ANIMAL WELFARE WITH AND WITHOUT CONSCIOUSNESS

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21 ABSTRACT

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

37

38 INTRODUCTION

39 In 1866 T.H. Huxley wrote in his book *The Nature of Consciousness* (p. 93): “what
40 consciousness is, we know not and how it is that anything so remarkable as a state of
41 consciousness comes about as a result of irritating nervous tissue, is just as unaccountable
42 as the appearance of the Djinn when Aladdin rubbed his lamp in the story”. Even today, after
43 countless more words have been written about the nature of consciousness, there is a
44 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 behavior, some of them involving consciousness and others not (Cardinal, Parkinson, Hall *et al.*, 2002; Rolls, 2016). For example, what we call ‘fear’ might consist of many different responses, each one controlled by separate neural circuits - one controlling autonomic responses such as an increase in heart rate, another controlling reflex withdrawal from an approaching stimulus, another controlling innate behavior patterns and yet others giving rise to conscious feelings of fear (LeDoux, 2014; Rolls, 2016). 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

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

126 Even clearer examples of behavior being controlled by different circuits in the brain
127 include breathing, which most of the time we do quite unconsciously but which we can if we
128 wish bring under conscious control and playing sport or a musical instrument, which are
129 done consciously when we are learning and then become automatic and unconscious when
130 we have acquired the skill. A growing number of studies that show both conscious and
131 unconscious routes exist for a range human emotions too (Berridge and Winkielman, 2003;
132 Williams et al., 2009; Anselme and Robinson, 2016). For example, people can respond
133 emotionally to a human face quite differently depending on whether that face is showing a
134 happy, sad or angry expression even when they have no conscious awareness of having
135 seen a face at all (Dimberg et al., 2000; Winkielman, Berridge and Wilbarger, 2005;
136 Tamietto, Castelli, Viggetti *et al.*, 2009). Our ability to interpret the emotional expression of
137 a human face appears to go on quite unconsciously, via the right hemisphere through which
138 emotional stimuli quickly reach the amygdala along a subcortical route quite separate from

139 the cortical pathways associated with conscious awareness (Gainotti, 2012). Similarly, the
140 processing of fearful stimuli such as the presence of dangerous animals can take place in the
141 human brain quite unconsciously in the amygdala and subcortical regions so that we react
142 quickly to these threats to our survival without being consciously aware of what we are
143 responding to (Fang, Li, Chen *et al.*, 2016).

144 The important point here is that we humans have - ‘multiple routes to action’ for a
145 wide range of behavior, some of which involve consciousness and some of which do not, but
146 the words we use do not allow us to express this diversity. We make a single word, such as
147 “fear”, or “emotion” do the work of describing all of them. And because those words
148 themselves are loaded with implications of conscious experience of ‘being afraid’ or ‘feeling
149 anxious’, we all too easily assume that consciousness is always present, whatever circuit is
150 controlling the behaviour. We do not have enough words in common useage to describe
151 what neuroscience is telling us is going on, for example, that escape behavior may or may
152 not involve what we know as “being afraid”. As a result, the single word “fear” is applied to
153 all situations of escaping or avoiding danger, with the implication that all examples of
154 escape or avoidance involve “being afraid” (LeDoux, 2014, 2015).

155 A failure to appreciate that there may be several separate neural circuits underlying
156 the same behaviour and that even in humans only some of them involve conscious
157 experience should make us very careful about extrapolating to possible conscious
158 experiences in other species. Once, it might have been plausible to use the similarity of
159 behaviour between humans and other animals as evidence that if we are conscious when
160 we do something, then they are too. Now that it is clear that even in us the same behaviour
161 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 behavior 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 (Le Doux, 2014; Rolls, 2016). 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 and 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 behavior in rats and humans (learning to associate a

185 response with a particular taste) is actually carried out via completely different circuits and
186 with different consequences for what and how they learn.

