Journal of Zoology. Print ISSN 0952-8369

THOMAS HENRY HUXLEY REVIEW

Animal welfare with and without consciousness

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Keywords
animal welfare; consciousness; emotion; affective state; hard problem; ethics.

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Editor: Nigel Bennett

Received 10 November 2016; accepted 15 November 2016

doi:10.1111/jzo.12434

Abstract

Despite recent advances in understanding brain function, consciousness – specifically, how the brain gives rise to conscious experiences – remains 'the hard problem.' In humans, there are often multiple routes to the same actions, some of them involving conscious experience, others not. Furthermore, differences in brain circuitry make analogies between humans and other animals more difficult than is generally acknowledged. In this essay, I argue that both the study of consciousness itself and the science of animal welfare benefit from facing up to these difficulties rather than glossing over them. Animal welfare science, although often defining good welfare in term of what animals feel, does not have to be based on assumptions about which species have conscious experiences. Animal welfare (well-being) can be defined objectively in terms of animal health and what animals want. Such a conscious-free definition is readily understandable by people with very different views about animals and yet is practical enough to point to what factual scientific information is needed in any given case. While not precluding conscious awareness in other species, it allows animal welfare science to move forward without having solved the hardest biological problem of all.

Introduction

In 1866 T.H. Huxley wrote in his book *The Nature of Consciousness* (p. 93): 'what consciousness is, we know not and how it is that anything so remarkable as a state of consciousness comes about as a result of irritating nervous tissue, is just as unaccountable as the appearance of the Djin when Aladdin rubbed his lamp in the story'. Even today, after countless more words have been written about the nature of consciousness, there is a brilliant clarity in Huxley's stark way of expressing the dichotomy about what we know and what we do not know. On the one hand is the brain, a tangible lump of tissue that can be handled, weighed, measured, sliced and publicly examined. On the other are our conscious experiences - vivid and all-consuming but private and known only to the one person experiencing them. How the two are connected is still so unknown to us that it to say that there is something mysterious and almost magical about it seems entirely appropriate. Today, the dichotomy is often described as 'the hard problem' (Chalmers, 1995), implying that it is not necessarily an insoluble problem but that its solution is still beyond us in a way that is unlike any other biological question.

Of course, our knowledge of the brain and how it works is now vastly greater than it was in Huxley's day. The last 20 years in particular have seen an explosion in our understanding of how the brain lays down and retrieves memories, makes decisions and recognizes objects. We have imaging methods that show us which parts of a living human brain are active at any one time. Looking at the huge numbers of books and papers, not just in philosophy but in neuroscience, that have been published on the subject, anyone could be forgiven for thinking that no rubbing of magical lamps was needed any more and that the mystery of consciousness had now been solved. Certainly, modern brain science would have a great deal to teach Huxley and we can imagine that the updating process would be a source of amazement and delight to him. But I believe that his clear distinction between what a brain is made of and how it produces consciousness is as important now as it ever was and that our hugely greater understanding of how the brain functions has only blurred the distinction, making us think we have solved a mystery that in fact we have not.

In this essay I shall argue that a failure to make the distinction that Huxley made so dramatically and clearly all those years ago has had serious consequences for at least two areas of research. One is the study of consciousness itself. The other is the science of animal welfare, which often makes assumptions about the nature of consciousness in other species. In both cases, facing up to the very real difficulties that consciousness presents may be disappointing in the short term but biologically far more interesting and fruitful in the long run. To quote Huxley again: 'In matters of the intellect, do not pretend that conclusions are certain that are not demonstrated or demonstrable.' (Huxley, 1889).

Consciousness demonstrated?

Our ability to think clearly about consciousness is severely hampered (both in English and in other languages) by the very words we use to describe our conscious experiences. Words like 'fear', 'pain', 'suffering', 'pleasure' and even 'consciousness' itself describe what we ourselves experience in different situations. The primary emphasis in these words is on the subjective, private nature of the experiences that we know we have ourselves. The words can be used freely and quite appropriately with no implication of how the brain is related to conscious experiences. Indeed they can be used, and understood, by someone who believed that the brain had no connection whatsoever with subjective experience.

