

Love and Attachment: The Psychobiology of Social Bonding

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ABSTRACT

Basic animal studies and human imaging studies have contributed to our understanding of the psychobiology of love and attachment. There are overlaps and distinctions in the neuronal circuitry of maternal love, romantic love, and long-term attachment. In these circuits, important molecules, which have been demonstrated to play a role in the psychobiology of social bonding include dopamine, serotonin, opioids, oxytocin, and vasopressin. Particular genetic and environmental variations contribute to social-bonding phenotypes, consistent with an evolutionary perspective on the value of these behaviors. Advances in the psychobiology of social bonds have led to hypotheses about the pharmacotherapy of disorders of attachment.

CASE REPORT

Vanessa is a 23-year-old woman who was in psychotherapy because of conflicted feelings about a new relationship. She was a shy person, and when meeting new people always felt very self-conscious. On those occasions when she had been on a date, Vanessa had felt far too anxious to enjoy things, and the relationships had not developed further. However, she had recently succeeded in getting to know someone over time at her work, and they had also gotten together on occasion for a meal after work. Things were getting confusing for Vanessa, because he was much older than her and did not seem a suitable partner. Vanessa had, however, been attracted to him from the start, and her feelings for him were now overwhelmingly strong.

COGNITIVE-AFFECTIVE NEUROSCIENCE

There is a growing understanding of the cognitive-affective neuroscience of maternal love, romantic love, and long-term attachment.^{1,2} Love and attachment may involve both high level cognitive-affective processing (eg, con-

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cepts of the other³ and memory) as well as more basic level processing (eg, experiences of reward and desire), and so may be mediated by a broad range of different neuronal circuits.⁴ When attraction is high, there may be significant overlap of and interaction between the neurocircuitry involved in mediating bonding, and that involved in mediating reward.^{5,6} Conversely, in separation and depression, when there is loss of attachments, overlapping circuitry may also be relevant.⁷

Neuroanatomy/Neurochemistry

Functional brain imaging studies indicate that maternal love, romantic love, and longer-term attachment are mediated by distinct but overlapping neurocircuitry. Relevant circuitry in such studies has included the anterior cingulate, medial insula, striatum, and ventral tegmental area (VTA). Both maternal and romantic love, for example, appear mediated by anterior cingulate, medial insula, and caudate nucleus,⁸ and both may also involve the VTA (Figure 1).^{9,10} Similarly, in longer-term relationships, anterior cingulate and insular cortex are again involved.^{11,12} There is growing range of studies in this area,¹³⁻¹⁷ attempting to more acutely delineate the role of different neuronal circuits in social bonds (Figure 2).

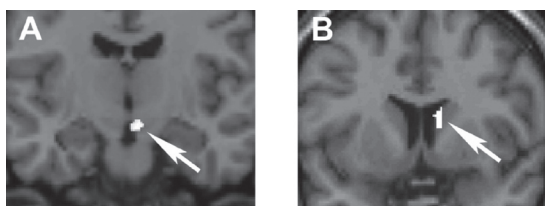
Functional imaging studies also point to overlapping areas of deactivation during attachment and love. Thus, there may be decreased activation of frontal, parietal, and temporal areas (including the amygdala) in maternal and romantic love (Figure 3).⁸ It is noteworthy that the neurocircuitry of love and attachment over-

laps in part with that which mediates sexual arousal,¹⁸ including some similarity in areas of de-activation.¹⁹ Zeki¹⁹ has argued that these findings are consistent with the universal concepts that “love is blind” or that there is “unity in love”; during attachment, love, sex, and other rewarding states there may be a relative suspension of judgment.

Dopaminergic fibers originate in the VTA, and indeed dopamine plays a key role in both attachment states and in reward processing.^{4,20} Other monoamines, such as serotonin and norepinephrine, play a key role in the relevant cognitive-affective phenomena,²¹ and various neuropeptides, other hormones, and neurotrophic factors may also be crucial.²²⁻²⁵ Prosocial neuropeptides, such as oxytocin and vasopressin, which are released during sex and lactation, may facilitate dopamine release in reward centers, and enhance memory, thus, presumably strengthening social bonds with particular individuals.^{6,20}

Seminal research on vole attachment has found that in the promiscuous montane vole, there is less expression of receptors for oxytocin and vasopressin in reward areas, while in the monogamous prairie vole there are more receptors.²⁶ In prairie voles, infusion of antagonists of these neuropeptides into reward areas prevents partner preference formation, and leads to promiscuity. Conversely, transfection of the pallidum of montaine voles with the (structurally different) prairie vole vasopressin receptor gene, leads to upregulation of vasopressin receptors, and exclusive mating.

