing out versus holding her tongue? How do we determine whether her bad feelings are really due to the insult or to the amount of work she has been given. Self-report is notoriously unreliable in these kinds of situations. People are good at reporting how they feel, but are often quite poor at reporting on the reasons why they feel a certain way (Nisbett & Wilson, 1977) How would Sarah have responded to a more fair division of labor? Over the past decade, brain scientists have begun to answer exactly these kinds of questions.

More broadly, a field called social cognitive neuroscience (Lieberman, 2007; Ochsner & Lieberman, 2001) has examined both the painful and the pleasurable aspects of social living. To give away our conclusion right at the outset, social pains and pleasures bear a surprising resemblance to physical pains and pleasures. The brain uses similar circuits to handle the social and physical variants of pain and pleasure. This has enormous consequences as we think about the feelings of others and ourselves. Its easy to imagine that Sarah's pain comes primarily from the extra work that she will have to do if she accepts Gil's proposal, but brain science suggests that her pain may well come from the social hurt of not being treated like an equal. And this social injury may affect her brain in much the same way as physical injury.

In this review, we will survey the neuroscience of social pain and social pleasure. We will begin by examining the consequences of being excluded from a group, which is probably a rare event in everyday life, but a truly painful one when it occurs and one that we commonly fear in an anticipatory way. Then, we will turn from social pain to social pinches, which refer to the more minor but more frequent types of social pain (e.g. unfair treatment). Finally, we will discuss social pleasures, which activates the brain's reward circuitry far more than most would have guessed.

Social Pains

When one is on the receiving end of a relationship breakup, it is not uncommon to describe this to others in terms of one's *hurt feelings* or one's *broken heart*. It is striking to notice that the language we use to describe this social pain is in fact the language of physical pain. Indeed, a review of social pain terminology in 15 different languages found that social pain words are almost exclusively borrowed from the physical pain domain in each language (MacDonald & Leary, 2005). This could be a coincidence but mounting evidence suggests that the connection is much deeper.

The brain's physical pain system consists of three regions in the cortex. The somatosensory cortex codes for where in the body a painful stimulation has occurred, particularly for pain on the outer surface of the body. For instance, it can differentiate between pain applied to the left or the right hand. The insula responds to painful stimulation, particularly internal or visceral forms of pain, and seems to provide the brain with a representation of the body's overall state. Lastly, the dorsal anterior cingulate cortex (or dACC for short) is the region that's associated with the distress of physical pain. This region is associated with how much a particular pain stimulation bothers an individual. Although the intensity of the stimulation and the subjective distress experienced by an individual are often highly correlated, they can be separated. For instance, through hypnotic suggestion, the same physical stimulus can be experienced as more or less distressing, and it is this experience of distress that is correlated with activity in the dACC (Rainville, Duncan, Price, Carrier, & Bushnell, 1997). Similarly, patients who have tissue surgically removed from their dACC to deal with chronic pain, report that they can still identify where painful stimulation occurs and its level of intensity, but they also report that it no longer seems to bother them (Folz & White, 1968).

We were particularly interested in the dACC with regards to social pain because in addition to its role in physical pain processing, there is evidence from animal research that it may play a role in social pain as well. One primate study found that when the dACC was electrically stimulated in monkeys, these monkeys produced distress vocalizations, which are specifically associated with being separated from a caregiver (MacLean & Newman, 1982). Similarly, surgical lesions of the dACC led to diminished distress vocalization production in monkeys when separated from their mothers (Kirzinger & Jurgens, 1982).

In order to examine whether social pain in humans uses the same neural circuitry as physical pain, we conducted the first functional magnetic resonance imaging (fMRI) study of social exclusion (Eisenberger, Lieberman, & Williams, 2003). fMRI is a technique that allows us to assess which regions of the brain are relatively more active when processing a stimuli of interest, performing a task, or having a particular experience. One of the major limitations of fMRI research is that the subject needs to lay absolutely still inside the scanner, not speaking, only pressing buttons on a small 4-button keyboard to provide responses. Under these circumstances, socially rejecting an individual can be quite a challenge.