David Chalmers, who invented the term 'the hard problem', shows his frustration at the way words can result in people deceiving themselves as to what they have or have not explained: 'The ambiguity of the term "consciousness" is often exploited by both philosophers and scientists writing on the subject. It is common to see a paper on consciousness begin with an invocation of the mystery of consciousness, noting the strange intangibility and ineffability of subjectivity, and worrying that so far we have no theory of the phenomenon. Here, the topic is clearly the hard problem - the problem of experience. In the second half of the paper, the tone becomes more optimistic, and the author's own theory of consciousness is outlined. Upon examination, this theory turns out to be a theory of one of the more straightforward phenomena - of reportability, of introspective access, or whatever. At the close, the author declares that consciousness has turned out to be tractable after all, but the reader is left feeling like the victim of a bait-and-switch. The hard problem remains untouched.' (Chalmers, 1995, p.3). The trick (often more self-deception than deliberate deceit) is, as Chalmers points out, in the power of words to mislead, with the word 'consciousness' leading the pack with its ambiguity, and its dual existence as a word in everyday speech and as a more restricted way of describing private experience.

This ambiguity about the meaning of words then gives rise to an even more serious confusion about the relationship between brains and conscious experiences: it hides the growing body of scientific evidence that there are often many different neural circuits underlying the same behaviour, some of them involving consciousness and others not (Cardinal *et al.*, 2002; Rolls, 2017). For example, what we call 'fear' might consist of many different responses, each one controlled by separate neural circuits - one controlling autonomic responses such an increase in heart rate, another controlling reflex withdrawal from an approaching stimulus, another controlling innate behaviour patterns and yet others giving rise to conscious feelings of fear (LeDoux, 2014; Rolls, 2017). To use the single word 'fear' to describe all of these different responses, and particularly to use a word that in ordinary everyday speech is so closely tied to conscious experience, inevitably leads to the erroneous conclusion that an organism showing any one of these responses must also be consciously experiencing what we humans understand as the emotion of fear. If there is only one word to describe a multiple of different processes, it becomes difficult to even articulate the possibility that these processes might be operating separately.

LeDoux (2014) is one of the few people who have publicly admitted to regretting his own choice of words. He originally thought it would be reasonable to refer to the various brain circuits underlying how animals detect and respond to external threats as the 'fear' system but then says: 'This was a mistake that has led to much confusion. Most people who are not in the field naturally assume that the job of a fear system is to make conscious feelings of fear, because the common meaning of fear is the feeling of being afraid. Although research on the brain mechanisms that detect and respond to threats in animals has important implications for understanding how the human brain feels fear, it is not because the threat detection and defense responses mechanisms are fear mechanisms. It is instead because these nonconscious mechanisms initiate responses in the brain and body that indirectly contribute to conscious fear.' (p.2872).

Even clearer examples of behaviour being controlled by different circuits in the brain include breathing, which most of the time we do quite unconsciously but which we can if we wish bring under conscious control and playing sport or a musical instrument, which are done consciously when we are learning and then become automatic and unconscious when we have acquired the skill. A growing number of studies that show both conscious and unconscious routes exist for a range human emotions too (Berridge & Winkielman, 2003; Williams *et al.*, 2009; Anselme & Robinson, 2016). For example, people can respond emotionally to a human face quite differently depending on whether that face is showing a happy, sad or angry expression even when they have no conscious awareness of having seen a face at all (Dimberg *et al.*, 2000; Winkielman, Berridge & Wilbarger, 2005; Tamietto *et al.*, 2009). Our ability to interpret the emotional expression of a human face appears to go on quite unconsciously, via the right hemisphere through which emotional stimuli quickly reach the amygdala along a subcortical route quite separate from the cortical pathways associated with conscious awareness (Gainotti, 2012). Similarly, the processing of fearful stimuli such as the presence of dangerous animals can take place in the human brain quite unconsciously in the amygdala and subcortical regions so that we react quickly to these threats to our survival without being consciously aware of what we are responding to (Fang *et al.*, 2016).

