

SCIENCE AND TECHNOLOGY NEWS | THE WEEK'S BEST IDEAS

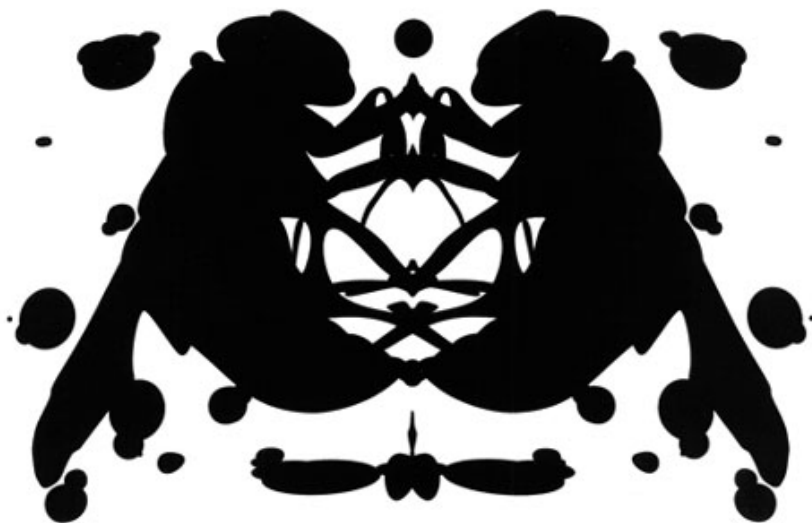
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VALENTINE BLUES

The upside of being rejected

THE ACID MOON

Europa springs a surprise

Dumped!



PHOTO: JONAS

Why is it so painful when romance goes wrong? Blame the wiring of your brain and the harsh realities of evolution, says anthropologist **Helen Fisher**



● **EMPTINESS**, hopelessness, fear, fury: almost everyone endures the agony of romantic rejection at some point in their lives. Why do we suffer so? Sorrow and anger are metabolically expensive and time consuming. Why didn't humanity evolve a way to shrug off romantic loss and easily renew the quest to find a suitable reproductive partner?

I have been studying romantic love for 10 years or so and have come to see it as an evolutionary adaptation. The ability to fall in love evolved because those who focused their courtship attention on a preferred partner saved time and energy and improved their chances of survival and reproduction.

Unfortunately, the same applies to love's darker side. We humans are soft-wired to suffer terribly when we are rejected by someone we adore – for good evolutionary reasons.

Back in 1996 I decided to use a technique called functional MRI to study the brains of men and women who had just fallen madly in love. I and several collaborators, including neuroscientist Lucy Brown of the Albert Einstein College of Medicine in New York and psychologist Arthur Aron of the State University of New York at Stony Brook, asked our subjects, a group of seven men and 10 women, to look at a photograph of their beloved projected on a screen just outside the brain scanner. We also showed each participant an emotionally neutral picture – a photograph of an acquaintance for whom they had no positive or negative feelings. In between looking at these photos, we asked each to perform a "distraction task" to wash the mind clean of all emotion.

The resulting scans told us many things about the brain in love (*New Scientist*, 22 November 2003, p 18). Most significantly, when subjects were looking at their sweetheart, their brain showed increased activity in two regions: the right ventral tegmental area (VTA) in the midbrain, and parts of the caudate nucleus, a large C-shaped region near the centre. The VTA is rich in cells that produce and distribute the powerful stimulant dopamine to many areas of the brain, including the caudate nucleus. It is part of the brain's network that controls general arousal, focused attention and motivation to acquire rewards. The regions of the caudate nucleus that became active are rich in dopamine receptors and are also associated with attention and motivation to acquire rewards.

The fact that intense, early-stage romantic passion is associated with areas rich in dopamine suggested to us that romantic love is not, in fact, an emotion, but primarily a motivational state designed to make us pursue a preferred partner. Indeed, romantic love appears to be a drive as powerful as hunger. No wonder people around the world live – and die – for love.

But we weren't interested in just the lovey-dovey side of romance. We wanted to understand every aspect. So in 2001 we began scanning the

brains of people who were suffering the trauma of a recent rejection in love.

The study is still in progress, but we suspect we will find continued activity in the VTA and associated parts of the caudate nucleus, largely because lovers keep loving long after they have been spurned. I think we will find much more than that, however. Being rejected in love is among the most painful experiences a human being can endure, so many other brain regions may be involved as well.

