The neurobiology of human social behaviour: an important but neglected topic

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The past few decades have produced important advances in our understanding of how the brain regulates emotion and cognition. In comparison, research on the neuroscience of human social behaviour is a relatively neglected topic in spite of the importance of social interactions for mental health. In this editorial, I give examples of some of the experimental approaches that have been used to study the neural substrates of human social behaviour in the hope that this will stimulate more researchers to become involved with this fascinating and important topic.

Humans are inherently social. We are not special in this way; it is hard to think of any animal for whom the regulation of social behaviour is not important. Something akin to social behaviour may even occur in organisms lacking a nervous system. For example, *Science* recently published an article titled "Genetic determinants of self identity and social recognition in bacteria."[1] Different animals, including humans, share many of the same types of social behaviour such as affiliation and aggression, the establishment of hierarchy and territoriality. This can be the case even in species, such as ants, with a primitive brain. Although we may share some of the broader aspects of our social behaviour with more primitive species, human social behaviour is obviously more complex but no less important for our health and survival. Given the importance of social interactions for humans, it is not surprising that most psychiatric disorders involve some disruption of normal social behaviour, and that in several disorders abnormal social functioning is one of the central symptoms. Examples are autism, social anxiety disorder, borderline personality disorder and schizotypal personality disorder.

Despite the importance of social interaction, our understanding of the neural factors that control social behaviour is limited. Human social neuroscience is receiving increasing attention, but much of the current work concerns social cognition. For example, studies on the activation of different brain areas in response to faces with different expressions are interesting and important, but they are not central to the regulation of actual social behaviour. If response to faces was an essential determinant of social interaction, then blind people would not be able to form adequate social relationships and the use of text messaging would not be nearly as widespread as it is.

The most extensive knowledge on the neurobiology of human social behaviour concerns one particular aspect of social behaviour: aggression.[2,3] Research on aggression has led to the use of selective serotonin reuptake inhibitors (SSRIs) for the treatment of impulsive aggression,[4] an illustration of how social neuroscience can lead to treatments for disordered social behaviour. However, aggression, although an important societal problem, does not feature prominently in many disorders even though it is required for the diagnosis of intermittent explosive disorder. Furthermore, overt aggression is not a common part of everyday social interactions.

Research on the neurobiology of less extreme forms of social behaviour than aggression is limited. Two examples of how research on animals is starting to be applied to human social behaviour follow. In some species of monkeys, serotonin can influence both agonistic-affiliative behaviours and hierarchy. Although low levels of serotonin increase aggressive behaviours, as in humans, increasing serotonin function enhances prosocial behaviours such as grooming other animals.[5,6] Increasing serotonin function also helps a male to achieve dominant status.[7] Similar results have been reported in a few studies involving humans, carried out both in the laboratory and in everyday life. In the laboratory, healthy participants receiving an SSRI were rated more dominant and more cooperative during a mixed motive game[8] and showed more affiliative behaviours during a dyadic puzzle task requiring cooperation.[9] On the other hand, acute tryptophan depletion to lower serotonin levels caused reductions in the level of cooperation shown by participants when playing the prisoner's dilemma game.[10] Acute tryptophan depletion also changed behaviour in an ultimatum game in which players had to decide whether to accept or reject fair or unfair monetary offers from another player. Participants with low

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serotonin levels rejected a greater proportion of unfair offers, but not fair offers.[11] This result was consistent with a lowered level of affiliation. In studies investigating social behaviour in everyday life, social behaviour can be studied using an ecological momentary assessment methodology (discussed recently in this journal[12]) that measures behaviours along 2 axes, agreeable–quarrelsome and dominant–submissive. In crossover studies comparing placebo with the administration for 2 or 3 weeks of tryptophan to increase serotonin, increased serotonin was associated with decreased quarrelsomeness and increased dominance among healthy participants,[13] and with decreased quarrelsomeness and increased agreeableness among participants with high trait hostility.[14] In both studies, participants were not able to guess, better than by chance, when they were taking tryptophan and when they were taking placebo, indicating that participants were unaware that their behaviour was changed by tryptophan.