The important point here is that we humans have - 'multiple routes to action' for a wide range of behaviour, some of which involve consciousness and some of which do not, but the words we use do not allow us to express this diversity. We make a single word, such as 'fear', or 'emotion' do the work of describing all of them. And because those words themselves are loaded with implications of conscious experience of 'being afraid' or 'feeling anxious', we all too easily assume that consciousness is always present, whatever circuit is controlling the behaviour. We do not have enough words in common usage to describe what neuroscience is telling us is going on, for example, that escape behaviour may or may not involve what we know as 'being afraid'. As a result, the single word 'fear' is applied to all situations of escaping or avoiding danger, with

the implication that all examples of escape or avoidance involve 'being afraid' (LeDoux, 2014, 2015).

A failure to appreciate that there may be several separate neural circuits underlying the same behaviour and that even in humans only some of them involve conscious experience should make us very careful about extrapolating to possible conscious experiences in other species. Once, it might have been plausible to use the similarity of behaviour between humans and other animals as evidence that if we are conscious when we do something, then they are too. Now that it is clear that even in us the same behaviour can be performed through either a conscious or unconscious route, such a simplistic use of analogies between species is invalid and we can only justify the use of such analogies if we have much more detailed knowledge of the actual mechanisms involved (LeDoux, 2014). It is not just an obscure logical point to say that the behaviour may be similar but the conscious awareness may or may not be there. It is a demonstrable fact even in humans that there are many different ways of achieving the same ends and some of them do not involve conscious awareness. If the behaviour of humans and non-humans is similar, it is not clear whether they are like us when we are conscious or like us when we are using an unconscious route. Neuroscience has made using argument by analogy much, much harder.

A further reason for being cautious about analogies between other species and ourselves is that recent advances in neuroscience have shown that there are major differences between species in how their brains are structured and in how they process the same information. This means that extrapolations from one species to another are not justified without a detailed understanding of the underlying mechanisms (LeDoux, 2014; Rolls, 2017). For example, in humans and other primates, the processing of taste information shows a clear separation between *what* is being tasted, which takes place in the primary taste cortex and its *value* (how pleasant it is), which does not take places until further up into the brain, in the orbito-frontal cortex (Rolls & Scott, 2003). A consequence of this is that primates can keep their recognition of what an object is intact and at the same change their evaluation of it and so perform rapid reversal learning. In rodents, on the other hand, there is no clear separation between what a taste is and how pleasant it is. The taste pathways are connected differently, with subcortical connections by-passing the cortex altogether and making connections directly to the hypothalamus and the amygdala (Rolls, 2014). What look like the same behaviour in rats and humans (learning to associate a response with a particular taste) is actually carried out via completely different circuits and with different consequences for what and how they learn.

We can now see that the use of emotionally-loaded words such as 'fear' 'pleasure' and even 'emotion' have confused the way we think about consciousness and made it difficult to incorporate major new findings about the way the brain actually works into our picture of how emotional responses arise. By using single words such as 'fear' to cover a multitude of different mechanisms, some involving conscious awareness and some not, we blur important distinctions and are in danger of assuming consciousness when it is not there as well as failing to recognize it when it is. It is easy to become convinced that all animals that show evidence of escaping from threats to their survival are 'afraid' in the same way that we are. But because there are many different brain structures that can give rise to the same danger-avoidance behaviour, such an assumption is invalid without a much greater understanding of the underlying mechanisms than we have at the moment LeDoux, 2015). We are just as ignorant of where (and if) consciousness kicks in as Huxley was because we are just as baffled by the hard problem of consciousness – that of experience – as he was. In fact, as I have argued, we have even more reason to be baffled because we now know how much can be accomplished without conscious awareness at all. We now know that are more alternative explanations to be tested and we are only at the beginning of testing them all.

To avoid confusion, I want to stress that I am not denying consciousness in animals. For all we know, many species besides our own do have subjective feelings, possibly like ours, but possibly quite different. What I am arguing is that in the long run we will have a healthier biological approach to the study of consciousness if we acknowledge the uncomfortable, inconvenient and unsatisfactory truth that conscious awareness is still an unsolved problem. It may be less exciting, it may even attract less public attention (and grants) to acknowledge this. It may be regarded as 'kill-joy' (Dennett, 1983; Shettleworth, 2010) but it will have a sounder biological basis and will in the end command more widespread attention and therefore be better for animals themselves than pretending we know more than we do or that we are certain when we are uncertain.

