Love as medicine

Dr Sue Carter, Director of the Kinsey Institute provides an expert insight into an aspect of biology that concerns the healing power of love

Love is intrinsically beautiful, but also complex and mysterious. Although love can be difficult to define, the list of love's functions is long. Love influences all aspects of human existence. Love is powerful medicine. Healthy relationships can protect against disease and restore the body in the face of illness.

Without loving relationships, humans fail to flourish, even if all of their basic needs are met. "Love lost" is one of the most powerful forms of stress and trauma. We now understand that the causes and consequences of love or its absence are grounded in a biology that operates largely below the level of human consciousness.

> "The mechanisms through which love protects and heals are only now being discovered."

Remarkably, the origins of this knowledge began in research conducted in a small field mouse known as the prairie vole. In the 1980s, working at the University of Illinois, my colleague Lowell Getz and I uncovered evidence that both in nature and in the laboratory, prairie voles were capable of forming life-long pair bonds. In this species, both parents nurtured the young, with fathers sharing all aspects of infant care except nursing. Older siblings also cared for younger babies. Juvenile prairie voles left the family to find mates and scrupulously avoided incest. Prairie voles exhibited the traits of the mating system that humans associated with monogamy.

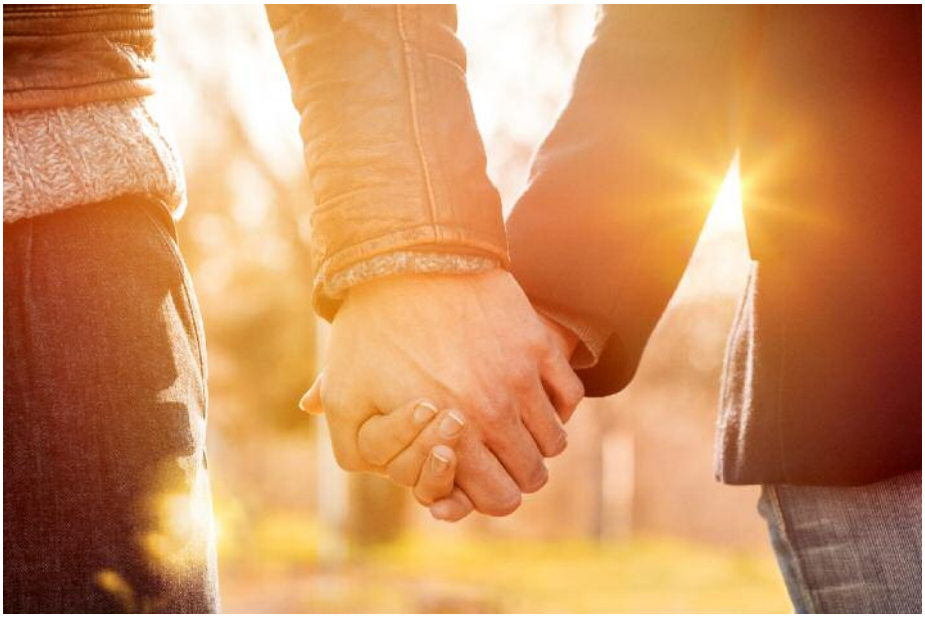
As in humans, the core of the prairie vole monogamy was based on social bonds, not simply defined by sexual exclusivity. The capacity for pair bond formation was regulated physiological and emotional states, based on neural systems also found in humans. We also found that prairie voles have high levels of oxytocin, a human-like autonomic nervous system, and they are exquisitely sensitive to the neural and epigenetic effects of early nurture. Thus, by studying pair bonding in voles, we had created a laboratory model allowing us to examine the neurobiology of what humans' call "love."

The evolutionary and biochemical prototype for love and social bonds is the mother-child interaction. The physiological pathways that permit social bonds are shared with parental behaviour, as well as birth and lactation. Our research in prairie voles revealed that two ancient neuropeptides and their receptors are foundational to the capacity to form pair bonds and also show defensive aggression. Those molecules are oxytocin and vasopressin. Both oxytocin and vasopressin are important to the social bond formation, but their functions are strikingly different.