We convinced subjects that while they were laying in an fMRI scanner in one location, two other subjects were laying in scanners elsewhere on campus and that the three of them were going to play a game together over the internet while they all had their brain's scanned. In face, there were no other players; participants played with a preset computer program but this cover story allowed us to set up an experience for the subject that was truly experienced as social and allowed us to control the events that would transpire in order to create the experience of social pain.

While in the scanner, subjects played a game called *Cyberball* (Williams, Cheung, & Choi, 2000) in which the subject and two other supposed players played a virtual game of "catch". The two computer players were programmed to throw the ball equally to everyone for a while but then to only throw the ball to each other after that, leaving the one real subject excluded from the game from that point on. It was quite obvious from self-reports that being left out of the game really bothered most of the subjects, but to quantify this social pain, subjects answered questions regarding how much social pain they felt ("I felt rejected", "I felt meaningless") after getting out of the scanner.

What we found was striking. Subjects showed greater activity in dACC when they were excluded compared to when they were included. Moreover, subjects who reported feeling more social pain also showed greater activity in the dACC during the exclusion phase of the game.

In contrast, right ventrolateral prefrontal cortex (RVLPFC), a brain region involved in pain regulation (Wiech, Farias, Kahane, Shackel, Tiede & Tracey, in press), was also more active during exclusion than inclusion, however, this region was more active to the extent that people reported feeling less social pain. In other words, RVLPFC appeared to be helping to regulate or cope with the social pain and to the extent that it was active, subjects felt less distressed. Figure 1 displays the results of this study side by side with the results of another study of physical pain regulation (Lieberman et al., 2004). As can be seen, the regions involved in these social and physical pain studies are quite similar and the relations between them, as indicated by the correlation values next to the arrows, are quite similar as well.

Why would our brain be organized this way? We believe that the social pain system in the brain may have piggybacked onto the physical pain system during mammalian evolution (Eisenberger & Lieberman, 2004; Panksepp, 1998), borrowing the pain signal to indicate broken social bonds. Although people generally agree that our basic survival needs are food, water, and shelter, because mammalian young are born immature, incapable of providing for their own physical needs, they must stay connected to their caregivers. In young mammals, the need for this social connection actually supercedes the need for food, water, and shelter, because without a caregiver to provide for these needs, young mammals would not survive. Just as evolution has wired us to feel pain when we lack food (e.g. hunger), water (e.g. thirst), or shelter (e.g. freezing, sunburn), perhaps evolution has wired us to feel pain when we lack or anticipate a lack of social connection.

Several follow-up studies have been conducted to further examine this possible connection between social and physical pain. First, the basic correlational pattern of activity in dACC, RVLPFC, and self-reported social pain during exclusion has been replicated (Eisenberger, Way, Taylor, Welch, & Lieberman, 2007). Second, we have shown disapproving faces to subjects who vary in their self-reported rejection sensitivity and found that those who are more sensitive to rejection produced greater dACC activity to the disapproving faces (Burklund, Eisenberger, & Lieberman, 2007). We have also found that those individuals who have a higher tolerance for physical pain also have a higher tolerance for social pain (Eisenberger, Jarcho, Lieberman, & Naliboff, 2006), such that these individuals are less sensitive to both physical and social pain experiences. Lastly, we have observed that those who show greater dACC activity during social rejection in the scanner also report greater feelings of social disconnection in their real life daily social interactions (Eisenberger, Gable, & Lieberman, 2007).

Social Pinches

People rarely experience the kind of full blown social exclusion that we examined with the *Cyberball* game. How do the more minor slings and arrows of everyday social living affect us? Do social pinches hurt like social pains? A number of investigators have used economic bargaining games such as the *ultimatum game* to examine how the brain responds to the social pinch of being treated unfairly. Unfair treatment occurs frequently in daily life and thus may represent an important complement to the social rejection research.