But if consciousness is still so difficult to study that it falls outside the realm of what can be currently demonstrated or even the possibly demonstrable, where does that leave the scientific study of animal welfare? Doesn't this owe its very existence to the assumption that animals do have consciously experienced emotions? At the very least there appears to be a paradox at the heart of welfare science (Fraser, 2008; Dawkins, 2015): to be comprehensive enough to include what most people mean by animal welfare, it must involve understanding what animals consciously feel and experience. But to be a science, it has to embrace the one thing that biology currently finds difficult or impossible to study, namely, animal consciousness.

Animal welfare scientists respond to the paradox in different ways, some claiming that it is so obvious that animals have conscious awareness it is absurd and even dangerous to question the idea (Bekoff, 2007, 2012), and others that it is a problem but that we have either solved or are on the verge of solving (e.g. Broom & Johnson, 1993; Webster, 1994; Boissy *et al.*, 2007; Fraser, 2008; Whiteham & Wielbrowski, 2013; Platt, 2014; Mellor & Beausoleil, 2015). However, as can be seen from the arguments put forward in this essay, we are very far from understanding a key problem in consciousness - that of experience – and are perhaps further than we thought before neuroscience showed just how complex the problem really is. That does not mean that the search is pointless or that what has so far not been demonstrated might become demonstrable in the future. Such a search is as fascinating as it is important (Braithwaite, 2010; Boly *et al.*, 2013; Tononi & Koch, 2015;

Feinberg, Todd & Mallat, 2016) but it is proving to be much more complex than we had hoped. Consequently some animal welfare scientists have come to think that animal welfare is far too important to be made to wait until we have a solution to the most difficult of all biological problems, and have looked for ways of studying animal welfare scientifically that avoid the consciousness issue altogether (Arlinghaus *et al.*, 2009; Dawkins, 2012; Wuerbel, 2009).

Animal welfare without consciousness

While some philosophers argue that the ability to have subjective feelings is not relevant to how animals should be treated (e.g. Carruthers, 2011), for many people, consciousness is at the heart of their concern for animals. The belief that animals have conscious feelings and are capable of experiencing pain and emotions is the basis of their concern for animals and provides the reason for treating animals with more moral consideration than plants or inanimate objects: (Singer, 1975; Midgley, 1983; Rollin, 1989) This view is summed up for many people by Jeremy Bentham's famous declaration about moral attitudes to animals that 'The Question is not, Can they reason? Nor, Can they talk? But, Can they suffer?' (1789). Suffering refers to a wide range of unpleasant emotional states such as fear, anxiety, pain frustration etc. that are prolonged and/or severe (Dawkins, 1990). Suffering, animal welfare and consciousness seem inevitably and inextricably bound together in the very way these words are used in common speech.

Among animal welfare scientists, too, the search for animal consciousness is seen as fundamental to the whole subject and many definitions of 'welfare' are based on what animals feel – meaning conscious awareness of feelings of suffering, pain and pleasure (Duncan, 1993; Fraser, 2008). For example, Duncan (1993) argued 'it is not *being* ill that reduces welfare but *feeling* ill'. I have also argued in the past that what animals feel is key to welfare (Dawkins, 1990), a view I now think was mistaken. Even when the words 'consciousness' or 'feelings' do not explicitly appear in the definition, substitutes such as 'affective state' or 'positive emotions' serve as useful stand-ins (Panksepp, 1998; Boissy *et al.*, 2007; Mellor & Beausoleil, 2015) but in practice only add to the ambiguity surrounding conscious feelings. These words may sound as though they have more scientific basis than 'what animals feel' but what they used to describe is the same. 'Consciousness' has been initially treated with due caution but then allowed to creep back under the radar with a new label. Much of animal welfare science has therefore been concerned either explicitly or implicitly with what animals subjectively feel, initially with their ability to suffer and feel pain (Dawkins, 1990; Broom & Johnson, 1993; Broom, 1998; Wemelsfelder, 2001; Bateson, 2004a,b; Fraser, 2008) and more recently with their capacity to experience pleasure and more positive emotions (Boissy *et al.*, 2007; Mendl, Burman & Paul, 2010; Whiteham & Wielbrowski, 2013; Mellor, 2015).