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

203 To avoid confusion, I want to stress that I am not denying consciousness in animals.
204 For all we know, many species besides our own do have subjective feelings, possibly like
205 ours, but possibly quite different. What I am arguing is that in the long run we will have a
206 healthier biological approach to the study of consciousness if we acknowledge the
207 uncomfortable, inconvenient and unsatisfactory truth that conscious awareness is still an

208 unsolved problem. It may be less exciting, it may even attract less public attention (and
209 grants) to acknowledge this. It may be regarded as 'kill-joy' (Dennett, 1983; Shettleworth
210 2010) but it will have a sounder biological basis and will in the end command more
211 widespread attention and therefore be better for animals themselves than pretending we
212 know more than we do or that we are certain when we are uncertain.

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

222 Animal welfare scientists respond to the paradox in different ways, some claiming
223 that it is so obvious that animals have conscious awareness it is absurd and even dangerous
224 to question the idea (Bekoff, 2007, 2012), and others that it is a problem but that we have
225 either solved or are on the verge of solving (e.g. Broom and Johnson, 1993; Webster, 1994;
226 Boissy, Manteuffel and Jensen, 2007; Fraser, 2008; Whiteham and Wielbrowski, 2013; Platt,
227 2014; Mellor and Beusoleil, 2015). However, as can be seen from the arguments put
228 forward in this essay, we are very far from understanding a key problem in consciousness -
229 that of experience – and are perhaps further than we thought before neuroscience showed
230 just how complex the problem really is. That does not mean that the search is pointless or

231 that what has so far not been demonstrated might become demonstrable in the future.
 232 Such a search is as fascinating as it is important (Braithwaite, 2010; Boly, Seth and Wilkie et
 233 al. 2013; Tononi and Koch, 2015; Feinberg, Todd and Mallatt, 2016) but it is proving to be
 234 much more complex than we had hoped. Consequently some animal welfare scientists have
 235 come to think that animal welfare is far too important to be made to wait until we have a
 236 solution to the most difficult of all biological problems, and have looked for ways of studying
 237 animal welfare scientifically that avoid the consciousness issue altogether (Arlinghaus,
 238 Schweb, Cooke et al., 2009; Dawkins, 2012; Wuerbel, 2009).

239

240 ANIMAL WELFARE WITHOUT CONCIOUSNESS

241 While some philosophers argue that the ability to have subjective feelings is not
 242 relevant to how animals should treated (e.g. Carruthers, 2011), for many people,
 243 consciousness is at the heart of their concern for animals. The belief that animals have
 244 conscious feelings and are capable of experiencing pain and emotions is the basis of their
 245 concern for animals and provides the reason for treating animals with more moral
 246 consideration than plants or inanimate objects: (Singer, 1975; Midgley, 1983, Rollin, 1989)
 247 This view is summed up for many people by Jeremy Bentham's famous declaration about
 248 moral attitudes to animals" that "The Question is not, Can they reason? Nor, Can they talk?
 249 But, Can they suffer?' (1789). Suffering refers to a wide range of unpleasant emotional
 250 states such as fear, anxiety, pain frustration etc that are prolonged and/or severe (Dawkins,
 251 1990). Suffering, animal welfare and consciousness seem inevitably and inextricably bound
 252 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 in the past also argued 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, Manteuffel and Jensen, 2007; Mellor and 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, 1998; Broom and Johnson, 1993; Wemelsfelder, 2001; Bateson, 2004; Fraser 2008) and more recently with their capacity to experience pleasure and more positive emotions (Boissy, Manteuffel and Jensen, 2007; Mendl, Burman and Paul, 2010; Whiteham and 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, Duggan, Roulston *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

276 Barnard and Hurst (1996) saw welfare as related to not just the health of an individual but
277 also to its fitness or reproductive success while for many people an important component of
278 welfare is the extent to which the animal is able to show 'natural behavior (Kiley-
279 Worthington, 1989; Bracke and Hopster, 2006). Yet others look to physiological measures of
280 'stress' (Moberg, 1985), and to indicators of autonomic endocrine changes such as
281 increased heart and the release of adrenaline and other hormones (Selye, 1956, 1974;
282 Toates, 1995; Ralph and Tilbrook, 2016). For more positive emotions, the hormone oxytocin,
283 which is found in both humans and other mammals, is commonly released during tactile
284 contact such as nursing, mating, grooming and massage and used as an indication of good
285 welfare (Uvnäis-Moberg, 1998).

