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## Animal Minds and Animal Emotions<sup>1</sup>

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**SYNOPSIS.** The possibility of conscious experiences of emotions in non-human animals has been much less explored than that of conscious experiences associated with carrying out complex cognitive tasks. However, no great cognitive powers are needed to feel hunger or pain and it may be that the capacity to feel emotions is widespread in the animal kingdom. Since plants can show surprisingly sophisticated “choice” and “decision-making” mechanisms and yet we would not wish to imply that they are conscious, attribution of emotions to animals has to be done with care. Whether or not an animal possesses anticipatory mechanisms associated with positive and negative reinforcement learning may be a guide as to whether it has evolved emotions.

The search for animal consciousness is frequently seen as the search for higher and higher cognitive abilities in animals. Thus most theories of consciousness emphasise intellectual achievement—the ability to form abstract concepts, for example, to understand and to use language or to be able to plan ahead and work out what to do in novel situations. For this reason, the achievements of animals such as Alex the parrot (Pepperberg, 1999) and Kanzi the Bonobo (Savage-Rumbaugh and Lewin, 1994) are immensely significant. But although these achievements are impressive, too much emphasis on the cognitive and intellectual side of consciousness may lead us to overlook other aspects that are equally important. It does not take much intellectual effort to experience pain, fear or hunger. We can be conscious of a headache or afraid of flying without being able to put the experience into words or reason about it. We may in fact tell ourselves that flying is a relatively safe way of travelling—in other words, we try to dispel a basic emotion with cognitive reasoning.

Might it be, then, that our search for animal consciousness could fruitfully be extended to the realm of the emotions and therefore potentially to a much wider range

of animals than just the ones that are outstandingly clever? Might it not be that the conscious experience of emotions is far older in evolutionary time than the ability to form concepts and certainly than that to use language? The purpose of this contribution is to see what the study of animal emotions can tell us about consciousness in animals.

My own interest in animal emotions arose from working for many years on animal welfare, where a central issue is whether and under what circumstances animals suffer—that is, experience strong or persistent negative emotions. These are questions of far more than just theoretical importance. If animals do experience fear and pain and if they experience frustration as a result of being unable to perform their natural behaviour patterns, then this has legal and ethical importance and in turn may have major economic consequences.

Indeed, the really important moral issues in animal welfare arise precisely because of the belief held by many people that animals do have conscious emotional experiences. An early advocate of this idea was Jeremy Bentham (1789) who wrote the often-quoted lines: “The question is not, Can they reason? nor, Can they talk but Can they suffer?” And such views are echoed by more recent philosophers such as Bernard Rollin. It is thus very important that we have some way of studying suffering—the unpleasant emotions of animals.

There are basically two approaches that

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have been adopted to studying animal emotions—the functional and the mechanistic. The functional approach means examining the *role* of emotions in human behaviour and then asking whether the function is the same in humans and non-humans. In many cases it is possible to apply Darwinian ideas to emotions and ask how emotions (in us or in other species) contribute to an organism's fitness. Fear, for example, is adaptive and functions to increase fitness both through motivating an animal to remove itself from danger and also to avoid similar situations in the future.

A widely used framework for viewing emotions in a functional context is that described by Oatley and Jenkins (1998) who see emotions as having three stages: (i) *appraisal* in which there is a conscious or unconscious evaluation of an event as relevant to a particular goal. An emotion is positive when that goal is advanced and negative when it is impeded (ii) *action readiness* where the emotion gives priority to one or a few kinds of action and may give urgency to one so that it can interrupt or compete with others and (iii) *physiological changes, facial expression and then behavioural action*. The trouble with this formulation is that it is so general and unspecific that it encompasses almost all behaviour in the sense that almost everything that humans or other animals do would have to involve such stages. Building a robot to behave in an autonomous and useful way, would almost certainly involve ensuring that it could evaluate its environment as either beneficial or harmful, give priority to one action that would be beneficial and then carry out the action. Worse, it even seems to apply to plants operating without nervous systems and using the simplest of mechanisms. For example, the parasitic plant, Dodder (*Cuscuta europaea*) appears to “choose” which host plants to parasitize on the basis of an initial evaluation of a potential host's nutritional status. Kelly (1992) tied pieces of Dodder stem onto Hawthorn bushes which had been either fed extra nutrients or starved of nutrients. The transplanted growing shoots were more likely to coil on (“accept”) host plants of high nutritional status and grow away from (“reject”) hosts of