In the ultimatum game, two individuals must split a sum of money, called the *stake*, between them. One player, the *proposer*, proposes a way to split the money. The other player, the *responder*, then chooses whether or not to accept the offer. If the offer is accepted, both players receive what the proposer proposed. If the offer is rejected, both players receive nothing. Thus, from a $10 stake, the proposer might propose to keep $8 and pass on $2 to the responder. If the responder feels sufficiently insulted, this offer would be rejected and both individuals would leave with $0. Even when subjects know they will only play one time, and thus there is no need to create a particular reputation for oneself, subjects typically reject offers that are less than 20-30% of the total stake (Guth, Schmittberger, & Schwarze, 1982).

In the first fMRI study of the ultimatum game (Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003), subjects played 10 rounds of the game, each round with a new partner. In all rounds the subject played the role of the responder. Approximately half of the offers were fair ($5 out of $10) and half were unfair ($1 or $2 out of $10). Subjects produced greater activity in the anterior insula and the dACC when confronted with unfair, relative to fair offers. Both of these regions are part of the physical pain system in the brain. Additionally, the anterior insula has been associated with physical disgust sensations and thus was interpreted as reflecting the degree of insult or disgust the subject felt upon being treated unfairly. Critically, the magnitude of the insula activity predicted the likelihood that the offer would be rejected.

In a follow-up study (Crockett, Clark, Tabibnia, Lieberman, & Robbins, 2008), some subjects played the ultimatum game after drinking a pharmaceutical cocktail that put them into a "low serotonin" state. To give a bit of context, low serotonin has been associated with anxiety, depression, impulsivity and aggression. When people take selective serotonin reuptake inhibitors (SSRI's) such as Zoloft, Paxil, and Prozac, the pharmacological effect is, roughly speaking, to move the individual's brain chemistry from a low serotonin state to a high serotonin state. Crockett and colleagues found that when people were put into a low serotonin state pharmacologically, people were more likely to reject unfair offers. These results suggest that fairness is truly in the eye of the beholder and that eye can change from day to day as one's brain chemistry changes.

In both of these ultimatum game studies it is difficult to separate out the sense of insult from the desire for retribution. Another study using a similar game (de Quervain et al., 2004), separated out the phases of feeling insulted and deciding whether to punish and observed that punishing a partner that was unfair, activated one of the reward region of the brain. Justice, it appears, can feel sweet indeed.

Sometimes it is necessary to hold one's tongue after unfair treatment. The ability to regulate one's responses to social insults can be critical for managing longterm goals and relationships. This was investigated in a study of the ultimatum game that included financially desirable but unfair offers (Tabibnia, Satpute, & Lieberman, 2008). Recall that in the previous fMRI study (Sanfey et al., 2003), offers were either fair and desirable ($5 out of $10) or unfair and not very desirable ($1 out of $10). We added in trials that were unfair but financially desirable ($5 out of $20). A typical college undergraduate finds this a desirable amount of money, however, it is still insulting as it represents only 25% of the stake. Tabibnia and colleagues found that some subjects were far more likely to accept these desirable but unfair offers. These individuals tended to activate RVLPFC more, the region we previously described as playing a role in the regulation of physical and social pain distress. In addition, as RVLFPC activity increased, anterior insula activity decreased, suggesting the possible regulation of the insulted feelings associated with this region in the earlier study (Sanfey et al., 2003).

Thus, social pinches like unfair treatment do appear to activate the social pain system. Additionally, regulation of these responses activates the same RVLPFC region that was involved in the regulation of social pain due to full blown social rejection.