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

299 welfare issues but it is not on its own a reliable indicator that welfare is necessarily reduced.

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

304 The first criterion – physical health – is the most obvious and is almost universally
305 accepted as essential to good welfare. Many of the major welfare issues such as feather-
306 pecking in hens (Hartcher, Wilkinson, Hemsworth *et al.*, 2016), tail-biting in pigs (Taylor,
307 Main, Mendl *et al.*, 2012) or lameness in dairy cows (Green, Hedges, Schukken *et al.*, 2002)
308 result in injury or obvious deterioration in physical health and it would be difficult to argue
309 that these indicate anything other than severely reduced welfare. Physical health can
310 include longevity and absence of the pathological signs of prolonged stress such as enlarged
311 adrenal glands and reduced immune response. Basic concerns to maintain the health and
312 survival and commercial value of animals are often enough to drive the search for solutions
313 to welfare problems with no reference whatsoever to conscious experiences. Finding ways
314 of preventing animals injuring themselves through self-mutilation or breaking their bones
315 through ill-constructed environments will improve welfare, as will finding ways of
316 preventing outbreaks of diseases. In fact, there is a great deal to be done towards improving
317 the welfare of animals in zoos, farms and laboratories across the world that owes nothing to
318 the belief that animals are conscious and everything to do with improving their physical
319 health by changing the conditions in which they live so that their chances of dying or
320 succumbing to disease and injury are reduced and their chances of remaining healthier for
321 longer are increased. Improving the physical health of animals has the potential to improve

322 the efficiency of farming through reduction of waste, lower disease risk, less need for
323 medication and better quality products (Dawkins, 2016).

324 The second criterion – what the animal wants – is equally essential. For most people,
325 there is more to good welfare than just not dying of disease and injury so that while physical
326 health may be one essential component of good welfare, it is certainly not the only one.
327 Animals ‘having what they want’ is a shorthand way of covering a wide variety of way in
328 which animals can, in a publicly observable way, show us whether the environment they are
329 in is positive (something they like and want to continue with) or negative (something they
330 dislike and want to escape from or avoid). Although animals cannot tell us in words what
331 they want, they can vote with their feet, beaks, paws or fins. The simplest method is a
332 straight choice test – animals are “asked” which of two or more alternatives they prefer.
333 Thus cows can be asked whether they prefer to feed inside a shed or outside on pasture
334 (Charlton, Rutter, East *et al.*, 2011) and zoo animals can be asked whether they prefer to be
335 able to see or be hidden from zoo visitors (Bloomfield, Gillespie, Kerswell, *et al.*, 2015). This
336 method can even be used find out what wild animals like or dislike, for example, whether
337 dolphins like or dislike the presence of tourist boats on their feeding areas (Constantine,
338 Brunton and Dennis, 2004; Lusseau, 2004). An indication of what animals want over a longer
339 time scale can be ascertained by seeing how they respond to repeated exposure to
340 something and whether they learn to do something to obtain it (they find it positively
341 reinforcing) or will work to avoid it (negatively reinforcing). For example, Rushen, (1986)
342 showed that sheep disliked the process of electro-immobilisation, sometimes used to
343 prevent them struggling when being sheared of their wool by demonstrating that they
344 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 and 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 and Matthews, 1997; Bateson, 2004). 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 and Mendl, 2004; Bateson and Mather, 2009; Mendl, Burman and Paul, 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 and Mendl, 2005; Bateson and Mather, 2007; Destrez, Deiss, Le Terrier, *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 learning. 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, Burman and Paul, 2010) to a host of other suggested measures of welfare, such as how much they play (Held and Spinka, 2011), the rate of telomere attrition (Bateson, 2004), 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 and 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

