Why Love Literally Hurts

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Most of us see the connection between social and physical pain as a figurative one. We agree that “love hurts,” but we don’t think it hurts the way that, say, being kicked in the shin hurts. At the same time, life often presents a compelling argument that the two types of pain share a common source. Old couples frequently make the news because they can’t *physically* survive without one another. In one example from early 2012, Marjorie and James Landis of Johnstown, Pennsylvania, who’d been married for 65 years, died just 88 minutes apart.

Truth is you don’t have to be a sentimentalist to believe in broken hearts — being a subscriber to the *New England Journal of Medicine* will do. A few years ago a group of doctors at Johns Hopkins University reported a rare but lethal heart condition caused by acute emotional distress. The problem is technically known as “stress cardiomyopathy,” but the press likes to call it “broken heart syndrome,” and medical professionals don’t object to the nickname.

Behavioral science is catching up with the anecdotes, too. In the past few years, psychology researchers have found a good deal of literal truth embedded in the metaphorical phrases comparing love to pain. Neuroimaging studies have shown that brain regions involved in processing physical pain overlap considerably with those tied to social anguish. The connection is so strong that traditional bodily

painkillers seem capable of relieving our emotional wounds. Love may actually hurt, like *hurt* hurt, after all.

A Neural Couple

Hints of a neural tie between social and physical pain emerged, quite unexpectedly, in the late 1970s. APS Fellow Jaak Panksepp, an animal researcher, was studying social attachment in puppies. The infant dogs cried when they were separated from their mothers, but these distress calls were much less intense in those that had been given a low dose of morphine, Panksepp reported in *Biological Psychiatry*. The study's implication was profound: If an opiate could dull emotional angst, perhaps the brain processed social and physical pain in similar ways.

Panksepp's findings on social distress were replicated in a number of other species — monkeys, guinea pigs, rats, chickens. The concept was hard to test in people, however, until the rise of neuroimaging decades later.

A breakthrough occurred in an fMRI study led by APS Fellow Naomi Eisenberger of University of California, Los Angeles. The researchers knew which areas of the brain became active during physical pain: the anterior cingulate cortex (ACC), which serves as an alarm for distress, and the right ventral prefrontal cortex (RVPFC), which regulates it. They decided to induce social pain in test participants to see how those areas responded.

Eisenberger and colleagues fed participants into a brain imaging machine and hooked them into a game called Cyberball — essentially a game of virtual catch. Participants were under the impression that two other people would be playing as well. In actuality, the other players were computer presets controlled by the researchers.

Some test participants experienced "implicit" exclusion during the game. They watched as the other two players tossed the virtual ball, but were told that technical difficulties had prevented them from joining the fun. Others experienced "explicit" exclusion. In these cases, the computer players included the participant for seven tosses, then kept the ball away for the next 45 throws.

When Eisenberger and colleagues analyzed the neural images of exclusion, they discovered "a pattern of activations very similar to those found in studies of physical pain." During implicit exclusion, the ACC acted up while the RVPFC stayed at normal levels. (The brain might have recognized this exclusion as accidental, and therefore not painful enough to merit corrective measures.) During explicit social exclusion, however, both ACC and RVPFC activity increased in participants.

The study inspired a new line of research on neural similarities between social and physical pain. "Understanding the underlying commonalities between physical and social pain unearths new perspectives on issues such as … why it 'hurts' to lose someone we love," the researchers concluded in a 2003 issue of *Science*.

In a review of studies conducted since this seminal work, published in the February 2012 issue of *Current Directions in Psychological Science*, Eisenberger offered a potential evolutionary reason for the relationship. Early humans needed social bonds to survive: things like acquiring food, eluding predators,

and nursing offspring are all easier done in partnership with others. Maybe over time this social alert system piggybacked onto the physical pain system so people could recognize social distress and quickly correct it.

“In other words,” wrote Eisenberger, “to the extent that being separated from a caregiver or from the social group is detrimental to survival, feeling ‘hurt’ by this separation may have been an adaptive way to prevent it.”

Physical Pain Dies, Lost Love Doesn’t

Psychologists believe that physical pain has two separate components. There is the sensory component, which gives basic information about the damage, such as its intensity and location. There’s also an affective component, which is a more qualitative interpretation of the injury, such as how distressing it is.