However, as Fraser (2008) points out, there is also a long tradition of defining animal welfare without any reference to conscious feelings either explicit or implicit. For example, Hurnik (1993) and Walker *et al.* (2012) argue that longevity can be used as an indirect measure of the quality of life on the grounds that only animals that had most of their needs met for most of their lives will survive to healthy old age. Broom (1991) and Barnard & Hurst (1996) saw welfare as related to not just the health of an individual but also to its fitness or reproductive success while for many people an important component of welfare is the extent to which the animal is able to show 'natural behaviour (Kiley-Worthington, 1989; Bracke & Hopster, 2006). Yet others look to physiological measures of 'stress' (Moberg, 1985), and to indicators of autonomic endocrine changes such as increased heart and the release of adrenaline and other hormones (Selye, 1956, 1974; Toates, 1995; Ralph & Tilbrook, 2016). For more positive emotions, the hormone oxytocin, which is found in both humans and other mammals, is commonly released during tactile contact such as nursing, mating, grooming and massage and used as an indication of good welfare (Uvnäis-Moberg, 1998).

A problem with many of these ways of assessing welfare is that while they are objectively measurable and make no reference to unmeasurable conscious feelings, they are often difficult to interpret in terms of good or bad welfare. For example a rise in so-called 'stress' hormones such as corticosteroids occurs not only when an animal is confronted with a predator or other danger (implying reduced welfare) but also in anticipation of food, sex, access to improved environments and other situations normally associated with positive emotions (Mendl, 1991; Rushen, 1991; Toates, 1995; Otovic & Hutchinson, 2015). They appear to be more indicators of arousal and preparation for activity than indicators of good or bad welfare in themselves. A similar situation arises with the interpretation of 'natural behaviour': differences between the behaviour of captive and wild animals can be documented but it is then difficult to argue that the captive animal, safe from predation, has reduced welfare because it lacks the 'natural' behaviour of running away from a predator (Špinka, 2006). 'Natural behaviour' may be a good pointer to possible welfare issues but it is not on its own a reliable indicator that welfare is necessarily reduced.

In an attempt to answer some of these objections and at the same time to provide a clear definition of 'welfare' that did not include (but did not preclude) conscious experiences in animals, I proposed a twofold criterion for good welfare: whether the animal was healthy and whether the animal had what it wanted (Dawkins, 2008).

The first criterion – physical health – is the most obvious and is almost universally accepted as essential to good welfare. Many of the major welfare issues such as feather-pecking in hens (Hartcher *et al.*, 2016), tail-biting in pigs (Taylor *et al.*, 2010) or lameness in dairy cows (Green *et al.*, 2002) result in injury or obvious deterioration in physical health and it would be difficult to argue that these indicate anything other than severely reduced welfare. Physical health can include longevity and absence of the pathological signs of prolonged stress such as enlarged adrenal glands and reduced immune response. Basic concerns to maintain the health and survival and commercial value of animals are often enough to drive the search

for solutions to welfare problems with no reference whatsoever to conscious experiences. Finding ways of preventing animals injuring themselves through self-mutilation or breaking their bones through ill-constructed environments will improve welfare, as will finding ways of preventing outbreaks of diseases. In fact, there is a great deal to be done towards improving the welfare of animals in zoos, farms and laboratories across the world that owes nothing to the belief that animals are conscious and everything to do with improving their physical health by changing the conditions in which they live so that their chances of dying or succumbing to disease and injury are reduced and their chances of remaining healthier for longer are increased. Improving the physical health of animals has the potential to improve the efficiency of farming through reduction in waste, lower disease risk, less need for medication and better quality products (Dawkins, 2016).