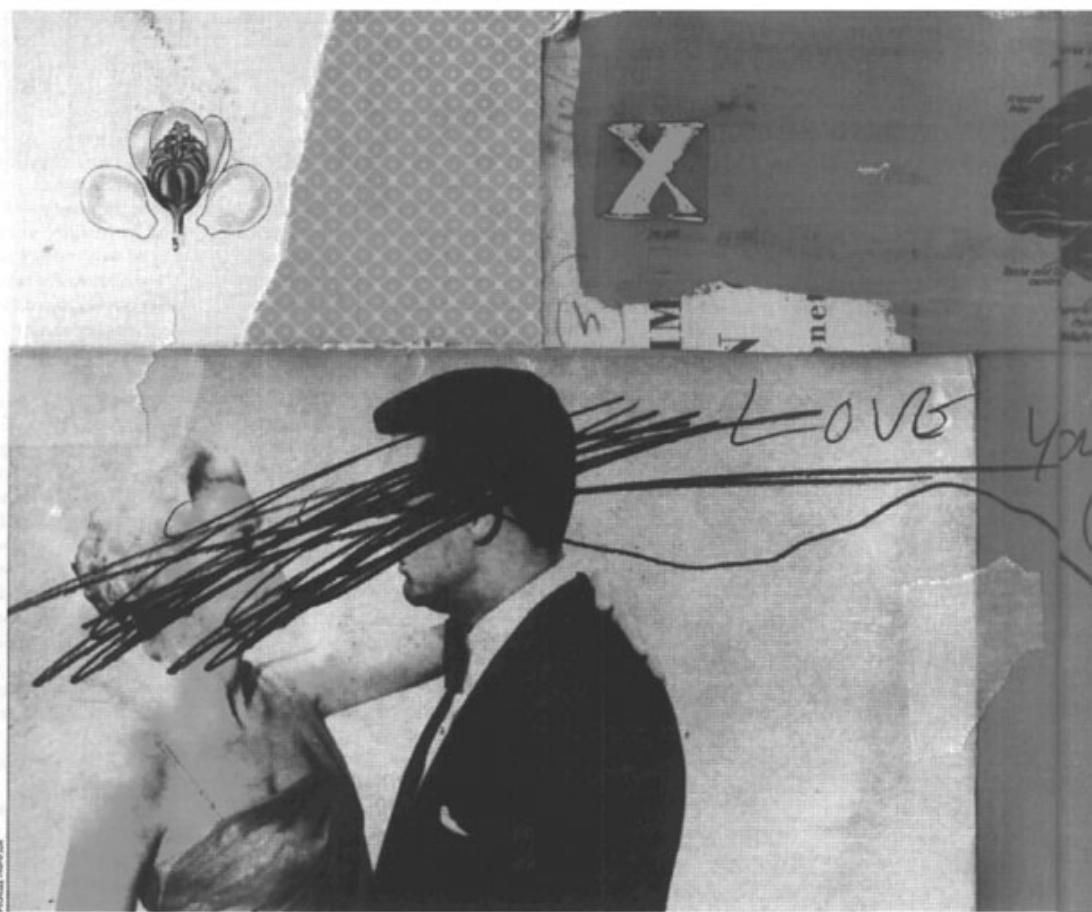
Even before the results come in, there is a lot we can say about the biology of rejection which suggests that it is an evolved response with specific functions. Psychiatrists have long divided romantic rejection into two phases: "protest" and "resignation/despair". During the protest phase, deserted lovers become obsessed with winning back the object of their affections. They agonise over what went wrong and how to rekindle the flame. They make dramatic, often humiliating, appearances at their lover's home or workplace, then storm out, only to return to berate or plead anew. They phone, email and write letters. They revisit mutual haunts and mutual friends. And alas, as the adversity intensifies, so does the romantic passion. This phenomenon is so common in the psychological literature (and in life) that I coined a term for it – frustration attraction. When romantic love is thwarted, the lover just loves harder.

But I love you more than ever

What brain systems might underlie these odd behaviours? Psychiatrists Thomas Lewis, Fari Amini and Richard Lannon, all of the University of California, San Francisco, have argued that protest is a basic mammalian response to the rupturing of any social tie. They believe it is associated with dopamine, as well as with the closely related neurotransmitter norepinephrine. Elevated levels of both these chemicals lead to heightened alertness and stimulate the forlorn animal to call for help and search for its abandoner – generally its mother.