poor quality and this acceptance or rejection occurred before any food had been taken from the host. It was thus based on an as yet unknown evaluation by the parasite of the host's potential food value and, within three hours, the growing tips could be seen either growing at right angles away from a rejected stem or coiling around one it would eventually feed from. By changing the time scale (hours rather than minutes) and the mechanism (growth rather than behaviour), we have an organism that shows appraisal, action readiness and action—the supposed functions of emotion without needing a nervous system at all. This suggests that merely defining emotions in a rather vague functional way of what they do in us and then asking whether there is evidence of similar functions in non-human animals is not going to be very fruitful. We need to look in more detail at how the functions are carried out.

The second possible approach to the study of animal emotions is therefore to look at the mechanisms underlying emotions and to see whether they are similar in ourselves and other species. Can we look at what changes both physiologically and behaviourally when we feel happy, sad, etc. and see whether similar changes take place in non-human animals?

In humans, there are three systems underlying emotions (*e.g.*, Oatley and Jenkins, 1998). These are (i) the cognitive/verbal. People can report on what they are feeling and indeed this is one of the main ways we have of knowing what other people are feeling. (ii) autonomic. These include changes in heart rate, temperature and hormone levels when we experience emotions (iii) behaviour/expressive. Different emotions give rise to different behaviour and different facial expressions.

Although of course we cannot use (i) for non-human species since they cannot tell us what they are feeling, it might be possible to use similarities in (ii) and (iii) to tell us what emotions they might be having. Unfortunately, there are problems since the three emotional systems do not necessarily correlate with each other, even in humans. Sometimes, for example, strong subjective emotions occur with no obvious autonomic

changes, as when someone experiences a rapid switch from excitement to fear on a roller coaster. This does not mean that the change in emotional experience has no physiological basis. It just means that it is probably due to a subtle change in brain state rather than the obvious autonomic changes that most physiological methods pick up. At other times, the emotion we experience and report corresponds to several different kinds of autonomic change or one kind of autonomic change such as heart rate can be shown to accompany very different emotions (Wagner, 1989; Frijda, 1986; Cacioppo *et al.*, 1993).

This lack of correlation is not in fact, very surprising. Many of the physiological changes that occur in our bodies when we feel different emotions are related to the actions we are likely to take, such as running. As running occurs when we are afraid and are running away or excited and running towards (chasing) something we want, the same physiological preparations are appropriate for both situations and consequently a range of emotions.

Another reason why the different emotional systems may diverge is that we have 'multiple routes to action' in other words, the same actions can be prompted by instructions from different parts of the brain (Rolls, 1999). An obvious example is breathing. Most of the time we are not conscious of taking breath—it is done automatically. But if we are drowning or told to take deep breaths by a doctor, control shifts to a conscious route. The existence of multiple routes to action makes the comparison with other species particularly difficult, since non-humans could show similar behaviour to ourselves but have it controlled by a pathway that, in ourselves, is just one of the possible routes we can use. The fact that we can, when the occasion demands, become conscious of what we are doing does not, therefore, necessarily mean that other species have all the same circuits that we do. We may have evolved an additional conscious verbal route that is lacking in them. Indeed the evolution of the vertebrate brain has often involved overlaying existing pathways with new ones rather than eliminating existing ones (Panksepp, 1998).

