Neuro-endocrinology
BRIEFINGS
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THE NEUROBIOLOGY OF SOCIAL BONDS

SUMMARY

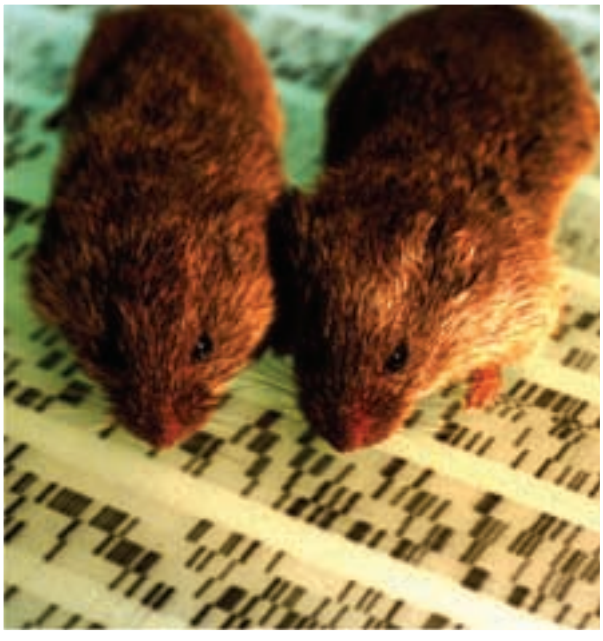
When released in the brain through giving birth or mating, the neuropeptides oxytocin and vasopressin are involved in promoting parent-offspring and monogamous bonds in animals such as sheep and voles. Bonds are only formed in species where receptors for these neuropeptides are highly expressed in dopamine-producing reward centres. In humans, dysfunctions in these same systems can be associated with autism and, when we see people we love, these systems become activated.

Social chemistry

Most mammalian species live in complex societies which provide advantages in terms of protection, reproduction and obtaining food. However, examples of strong social and emotional bonds between specific individuals are often hard to find. Fewer than 4 percent of species form monogamous pair bonds and while effective maternal care and general offspring recognition are the norm, relatively few species show the kinds of intense individual parent-offspring bonds seen in humans. In the last few decades work on some most unlikely animal species, voles and sheep, has begun to reveal the neural substrates and neurochemical systems which control monogamous and parental bonds. Surprisingly perhaps, these same systems also become activated when humans view individuals they love and may become dysfunctional in some affective disorders such as autism.

To know you is to love you

There is no point being able to bond with another individual unless you can recognise them. Brain neuropeptides like oxytocin and vasopressin, which are known to be associated with formation of social bonds, are also involved in promoting social recognition memory. So far, evidence for this has only been found for odour recognition and involves the potent facilitatory actions that these peptides have on noradrenaline release within the brain. However, there is some evidence in sheep that visual cues from faces can also provoke brain oxytocin release.



Prairie vole checking out a male partner's V1a receptor credentials.

While these two neuropeptides seem to be intimately involved with social recognition in a number of species, a key question is why they also promote social bonds in some but not others. The answer to this question is quite simply that bonding will

only occur if their receptors are highly expressed in brain dopamine-producing regions associated with reward. In females that bond selectively with offspring after giving birth, or form monogamous pair bonds after sex, oxytocin receptors are highly expressed in a region of the brain called the nucleus accumbens and the peptide can facilitate brain dopamine release. In species that do not form these bonds, this relationship with dopamine reward centres is much weaker. The same is true of the vasopressin system which promotes bonding responses in males, although the ventral pallidum is the critical dopamine-producing reward site involved. In this case however, specific DNA microsatellite repeat sequences have been identified in the gene encoding the V1a receptor for vasopressin which increase receptor distribution in the ventral pallidum. Remarkably, artificially taking the "social bonding" version of this gene from a monogamous Prairie vole and expressing it in this brain region in an asocial promiscuous species, the Meadow vole, will convert the latter to the ways of social monogamy. Humans also have a number of polymorphisms in the V1a receptor gene and there is a small but significant association between these and autism. Whether humans prone to more serial forms of monogamy lack the most appropriate bonding form of the gene remains a matter for speculation!

There is a strong link between oxytocin and vasopressin systems in the brain and modulation of the release of brain opioid peptides. The endogenous opioid system in the brain represents another important source of reward, and oxytocin effects on maternal bonding can be disrupted by blockade of opioid μ-receptors. In both monkeys and humans, turning down the gain in opioid reward centres in the brain by blockade of μ-receptors with drugs will actually induce individuals to seek social contact, and this has been used as a therapeutic approach in autism.

" It appears that social species have evolved a dual mechanism for ensuring that social bonds are both sought and maintained "

Bonds – a long term investment

Indeed, a seeming paradox is that the neurochemical systems involved in forming and maintaining social bonds are also potent stimulators of anxiety. It appears that social species have evolved a dual mechanism for ensuring that social bonds are both sought and maintained – you are anxious until social contact is achieved and once this happens your anxiety is hopefully, although not necessarily, replaced by feelings of pleasure.

The extent to which oxytocin and vasopressin are involved with maintaining bonds after they are formed is unclear. Certainly, once brain oxytocin release has stimulated maternal responses following birth, it is no longer essential for maintaining them–although suckling, or sex in the case of monogamous bonds, will continue to promote release. The major role of these peptides may simply be the formation of social bonds and linking social recognition systems in the brain with those that make us feel pleasure. Thereafter, perhaps continued episodes of release merely act to reinforce or at least help maintain these links for long periods.

But is it love?

Are these simple neuropeptide systems that are involved in social bond formation in voles and sheep responsible for our human feelings of "love"? Brain imaging studies on individuals viewing pictures of their romantic partners or newborn babies have confirmed that oxytocin and vasopressin-containing regions and dopamine reward centres are indeed particularly involved. So perhaps love really is a simple matter of chemistry and animal attraction after all!

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