The rising level of dopamine may help explain the biology of frustration attraction. Since our research suggests that the dopamine system is activated during early-stage romantic love, one would think that as dopamine activity increased during protest the rejected lover would feel even greater passion. And another brain mechanism kicks in during the protest phase that could add to this frustration attraction – the stress system. In the short term, stress triggers the production of dopamine and norepinephrine and suppresses serotonin activity, that heady combination of neurotransmitters that I maintain in my book, *Why We Love*, is associated with romantic love.

But frustration attraction may be due to other brain activities as well. Neuroscientist Wolfram Schultz at the University of Fribourg ►



in Switzerland reported in 2000 that when an expected reward, such as love, is delayed, "reward-expecting" neurons prolong their activities (*Nature Reviews: Neuroscience*, vol 1, p 199). These neurons do not make or distribute dopamine, but they are central components of the brain's reward system, the system associated with focused attention and motivation – the very behaviours that characterise romantic love.

What irony! As the beloved slips away, the brain networks and chemicals that most likely create the potent feelings of love increase.

The protest phase of rejection may also trigger activity in the brain's panic system. Neuroscientist Jaak Panksepp of Bowling Green State University in Ohio believes that this brain network generates the well-known "separation anxiety" response in infant mammals abandoned by their mother. When their mother leaves, infants become troubled. They express their alarm with a pounding heart, sucking gestures and distress calls.

Yet another brain system often becomes active as one protests against the departure of a lover: anger. Even when the departing lover severs the relationship with honesty and

compassion, and honours social and parental obligations, many rejected lovers swing violently from heartbreak to fury. Psychologist Reid Meloy of the University of California, San Diego, calls this reaction "abandonment rage". I use a different term: "love hatred". Whatever you call it, it's a curious reaction. Hate and rage don't generally entice a lover to return. Why does love turn to hate?

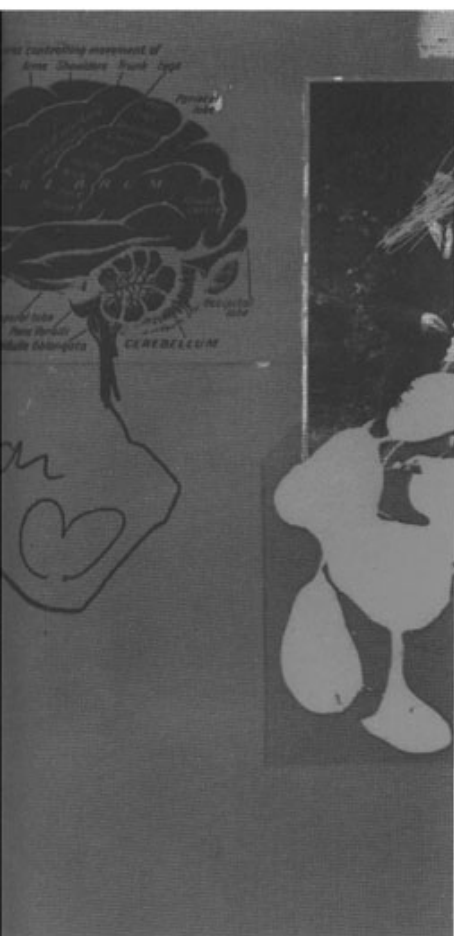
At first I assumed that hate was the opposite of love. But it isn't. The opposite of love is indifference. Moreover, it occurred to me that love and anger might be linked in the brain, and indeed they are. The basic rage network is closely connected to centres in the prefrontal cortex that anticipate rewards, including the reward of winning a beloved. In fact, experiments in animals have shown how intimately these reward and rage circuits are intertwined. Stimulate a cat's reward circuits and it feels intense pleasure. Withdraw the stimulation and it bites. This common response to unfulfilled expectations is known as the "frustration-aggression hypothesis".

So romantic love and love hatred are probably well connected in the brain.

And when the drive to love is thwarted, the brain turns passion into fury.

Why did our ancestors evolve brain links that enable us to hate the one we cherish? Rage is not good for your health: it elevates blood pressure, places stress on the heart and suppresses the immune system. So love hatred must have evolved to solve some crucial reproductive problems. Among these, I now believe that it developed to enable jilted lovers to extricate themselves from dead-end love affairs and start again.