Social pleasures

If being treated unfairly activates the social pain and disgust circuitry, what does being treated fairly do? One might expect it to have little effect on the brain as fairness seems like the baseline treatment that we expect, with only deviations from this baseline requiring attention and reaction. Others have argued that fair treatment represents an important social reward of its own. In our evolutionary past, and to some extent still today, being accepted and valued by one's group is important because it means access to critical resources for survival and thriving. Signs that one is accepted by a group indicate that one is likely to continue to be treated well by the group and share in that group's successes.

A series of studies have now begun to demonstrate that the brain's reward system, particularly the ventral striatum, reacts as strongly to social rewards in the form of social recognition as it does to one of the the most ubiquitous human rewards – money. In the ultimatum game study by Tabibnia et al. (2008), the brain's response to fair relative to unfair offers was examined. In typical ultimatum games, and in life in general, fair offers are usually of greater material benefit than unfair offers. Thus it is difficult to know whether the brain's reward response to an offer of $5 out of $10 (relative to an offer of $1 out of $10) is due to the fairness component or the financial reward. To address this, we included fair and unfair offers with equivalent material benefit. For instance, a fair offer of $5 out of $10 could be compared with an unfair offer of $5 out of $20. After controlling for the financial benefit in this manner, we still observed robust activity in the ventral striatum, a reward structure, when subjects were presented with fair, relative to unfair, offers (see Figure 2).

A second study examined the effects of social reputation (Izuma, Saito, & Sadato, 2008). In this study, subjects performed one task in which money could be earned on each trial. In a second task, subjects received feedback from others about their personality that varied in positivity. They observed that rewards in both tasks, financial and social, led to equivalent levels of ventral striatum activity. In other words, our brain's reward system responds to positive feedback about oneself from others in the same manner that it responds to monetary incentives.

Finally, another group of researchers has asked directly whether it is truly better to give than to receive. In this study (Moll, Krueger, Zahn, Pardini, de Oliveira-Souza, & Grafman, 2006), subjects chose whether to give a certain portion of their subject payment to real charities around the world and on other trials received money themselves. They found that donating to charity led to more activity in the ventral striatum than receiving money themselves. In addition, the extent to which ventral striatum was active when deciding whether or not to donate was associated with how often, during the task, subjects chose to donate. Thus, in some cases, giving to others can be more rewarding than receiving a financial reward.

Conclusions

For decades now, we have been hearing about the parts of the brain that support language, vision, memory, and higher cognitive skills such as math and reasoning. Because of this, it is not surprising that the human brain has been conceptualized as a computer or a machine that can be optimized in the workplace by increasing processing efficiency or correcting errors through feedback. These new findings from social cognitive neuroscience suggest that bringing out the best in people in the workplace depends at least as much on optimizing a person's social and emotional well-being as it does on those cognitive processes.

We would never expect someone who has a broken leg to run from one meeting to the next. But when someone is in social pain, we often treat this as if it should be compartmentalized and kept outside the office. Even worse, we sometimes think that people should simply "get over" their hurt feelings, despite the fact that we would never think someone should "get over" their broken leg. The evidence reviewed in this article clearly demonstrates strong similarities in how the brain reacts to social and physical pain. Accordingly, we need to appreciate that however much reality we accord to physical pain should also be extended to social pain.

On the other side of the equation, when our needs are met, we feel pleasure. Eating when hungry, drinking when thirsty, and coming in from the cold are all pleasurable experiences that occur while a need is being satiated. The need for social regard may seem less immediate and real than other needs, but it is a basic need (Baumeister & Leary, 1995). When our social needs are being satisfied, the brain responds in much the same way as it responds to other rewards that are more tangible.

This suggests that the exclusive premium put on financial rewards as an incentive around the office may be overstated. Being treated with respect and as a valued member of the organization may activate reward systems in the brain that promote stronger learning of behaviors that predict more of these social rewards in the future. And obviously, providing social rewards is an extremely cost effective measure, requiring only a bit of time and thoughtfulness.