FIGURE 1. During fMRI, viewing a romantic partner led to activation of the right ventral tegmental area (A) and the right caudate (B)⁹



fMRI=functional magnetic resonance imaging.

Fisher H, Aron A, Brown LL. Romantic love: an fMRI study of a neural mechanism for mate choice. *J Comp Neurol.* 2005;493:58-62. Reprinted with permission, Copyright 2005.

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FIGURE 2. Compared to individuals happily in love, those recently rejected, when shown a picture of their romantic partner during fMRI, had greater activation in the right ventral putamen-pallidum and accumbens core¹²



fMRI=functional magnetic resonance imaging.

Aron A, Fisher H, Mashek DJ, et al. Reward, motivation, and emotion systems associated with early-stage intense romantic love. *J Neurophysiol.* 2005;94:327-337. Reprinted with permission, Copyright 2005.

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Gene/Environment

Variants in genes coding for various monoamine and neuropeptide systems, including oxytocin and vasopressin, may contribute to differences in parenting,²⁷ reproductive behavior,²⁸ and partner bonding.^{29,30} Such work, as well as ongoing research on the genetics of attachment style and affiliative behavior,^{31,32} and the association between the genetics of pro-social neuropeptides and brain imaging, deserves replication and expansion.³³ In addition, early experiences are likely to modify subsequent attachments,^{34,35} and gene x environment analyses are needed.

Evolutionary Approaches

Early maternal attachment, subsequent romantic love, and long-term attachments are all crucial from an evolutionary perspective.^{34,36} Fisher and colleagues have suggested that mammals and birds have evolved three primary inter-related emotional-motivation systems for mating (sexual desire), reproduction (attraction), and parenting (attachment); each is associated with a specific neuronal circuitry and behavioral repertoire.⁵ Courtship attraction and partner attachment presumably operate more independently in non-monogamous species and in more promiscuous individuals. Indeed, under various circumstances, certain styles of social bonding may have particular survival value. An evolutionary perspective has also been used to theorize about gender differences in the neuronal circuitry that mediates romantic love.¹⁸

CLINICAL IMPLICATIONS

DSM-IV-TR Diagnosis

Love, it presumably goes without saying, is not a *Diagnostic and Statistical Manual of Mental*

Disorders, Fourth Edition-Text Revision diagnosis. Nevertheless, there are certainly disorders of attachment and love, including erotomania. Leckman and Mayes³⁷ have pointed out the overlap between normal attachment behaviors and obsessive-compulsive symptoms. Conditions such as autistic disorder have been conceptualized in terms of disordered attachment.

Assessment/Evaluation

There are a range of measures for assessing relationships, including attachment style. Several scales also focus on measures of romantic love, including the Passionate Love Scale, the Relationship Questionnaire, and the Experiences in Close Relationships-Revised scale.³⁸ Sternberg³⁹ has argued that love comprises three components: intimacy, passion, and commitment. Various measures have been developed in adults and adolescents to assess these constructs.⁴⁰⁻⁴²

Pharmacotherapy/Psychotherapy

Substances of abuse of course create a false sense of reward, and some substances may be used primarily because of the feelings of social attachment that they evoke. Conversely, disorders of love and attachment, such as erotomania, may require intervention with agents that inhibit such reward pathways.⁴³ Advances in neurobiology may ultimately be relevant to developing novel treatments for disorders of social attachment; it is notable that oxytocin has been considered for the treatment of autistic disorder as well as a range of other conditions.^{44,45}

CONCLUSION

It is humbling to consider that even the most sophisticated and noble of human behavior is rooted in mammalian biology. Rodent research has elegantly delineated the psychobiology of mate choice. Human social bonds, although more complex, are also mediated by evolutionarily conserved neurocircuitry and neurochemistry. Abstract concepts, such as love and beauty, are, therefore, embodied in more basic and overlapping structures.^{19,46} Conversely, sexual choice contributes to shaping human nature.⁴⁷ Future research in this area may contribute not only to our understanding of human bonds but also to the treatment of disorders of attachment. **CNS**

FIGURE 3.
Cortical deactivations when viewing pictures of loved partners during fMRI¹¹



fMRI=functional magnetic resonance imaging.

Bartels A, Zeki S. The neural basis of romantic love. *Neuroreport*. 2000;11:3829-3834. Reprinted with permission, Copyright 2000.

Stein DJ, Vythilingum B. *CNS Spectr*. Vol 14, No 5. 2009.

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