The second criterion – what the animal wants – is equally essential. For most people, there is more to good welfare than just not dying of disease and injury so that while physical health may be one essential component of good welfare, it is certainly not the only one. Animals 'having what they want' is a shorthand way of covering a wide variety of way in which animals can, in a publicly observable way, show us whether the environment they are in is positive (something they like and want to continue with) or negative (something they dislike and want to escape from or avoid). Although animals cannot tell us in words what they want, they can vote with their feet, beaks, paws or fins. The simplest method is a straight choice test – animals are 'asked' which of two or more alternatives they prefer. Thus, cows can be asked whether they prefer to feed inside a shed or outside on pasture (Charlton *et al.*, 2011) and zoo animals can be asked whether they prefer to be able to see or be hidden from zoo visitors (Bloomfield *et al.*, 2015). This method can even be used find out what wild animals like or dislike, for example, whether dolphins like or dislike the presence of tourist boats on their feeding areas (Constantine, Brunton & Dennis, 2004; Lusseau, 2004). An indication of what animals want over a longer time scale can be ascertained by seeing how they respond to repeated exposure to something and whether they learn to do something to obtain it (they find it positively reinforcing) or will work to avoid it (negatively reinforcing). For example, Rushen (1986) showed that sheep disliked the process of electro-immobilisation, sometimes used to prevent them struggling when being sheared of their wool by demonstrating that they would learn to avoid going to places where this had happened much more than places where just shearing (without immobilisation) had occurred. By asking 'do animals go back for more?', we can find out what animals want or they don't want in a completely objective way, such as establishing that arthritic rats want to ingest drugs that are known to reduce pain in humans (Colpaert *et al.*, 2001). We effectively have 'the animal's point of view' (Dawkins, 1990), particularly when the animal has to perform an arbitrary task to get what it wants (Rolls, 2014). What choice tests do not give us is any way of knowing whether this point of view is accompanied by conscious experiences (Dawkins, 2001a), particularly as 'wanting' and 'liking' may, even in humans, be associated with sub-cortical processes working at an unconscious level (Anselme & Robinson, 2016).

One of the most exciting trends in animal welfare science is the development of new methods of establishing what animals want that are more flexible than simple choice tests and have the advantage of overcoming some of the problems that have been raised (Fraser & Matthews, 1997; Bateson, 2004a, b). These include 'cognitive bias' which has the great advantage that it establishes not just short-term preferences but long term effects on an animal's long-term mood (Harding, Paul & Mendl, 2004; Bateson & Mather, 2007; Mendl *et al.*, 2010). Instead of giving animals choices or making them work for reinforcements to find out what they like or dislike, animals are trained to discriminate between two stimuli, such as two tones of different pitch, where one is associated with food and the other is associated with something unpleasant such as white noise. Once they have learnt this task, the animals are then played an intermediate tone. The question is whether they classify the intermediate stimulus as positive (more similar to the tone that is associated with food) or negative (more like the tone that was associated with the white noise). A number of studies have now shown that animals that have previously been living in less preferred environments are more likely to interpret an intermediate stimulus as like the negative one whereas animals that have been living in preferred environments tend to interpret intermediate stimuli as more like a positive stimulus (Paul, Harding & Mendl, 2005; Bateson & Mather, 2007; Destrez *et al.*, 2014). Their interpretation of the likelihood of a stimulus giving them a reward appears to be a reflection of their mood or long term emotional state.

The importance of this approach is that it measures long-term effects of living in a particular environment – that is, it measures the animal's mood even when it has been removed from that environment. As such, it has the potential to provide the animal's point of view of living in that environment over a long period of time. Unfortunately, positive and negative bias are sometimes referred to as pessimism and optimism, giving the impression (again through the subtle use of words) that cognitive bias is somehow a direct indicator of conscious state. In fact it is no more indicative of conscious experience than choice tests or reinforcement leaning. It just has the advantage of giving a more long-term view of what the animal wants or does not want.

The true value of invoking 'what the animal wants' in any of these ways is that it allows us to give 'valence' (Mendl *et al.*, 2010) to a host of other suggested measures of welfare, such as how much they play (Held & Špinka, 2011), the rate of telomere attrition (Bateson, 2016), the predictability and structure of their behaviour sequences (Asher *et al.*, 2009) or the occurrence of specific behaviours such as head-shaking in hens (Nicol *et al.*, 2011; Mackie & McKeegan, 2016). In each case, a given measure can be interpreted as indicating improved or reduced welfare by relating it to what the animal itself tells us by its behaviour. For example, we can ask whether an observed rise in corticosteroid ('stress' hormones) is associated with positive valence or something the animal wants (food, sex) or whether it is associated with negative valence or something it wants to get away from (a predator, injury). The physiological changes in the animal's body tell us that it is responding to something but by themselves are often

ambiguous, indicating merely that the animal is preparing for action of some sort but without telling us information whether it is preparing to run towards or away something. However, physiological measure taken in combination with what the animal wants or does not want allow us to ground the physiology in positive or negative welfare, for example to avoid stimuli that are causing injury (Bateson, 1991).