But if neither similarities of function nor similarities of mechanism between humans and non-humans can be reliably used to tell us about emotions in other species, what can we do? What is needed is a combination of a functional and mechanistic approaches that is considerably more specific than the very general approaches I have outlined so far. Only by understanding the very specific mechanisms associated with emotions in ourselves can we hope to be able to know what to look for in other species. As we have already seen, by being too general (emotions are associated with appraisal and action readiness), we include plants and organisms and machines that operate on the very simplest of mechanisms. And by expecting emotions to be reflected in obvious autonomic measures (such as hormonal state and heart rate), we are unable to distinguish the subtleties of emotions even in ourselves.

Let us start with a more specific evolutionary argument. Animals are able to respond to challenges to their health and well-being in various ways and the mechanisms they use can be divided into those that repair damage to the organism's fitness when damage has already occurred and those that enable the organism to anticipate probable damage and take avoiding action so that the damage does not occur at all. The ability to fight off infection with the immune system and to heal wounds are examples of repair mechanisms, whereas most behaviour (drinking before dehydration occurs, hiding before a predator appears) falls into the category of anticipation and pre-emptive action. In fact, we can see the evolution of cognitive abilities in animals as the evolution of more and more sophisticated anticipatory mechanisms, reaching further and further back in time away from the danger itself, until in ourselves we may take out a health insurance policy many years before any damage is done.

The important point about these anticipatory mechanisms, however, is that many of them can be highly effective without the organism being in any way conscious. Where an aspect of the environment is highly predictable (such as the sun rising every day), very accurate anticipation can

be achieved by endogenous rhythms or by simple kinesis and taxis. The ability of Dodder plants to anticipate which hosts are likely to yield the most food before investing in the coiling and growth needed to extract any nutrients is a very good example of a simple anticipatory mechanism and should serve as an object lesson about the dangers of using words like 'choice' or 'appraisal' to imply similarity to the mechanisms we ourselves use. Just to emphasise this point, we should be equally cautious about the conclusions we draw from choice tests in animals, such as those that show that chickens prefer one kind of flooring to another (Hughes and Black, 1973) or will "work" (squeeze through gaps or push heavy weights) to get at something they like. Even plants will push up through concrete to get at light and air so both simple choice tests and those involving physical obstacles to allow animals to get what they 'want' could be nothing more than the operation of animals being evolved by natural selection to respond to certain sorts of stimuli and to keep on responding even when there are obstacles. Despite some of the claims that have been made (*e.g.*, Dawkins, 1990), persistence in the face of physical difficulties does not imply that animals experience the same emotions that we have when we have to work harder to get what we want.

But some animals, including ourselves, have evolved anticipatory mechanisms that are quite different in kind from anything we find in plants, anticipatory mechanisms that cannot be explained by simple tropisms and taxis, anticipatory mechanisms that may necessitate emotions. The key is reinforcement learning or the ability to change behaviour as a result of experience so that behaviour is controlled by completely arbitrary stimuli, quite unlike anything that natural selection could have built into the organism. I am not speaking here of just any change that may occur as a result of experience. The immune system changes as a result of experience with certain pathogens but this can be done through a pre-programmed (if highly sophisticated) response. There is no need to invoke "emotions" in the way our immune systems

change as a result of their experiences of different diseases. Similarly, if an organism (plant or animal) habituates or changes its response as a result of repeated experience, there is no reason to suppose that they have emotions because receptors can be linked (hard-wired) to response mechanisms in predictable ways.

But where an animal learns to perform an arbitrary response to approach or avoid a stimulus, natural selection cannot hard-wire connections between receptor and response mechanisms or evolve simple rules for how responses should change as a result of experience (Rolls, 1999). For example, suppose a rat learns that turning in a right-hand circle gives it food and turning in a left-hand circle gives it an electric shock and then, when the experimenter changes the rules of the experiment, learns to go left to get food and right to avoid a shock. Natural selection could not have led to the evolution of rats able to do this by any simple rules. Hard-wiring or innate response biases could not account for the completely arbitrary response (turning or anything else the irritating human chose to devise) nor for the ability of the animal to change and do something different.