Initial studies that followed Eisenberger’s pioneering work focused on the affective component. (The ACC, for instance, is closely related to affective pain — so much so that animals without that part of their brain can feel pain but aren’t bothered by it.) As a result, researchers began to think that while the qualitative aspects of social and physical pain might overlap, the sensory components might not.

Recently that thinking has changed. A group of researchers, led by Ethan Kross of the University of Michigan, believed that social pain might have a hidden sensory component that hadn’t been found because games like Cyberball just weren’t painful enough. So instead they recruited 40 test participants and subjected them to a far more intense social injury: the sight of an ex-lover who’d broken up with them.

Kross and colleagues brought test participants into a brain imaging machine and had them complete two multi-part tasks. One was a social task: Participants viewed pictures of the former romantic partner while thinking about the breakup, then viewed pictures of a good friend. The other was a physical task: Participants felt a very hot stimulation on their forearm, and also felt another that was just warm.

As expected from prior research, activity in areas associated with affective pain (such as the ACC) increased during the more intense tasks (seeing the “ex” and feeling the strong heat). But activity in areas linked with physical pain, such as the somatosensory cortex and the dorsal posterior insula, also increased during these tasks. The results suggested that social and physical pain have more in common than merely causing distress — they share sensory brain regions too.

“These results give new meaning to the idea that rejection ‘hurts,’” the researchers concluded in a 2011 issue of *Proceedings of the National Academy of Sciences*.

Still it’s not quite accurate to say that physical and social pain are exactly the same. As other research suggests, social pain may actually be much worse in the long run. A kick to the groin might feel just as bad as a breakup in the moment, but while the physical aching goes away, the memory of lost love can linger forever.

A research group led by Zhansheng Chen at Purdue University recently demonstrated this difference in a

series of experiments. During two self-reports, people recalled more details of a past betrayal than a past physical injury and also felt more pain in the present, even though both events had been equally painful when they first occurred. During two cognitive tests, people performed a tough word association task significantly more slowly when recalling emotional pain than when recalling physical pain.

“Our findings confirmed that social pain is easily relived, whereas physical pain is not,” the researchers reported in a 2008 issue of *Psychological Science.*

Heart-Shaped Box (of Tylenol)

There is a bright side to the new line of research linking social and physical pain: Remedies for one may well double as therapy for the other. A group of psychological researchers, led by C. Nathan DeWall of the University of Kentucky, recently tested whether acetaminophen — the main ingredient in Tylenol — could relieve the pain of emotional distress as effectively as it relieves bodily aches.

In one experiment, some test participants took a 500-mg dose of acetaminophen twice a day for three weeks, while others took a placebo. All 62 participants provided self-reports on a “hurt feelings” scale designed to measure social exclusion. After Day 9, people who took the pain pill reported significantly lower levels of hurt feelings than those who took a placebo.

As a follow-up study, DeWall and colleagues gave either acetaminophen or a placebo to 25 test participants for three weeks, then brought them into the lab to play Cyberball. When participants were excluded from the game, those in the acetaminophen group showed significantly lower activity in their ACC than those in the placebo group — a sign that the painkiller was relieving social pain just as it normally did physical pain.

“For some, social exclusion is an inescapable and frequent experience,” the authors conclude in a 2010 issue of *Psychological Science*. “Our findings suggest that an over-the-counter painkiller normally used to relieve physical aches and pains can also at least temporarily mitigate social-pain-related distress.”

The effect breaks both ways. In another report from *Psychological Science*, published in 2009, a research group led by Sarah Master of University of California, Los Angeles, found that social support could relieve the intensity of physical pain — and that the supportive person didn’t even have to be present for the soothing to occur.

Master and colleagues recruited 25 women who’d been in relationships for at least six months and brought them into the lab with their romantic partner. They determined each woman’s pain threshold, then subjected her to a series of six-second heat stimulations. Half of the stimulations were given at the threshold pain level, half were given one degree (Celsius) higher.

Meanwhile the woman took part in a series of tasks to measure which had a mitigating effect on the pain. Some involved direct contact (holding the partner’s hand, a stranger’s hand, or an object) while others involved visual contact (viewing the partner’s photo, a stranger’s photo, or an object). In the end, contact involving a romantic partner — both direct and visual alike — led to significantly lower pain ratings compared to the other tasks. In fact, looking at a partner’s picture led to slightly lower pain ratings than actually holding his hand.

At least for all the hurt love causes, it has an equally powerful ability to heal.