'What the animal wants' is similarly important in helping to decide which 'natural behaviour' is essential for good welfare. The word 'natural' itself has such powerful emotional overtones that it is easy to assume without thinking too hard, that all natural behaviour must be good for welfare and conversely, that animals that are denied the opportunity to perform all their natural species-typical behaviour necessarily have reduced welfare. But whether this is the case is an empirical issue that we can investigate by seeing whether the animal shows evidence of wanting to do the behaviour. For example, being chased by a predator is very natural for many animals and we can see whether being chased is something the animal wants by asking it whether it will choose this as an option or even perform a task to bring about the presence of a predator. Comparable questions about whether animals want to do natural behaviour are becoming more and more important as regulations are brought in requiring animals in laboratories, zoos and farms to be given 'enrichments'. Before deploying or even insisting that enrichments are provided, it is important to ask whether the apparent enrichment results in a genuine improvement in animal welfare. We need, once again, not to be taken in by the power of words (who would not want to have their life enriched?). The animal's viewpoint is crucial here. Does it choose to use the supposed enrichment such as a perch, toy to play with or soil to burrow in? If so, that is good evidence that its welfare is improved, but if it doesn't, and there is no improvement in its health either, then it is difficult to argue that what well-meaning people see as an enrichment to welfare means anything at all to the animal.

The reason we need to include 'what animals want' in the definition of welfare in addition to what is good for their physical health is deeply rooted in the evolution of animal life. Animals are characterized as movers: they behave. They have evolved complex nervous systems and muscles which give them the ability to move around and change their circumstances. Unlike plants which are rooted in one place, most animals can take active steps to go somewhere if their survival and fitness is threatened where they are. Much animal behaviour (and brain power) is given over to a variety of mechanisms for dealing with threats to their health and fitness when these are only minor or even *before* an animal is physically damaged or in real danger (Dawkins, 2001b). For example, fear (or strictly, danger-avoiding mechanisms) come into play before an animal has been actually caught or injured by a predator, causing it to flee or hide so that the predator does not even get close. Hunger occurs long before an animal is in imminent danger of dying of starvation, and is part of mechanisms that lead it to search out food and so restore a food deficit before it gets more critical. This anticipatory element of animal behaviour (what Berridge (2004) calls 'wanting') is why we need to take into account the possibility that an animal may be physically healthy but still highly motivated to carry out behaviour.

To take a classic example, birds of migratory species kept in captivity may be well fed, protected from predators and have much better survival prospects than they would have in the wild. But they will also be highly motivated to fly long distances at certain times of year and, if kept in a cage, will spend long hours fluttering against the bars and attempting to escape. They may remain highly motivated to fly and, if consistently unable to do so, may experience physiological changes that we would describe as 'stress' (Broom & Johnson, 1993). This separation between what actually benefits the health of an animal (what it needs to keep it healthy) and what it wants is particularly noticeable in captive animals placed in environments that are very different from those in which their ancestors evolved. Migration in birds evolved because under some circumstances, the hazards of long distance movement were outweighed by the better food and other conditions found at their destination. Individuals that undertook the journey before conditions began to deteriorate survived better than those that left it too late. Natural selection favoured individuals that prepared for action and were highly motivated to fly. When kept in aviaries with plenty of food, and no need to migrate, the motivation to do so is still there. What we are up against when we keep animals in captivity is that they come with a legacy of how to behave in the wild, which may no longer be appropriate to their health or best prospects for survival now but which is deeply ingrained in them and brings with possibility of serious disorder if the behaviour is prevented. That is why establishing 'what the animal wants' and what it is trying to do has to be part of the definition of good welfare.

But it cannot stand on its own, any more than physical health can. The two criteria together – health and what the animal wants – are complementary and both are necessary for good welfare. Health provides an indication of what will increase survival but on its own leaves out the large number of mechanisms that animals have evolved to take preventative action before survival is threatened (in other words, what they have been evolved to want to do). What animals want provides an indication of their view of their environment but, because animals (and people) do not always choose what is good for their long-term survival, the health criterion has to be invoked as well. We need both to define good welfare.