The only way the rat could achieve such a feat would be by having a reward-punishment system which allowed it to associate any action it happened to make it "feel better" or "feel worse" and either repeat or avoid such actions in future (Rolls, 1999). Specific rules (such as always turn right or always turn towards red stimuli) would be very much less effective than more general rules (repeat what leads to feeling better or pleasure). General emotional states of pleasure and suffering would enable animals to exploit many more behavioural strategies to increase their fitness than specific stimulus-response links. The point is, however, that without emotions to guide it, an animal would have no way of knowing whether a behaviour never performed before by any of its ancestors should be repeated or not. By monitoring the consequences of its behaviour by whether it leads to "pleasure" or "suffering" it can build up a complex string of quite arbitrary responses. It can learn, for example, that pressing a lever



leads to the appearance of a striped box which contains food. By finding the striped box “pleasurable” because it is associated with food and learning to press the lever to obtain this pleasure, the rat learns to obtain food through a route that is not open to an animal totally pre-programmed in its responses. Emotions are therefore necessary to reinforcement learning.

We have thus come full circle. If it is only animals that are clever enough to master certain cognitive tasks (those associated with reinforcement learning) that have emotions, then the apparent distinction between cognition and emotions is illusory. Only certain kinds of task require emotions. Others, including those achieved by plants do not. At least this gives us a way of excluding plants from our discussion of consciousness and gives us a way of discriminating those organisms that are likely to have emotion from those that probably do not. We can at least do experiments to find out whether a given animal (an insect, say) does or does not have the capacity for arbitrary reinforcement learning.

But does this really solve the problem of the connection between emotion and consciousness? Of course it does not and I have to admit that I have so far blurred a distinction that is of great importance. I am guilty of using the word “emotion” in two quite different senses that must now be clearly distinguished (Dawkins, 1998). The first sense in which we might use the word “emotion” is to refer to strictly observable physiological and behavioural changes that occur under particular circumstances such as the appearance of a predator. But we might also use it in a second sense to refer to the subjective conscious experience (fear) that we know we experience under conditions of danger.

The problem with the word “emotion” is that it tempts us to slip from one meaning to the other, often without realising that we have done so. We start out describing what we can observe—the behaviour and physiology of the animals or people. I have indeed given an account of why emotional states may have evolved, with behavioural criteria for deciding whether they might exist in a given species. I carefully put scare

quotes around words such as “pleasure” and “suffering” in describing positive and negative emotional states. But the problem is that issue of whether conscious experiences as we know them accompany these states in other species is a totally separate question. Given the ambiguous nature of the word “emotion”, it may not be obvious that it is a separate question because it so easy to believe that once we have postulated a scale of positive to negative reinforcers, once, that is, we have a common currency in which different stimuli can be evaluated to how positive or negative they are on this emotional scale, then we have also into the conscious experience of pain and pleasure that we all know about from our human perspective. But this would be an error. It is quite possible (logically) for animals to have positive or negative emotional states without it *feeling like* anything. Stimuli could be evaluated as negative, in other words, but they wouldn’t necessarily hurt.

Strictly speaking, therefore, consciousness still eludes us. It is my personal view that emotional states defined in the way I have described (using reinforcement value) does imply subjective experience—a conscious awareness of pleasure and pain that is not so very different from our own. But that should be taken for what it is: a personal statement of where I happen to stand, not a view that can be grounded in empirical fact. It is just as valid (and just as open to challenge) as the more widely held beliefs that consciousness “kicks in” with the ability to form abstract concept or plan ahead or use a language (Rosenthal, 1993; Dennett, 1996).

If, however, consciousness is associated with reinforcement learning and the first conscious experiences that occurred on this planet were the basic ones of pain and pleasure, long before any concepts were thought of or any plans laid for the future, then this does have implications for the way we see other species. It implies that emotional awareness is evolutionarily very old and possibly very widespread in the animal kingdom. As Damasio (1999) and Rolls (1999) have others have recently empha-

sized, emotion deserves much more attention than it has had so far.

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