Oxytocin is another compound that has been shown to influence social behaviour in animals, and its effect on humans has been tested recently. Animal studies have shown that oxytocin is involved in the formation of bonds between mates and between mothers and their offspring, including the use of aggression in the protection of these relationships.[15] In laboratory studies involving healthy humans, intranasal administration of oxytocin altered behaviour in a way that indicated increased trust in others.[16,17]

In the past, one of the limiting factors in the study of the neurobiology of human social behaviour was the limitations in the methods for measuring social behaviour. In the past, this usually depended on peoples' own global assessment of their behaviour. The few studies described previously give an indication of the scope of the methodology that is now available for studying human social behaviour both in the laboratory and in everyday life. So far, most studies have looked at the effects on dyadic interactions. Future studies should also look at group interactions, both within groups and between groups. Group behaviour is an important component of human social behaviour and may differ in some ways from dyadic interactions. Social psychologists have studied what they term the interindividual–intergroup discontinuity, which refers to the fact that groups are sometimes more competitive or aggressive than individuals. This has been demonstrated in mixed-motive situations[18] with a test based on Milgram's[19] obedience research in which groups acting as teachers delivered significantly more severe shocks than individuals acting as teachers[20] and in the prisoner's dilemma game in which groups were more competitive than individuals.[21] Furthermore, discussion between groups was characterized by a higher frequency of fear and greed statements than discussion between individuals. How the manipulation of different neurotransmitters might affect these results is not known but should definitely be researched.

The techniques for the study of human social behaviour are available. There are a wide variety of drugs that target different neurotransmitter systems and are available for use in experimental research involving humans. What seems to be lacking at the moment are researchers willing to combine both in their research.

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References

1. Gibbs KA, Urbanowski ML, Greenberg EP. Genetic determinants of self identity and social recognition in bacteria. *Science* 2008;321:256-9.
2. Siever LJ. Neurobiology of aggression and violence. *Am J Psychiatry* 2008;165:429-42.
3. Nelson RJ, Trainor BC. Neural mechanisms of aggression. *Nat Rev Neurosci* 2007;8:536-46.
4. Walsh MT, Dinan TG. Selective serotonin reuptake inhibitors and violence: a review of the available evidence. *Acta Psychiatr Scand* 2001;104:84-91.
5. Higley JD, King ST, Hasert MF, et al. Stability of interindividual differences in serotonin function and its relationship to severe aggression and competent social behavior in rhesus macaque females. *Neuropsychopharmacology* 1996;14:67-76.
6. Raleigh MJ, Brammer GL, Yuwiler A, et al. Serotonergic influences on the social behavior of vervet monkeys (Cercopithecus aethiops sabaeus). *Exp Neurol* 1980;68:322-34.
7. Raleigh MJ, McGuire MT, Brammer GL, et al. Serotonergic mechanisms promote dominance acquisition in adult male vervet monkeys. *Brain Res* 1991;559:181-90.
8. Tse WS, Bond AJ. Serotonergic intervention affects both social dominance and affiliative behavior. *Psychopharmacology (Berl)* 2002;161:324-30.
9. Knutson B, Wolkowitz OM, Cole SW, et al. Selective alteration of personality and social behavior by serotonergic intervention. *Am J Psychiatry* 1998;155:373-9.
10. Wood RM, Rilling JK, Sanfey AG, et al. Effects of tryptophan depletion on the performance of an iterated prisoner's dilemma game in healthy adults. *Neuropsychopharmacology* 2006;31:1075-84.
11. Crockett MJ, Clark L, Tabibnia G, et al. Serotonin modulates behavioral reactions to unfairness. *Science* 2008;320:1739.
12. Moskowitz DS, Young SN. Ecological momentary assessment: what it is and why it is a method of the future in clinical psychopharmacology. *J Psychiatry Neurosci* 2006;31:13-20.
13. Moskowitz DS, Pinard G, Zuroff DC, et al. The effect of tryptophan on social interaction in every day life: a placebo-controlled study. *Neuropsychopharmacology* 2001;25:277-89.
14. aan het Rot M, Moskowitz DS, Pinard G, et al. Social behaviour and mood in everyday life: effects of tryptophan in quarrelsome individuals. *J Psychiatry Neurosci* 2006;31:253-62.
15. Campbell A. Attachment, aggression and affiliation: the role of oxytocin in female social behavior. *Biol Psychol* 2008;77:1-10.
16. Zak PJ, Kurzban R, Matzner WT. Oxytocin is associated with human trustworthiness. *Horm Behav* 2005;48:522-7.
17. Kosfeld M, Heinrichs M, Zak PJ, et al. Oxytocin increases trust in humans. *Nature* 2005;435:673-6.
18. Wildschut T, Pinter B, Vevea JL, et al. Beyond the group mind: a quantitative review of the interindividual-intergroup discontinuity effect. *Psychol Bull* 2003;129:698-722.
19. Milgram S. Some conditions of obedience and disobedience to authority. *Human Relations* 1965;18:57-76. Available: http://hum.sagepub.com/cgi/reprint/18/1/57) (accessed 2008 Aug 11).
20. Jaffe Y, Shapir N, Yinon Y. Aggression and its escalation. *J Cross Cult Psychol* 1981;12:21-36.
21. Insko CA, Schopler J, Graetz KA, et al. Interindividual-intergroup discontinuity in the prisoner's dilemma game. *J Conflict Resolut* 1994;38:87-116.