Fortunately, both are objectively measureable. Neither needs any necessary involvement with conscious experiences, although both leave open the possibility that these may be present. Both can be applied cross-culturally and used by people who have very different views about the status of animals and how they should be valued relative to human beings. Both have major economic and societal benefits. Healthy, disease-free animals deliver efficient farming, less need for medication and safe food (Dawkins, 2016). Good welfare improves food quality (Warris *et al.*, 1998) and increases the repeatability and consistency of the results of laboratory experiments (Richter, Garner & Wuerbel, 2009). Emphasizing the positive benefits that these two elements of good welfare bring to human well-being and prosperity may be one of the most important ways

of improving animal welfare in the future. This two-criterion approach, based firmly on what can be empirically demonstrated may in the end convince more people (and therefore benefit more animals) than insisting that good welfare must be based on the conscious feelings of animals.

For some people, this emphasis on the human benefits of animal welfare that does not depend on seeing animals as conscious beings is upsetting and even offensive. It goes against the trend that has been apparent over the last 50 years, which has been to increasingly view non-human animals as worthy of ethical consideration in their own right because of their capacity to suffer and feel pain, a view that has had a major impact on bringing about change in public opinion, voluntary codes and legislation around the world (Christensen *et al.* (2012). But a pragmatic, consciousness-free view of animal welfare does not replace an ethical view that animals are conscious beings worthy of ethical consideration in their own right. Nor, to repeat an important point made earlier, does it deny that many other species may have conscious feelings much like our own. It simply adds to arguments in favour of taking animal welfare seriously even in a world where much needs to be done to improve the lot of many humans and where many people see human food security and human welfare as having much higher priority than the welfare of non-human animals.

Although the belief that animals are consciously aware will remain for many people the cornerstone of their concern for animal welfare, what I have tried to argue is that trying to solve the hard problem should not be the foundation of animal welfare science. Conscious experience is still so elusive and so difficult to explain that giving it too much weight in animal welfare will only weaken the case for taking animal welfare seriously in the minds of those who are currently unconvinced by analogies between ourselves and other species. We need a science of animal welfare that is firmly rooted in the observable and what can be scientifically tested. If future research brings us closer to understanding how brains of any sort or size give rise to conscious experiences, that can only bring benefit to animal welfare science and added to our knowledge of animals and their welfare. But given the very real problems that attempting to study conscious experiences still poses, such knowledge should be seen as a welcome addition, not a current requirement for a science of animal welfare.

Conclusions

Although the pursuit of consciousness in both ourselves and other species is one of the most fascinating in the whole of biology, the extreme difficulty of the search means that understanding is still a long way off. Rather than pretend we understand it or that the difficulties are not real and likely to remain so for some time, I have argued that it is better to face up to the problems and admit that our ignorance is almost as great as it was when T.H. Huxley was wrestling with the same problem. We should not, therefore, base the science of animal welfare on the assumption that we understand consciousness or can decide which species are or are not conscious. Animal welfare is far too important to be made to wait until the hard problem of consciousness has been solved and deserves more than to be based on the pretence that we understand things that we do not. Animal welfare science has a much more secure future if it is based on hypotheses that can be tested now and on evidence than does not depend on the untestable. I have suggested two criteria – what keeps animals healthy and what they themselves want – that together constitute a necessary and at least partly sufficient basis for an objective, consciousness-free.science of animal welfare.

Although I have stressed the difficulties of studying consciousness in other species, this does not mean that we should abandon the search for consciousness and understanding the baffling problem of the relationship between brains and experience in other species. On the contrary, facing up to the difficulties fairly and squarely could set us free to be more objective about what we do and do not understand. We can investigate the mechanisms of behaviour and whether or not they involve conscious pathways without the pressure of feeling that it is 'good' (for animal welfare) to prove consciousness in a given species or 'bad' (for animal welfare) or dangerous to question it (Bekoff, 2012). The study of animal consciousness is far too important and far too difficult for us to pretend we have demonstrated it when have not or to underestimate the very real difficulties of making it demonstrable in the future.

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Graphical Abstract

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Consciousness, in both human and non-humans species remains such a ‘hard problem’ that both the study of consciousness and the science of animal welfare benefit from facing up to the problem rather than glossing over it. Animal welfare can be defined objectively without consciousness in terms of animal health and what animals want.