Abandonment rage also motivates people to fight for the welfare of their offspring. This certainly occurs in divorce proceedings: men and women who are otherwise well adjusted turn vicious to get the best deal for their children. In his book *Why We Hate* (New York, Contemporary Books, 2002), science writer Rush Dozier tells of a judge who regularly presides over child custody cases and trials of violent criminals, and reports that he is much more worried about his personal safety during the custody cases. He and other judges have even installed panic buttons in their chambers in case arguing spouses become violent.



"Why did our ancestors evolve brain links that cause us to hate the one we love? Perhaps because it enables jilted lovers to extricate themselves and start again"

Sadly, abandonment rage does not necessarily extinguish love. In a study of 124 dating couples, psychologists Bruce Ellis of the University of Canterbury in New Zealand and Neil Malamuth of the University of California, Los Angeles, found that romantic love and feelings of anger are independent, and can operate simultaneously. Hence, you can be terribly angry but still be very much in love.

Eventually, however, the jilted lover gives up. Then he or she must deal with new forms of torture: resignation and despair. Drugged by the potent liquor of sorrow, they cry, lie in bed, stare into space, drink too much or hole up and watch TV. Feelings of protest and anger or the desire for reconciliation sometimes resurface, but mostly they just feel deep melancholy. In 1991, sociologists at the University of California, Los Angeles, assessed 114 people who had been rejected by a sweetheart within the previous eight weeks. More than 40 per cent of them were clinically depressed.

Of these, 12 per cent were suffering moderate to severe depression. Some people even kill themselves, and some die of a broken heart. Psychiatrist Norman Rosenthal of Georgetown University in Washington DC has reported that broken-hearted lovers can expire from heart attacks or strokes caused by their depression.

Resignation and despair are well documented in other mammalian species. When infant mammals are abandoned by their mother, first they protest and panic. Later they slump into what psychologists call the "despair response".

Despair has been associated with several different networks in the brain. One is the reward system. As the abandoned partner realises that the expected reward will never come, the dopamine-making cells in the midbrain scale down their activity. And diminishing levels of dopamine produce lethargy, despondency and depression. The stress system also plays a part. As the stress of abandonment wears on, it suppresses the activity of dopamine and other potent neurotransmitters, contributing to feelings of depression.

Like abandonment rage, the despair response seems counterproductive. Why waste time and energy moping? Some scientists now believe that depression evolved millions of years ago as a coping mechanism. Theories on this subject abound. One I particularly like has been proposed by anthropologist Edward Hagen of Humboldt University in Berlin, biologists Paul Watson and Paul Andrews of the University of New Mexico in Albuquerque and psychiatrist Andy Thomson of the University of Virginia in Charlottesville. They argue that the high metabolic and social cost of depression is actually its benefit: depression is an honest, believable signal to others that something is desperately wrong. It is a cry for help which compels stressed people to request support in times of intense need.

Imagine a young woman living in a Palaeolithic tribe whose mate openly mated with another woman. First she protested, grew angry and tried to persuade her partner to give up his lover. She also appealed to her

friends and kin for help. Unable to influence her mate or relatives with words or tantrums, however, she became depressed. Eventually her despondency motivated her family to drive out her unfaithful partner and console her until she could recover her vitality, find a new mate and start contributing food and childcare again.

Depression is evolutionarily advantageous for another reason: it gives you insight. Depressed people suffer what psychologist Jeffrey Zeig of the Milton H. Erickson Foundation in Phoenix, Arizona, calls a "failure of denial", allowing them to make honest assessments of themselves and others. Severe depression can push a person to face unpalatable truths and make difficult decisions that ultimately promote their survival and reproductive success.

Not everyone suffers to the same degree, of course. Still, we human beings are intricately wired to suffer when we have been rejected by a loved one, and for good evolutionary reasons. I believe romantic love is one of three primary mating drives. The sex drive evolved to enable our ancestors to seek intercourse with any remotely appropriate individual. Romantic love developed to enable our forebears to focus their attention on preferred partners, thereby conserving precious mating time and energy. And long-term attachment evolved to motivate mates to rear their babies as a team. So falling in love is one of the most important (and powerful) things we do; it profoundly affects our social and genetic future.

As a result, we are built to suffer terribly when love fails – first to protest the departure and try to win the beloved back, and later to give up utterly, dust ourselves off and redirect our energy to fall in love again. We are likely to find evidence of any combination of these myriad motivations and emotions as we examine the rejected brain in love. ●

Helen Fisher is an anthropologist at Rutgers University in New Jersey. Her new book, *Why We Love: The nature and chemistry of romantic love*, is published this month by Henry Holt and Company (New York)

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