Vasopressin is the more primitive of the two and is associated with adaptive functions that protect humans against dehydration and regulate blood pressure. Vasopressin has been associated with the neurobiology of anxiety, fear and avoidance learning. Both males and females synthesise vasopressin. However, in areas of the brain implicated in defensiveness and territorial aggression, vasopressin production is increased by androgens, and may play a central role in sex differences in the expression of aggression.

Oxytocin, in contrast, is associated with prosocial behaviours, including social engagement and the formation of social bonds. Oxytocin also may induce a sense of safety, reduce reactivity to stressors, block fear and increase trust. Processes that help to define mammals, including lactation and maternal behaviour are facilitated by oxytocin. Although both sexes synthesise oxytocin, in some cases estrogen increases sensitivity to the actions of oxytocin, favouring this peptide in females. Oxytocin was essential to human evolution, facilitating the birth, growth and nurture of our immature babies.

Oxytocin helps, directly and indirectly, to promote healing and restoration. For example, oxytocin has anti-oxidant and anti-inflammatory properties. Oxytocin also regulates the immune system and the highly protective parasympathetic, vagal branch of the autonomic nervous system. Vagal pathways, regulated by oxytocin, are



necessary for social communication and engagement through actions on the muscles of the face and head.

Furthermore, the autonomic nervous system regulates all of our internal organs, as well as the distribution of blood and nutrients throughout the body. Through effects on the autonomic nervous system, oxytocin regulates blood flow and oxygen to the brain, thus further supporting human cognition, culture and eventually civilisation.

Thus oxytocin-vasopressin effects on the autonomic nervous system are likely a critical component of the healing power of love. The autonomic nervous system is one portal through which the peptide systems and love may be accessed and influenced.

Oxytocin and vasopressin evolved from a common ancestral peptide. Oxytocin and vasopressin are similar in structure and interact dynamically with each other's receptors. However, for several reasons, these molecules are difficult to study. Their actions are adaptive, quickly changing and also strongly affected by emotional context. Under conditions of safety, oxytocin promotes social engagement. But in a context of anxiety or fear, oxytocin may function like vasopressin, possibly by binding to vasopressin receptors.

Generally, oxytocin tempers fear and increase both trust and social behaviour. But in individuals who have a history of trauma or extreme stress, oxytocin may trigger the vasopressin system, enhancing fear and protective responses. The unique properties of the oxytocin and vasopressin systems allow these two molecules to be highly adaptive and support emotions such as love, but also jealousy and defensive aggression. The same novel properties that give oxytocin and vasopressin great power, also create serious challenges for understanding their functions.

The oxytocin-vasopressin system is constantly changing across the life cycle. Oxytocin affects the development of the brain, cardiovascular and immune systems. Recently, my colleagues and I have demonstrated that the expression of the gene for the oxytocin receptor in voles is epigenetically tuned by early experience. Loving relationships, especially in early life can influence behaviour and physiology across the lifespan, in part through changes in the sensitivity of the oxytocin system. The absence of nurture may create a pattern of self-defensive and a sense of threat that could inhibit the capacity for love in later life.

The mechanisms through which love protects and heals are only now being discovered. Oxytocin influences sociality and social experiences influence oxytocin. Knowledge of the neurobiology of love helps to explain the exceptional reproductive success of humans and also our resilience in the face of fear and aggression. The emotional and physical health and longevity of our species, and perhaps our planet, depends on our capacity to understand and apply our knowledge of the biology of the love, especially in this time of trauma.

Early nurture epigenetically tunes the oxytocin receptor. https://www.ncbi.nlm.nih.gov/pubmed/30227351

The Oxytocin-Vasopressin Pathway in the Context of Love and Fear. https://www.ncbi.nlm.nih.gov/pubmed/?term=Carter+love+and+fear

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