More generally, these results highlight what has been described as the human tendency towards affective forecasting errors (Gilbert, 2005). People have strong beliefs about what will make them more or less happy and we choose our careers, home, spouses, and friends on the basis of these emotional predictions, as we all want to maximize our positive feelings and minimize our negative feelings. Unfortunately, these forecasts of what will make us happy are often wrong. Most people would not predict that social rewards could be as pleasurable as financial rewards and most would not predict that social pain can hurt like physical pain in many ways. Consequently, in both our professional and private lives we make many choices that do not adequately take into account how much the human brain is sensitive to these factors. As we learn more about the brain it may help people to better appreciate how their well-being and the well-being of those around them is affected by the pains and pleasures of social living.

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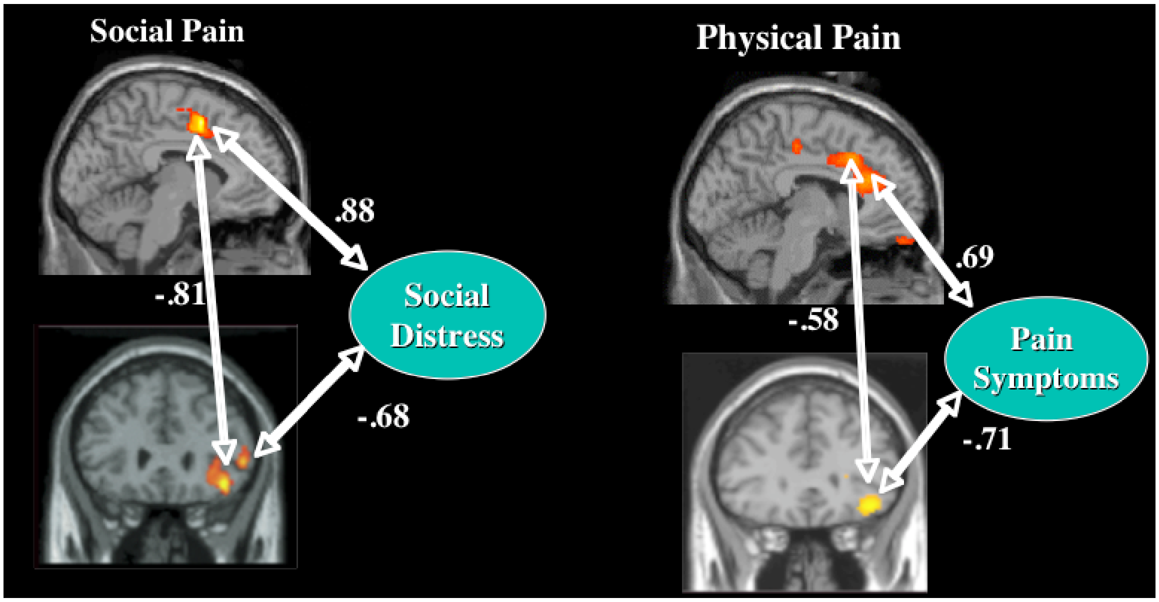
Figure Captions

Figure 1. Social and physical pain. In the left panel, the neural responses to social pain and their relation to self-reported distress are shown, with dorsal anterior cingulate cortex (dACC) shown at the top and right ventrolateral prefrontal cortex (RVLPFC) shown at the bottom (from Eisenberger, Lieberman, & Williams, 2003). In the right panel, the neural responses to physical pain and their relation to self-reported pain symptoms are shown, with dACC shown at the top and RVLPFC shown at the bottom (from Lieberman et al., 2004). The brain regions and the interrelationships between the brain regions and the experience are very similar in social and physical pain.

Figure 2. Being treated fairly activates the reward system. This figure shows activation in the ventral striatum when subjects were treated fairly, compared to when they were treated unfairly (Tabibnia, Satpute, & Lieberman, 2008).


Social Pain
Physical Pain
.88
-.81
-.68
Social Distress
.69
-.58
-.71
Pain Symptoms