391 corticosteroid (“stress” hormones) is associated with positive valence or something the
392 animal wants (food, sex) or whether it is associated with negative valence or something it
393 wants to get away from (a predator, injury). The physiological changes in the animal’s body
394 tell us that it is responding to something but by themselves are often ambiguous, indicating
395 merely that the animal is preparing for action of some sort but without telling us
396 information whether it is preparing to run towards or away something. However,
397 physiological measure taken in combination with what the animal wants or does not want
398 allow us to ground the physiology in positive or negative welfare, for example to avoid
399 stimuli that are causing injury (Bateson, 1991)

400 ‘What the animal wants’ is similarly important in helping to decide which ‘natural
401 behaviour’ is essential for good welfare. The word ‘natural’ itself has such powerful
402 emotional overtones that it is easy to assume without thinking too hard, that all natural
403 behaviour must be good for welfare and conversely, that animals that are denied the
404 opportunity to perform all their natural species-typical behaviour necessarily have reduced
405 welfare. But whether or not this is the case is an empirical issue that we can investigate by
406 seeing whether the animal shows evidence of wanting to do the behaviour. For example,
407 being chased by a predator is very natural for many animals and we can see whether being
408 chased is something the animal wants by asking it whether it will choose this as an option or
409 even perform a task to bring about the presence of a predator. Comparable questions about
410 whether animals want to do natural behavior are becoming more and more important as
411 regulations are brought in requiring animals in laboratories, zoos and farms to be given
412 ‘enrichments’. Before deploying or even insisting that enrichments are provided, it is
413 important to ask whether the apparent enrichment results in a genuine improvement in

414 animal welfare. We need, once again, not to be taken in by the power of words (who would
415 not want to have their life enriched?) The animal's viewpoint is crucial here. Does it choose
416 to use the supposed enrichment such as a perch, toy to play with or soil to burrow in? If so,
417 that is good evidence that its welfare is improved, but if it doesn't, and there is no
418 improvement in its health either, then it is difficult to argue that what well-meaning people
419 people see as an enrichment to welfare means anything at all to the animal.

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

436 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 and 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 behavior 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

460 action before survival is threatened (in other words, what they have been evolved to want
461 to do). What animals want provides an indication of their view of their environment but,
462 because animals (and people) do not always choose what is good for their long term
463 survival, the health criterion has to be invoked as well. We need both to define good
464 welfare.

465 Fortunately, both are objectively measureable. Neither needs any necessary
466 involvement with conscious experiences, although both leave open the possibility that these
467 may be present. Both can be applied cross-culturally and used by people who have very
468 different views about the status of animals and how they should be valued relative to
469 human beings. Both have major economic and societal benefits. Healthy, disease-free
470 animals deliver efficient farming, less need for medication and safe food (Dawkins 2016).
471 Good welfare improves food quality (Warris, Brown, Gade, *et al.*, 1998) and increases the
472 repeatability and consistency of the results of laboratory experiments (Richter, Garner and
473 Wuerbel, 2009). Emphasizing the positive benefits that these two elements of good welfare
474 bring to human well-being and prosperity may be one of the most important ways of
475 improving animal welfare in the future. This two-criterion approach, based firmly on what
476 can be empirically demonstrated may in the end convince more people (and therefore
477 benefit more animals) than insisting that good welfare must be based on the conscious
478 feelings of animals.

479 For some people, this emphasis on the human benefits of animal welfare that does
480 not depend on seeing animals as conscious beings is upsetting and even offensive. It goes
481 against the trend that has been apparent over the last 50 years, which has been to
482 increasingly view non-human animals as worthy of ethical consideration in their own right

483 because of their capacity to suffer and feel pain, a view that has had a major impact on
484 bringing about change in public opinion, voluntary codes and legislation around the world
485 (Christensen, Lawrence, Lund *et al.* (2012). But a pragmatic, consciousness-free view of
486 animal welfare does not replace an ethical view that animals are conscious beings worthy of
487 ethical consideration in their own right. Nor, to repeat an important point made earlier,
488 does it deny that many other species may have conscious feelings much like our own. It
489 simply adds to arguments in favour of taking animal welfare seriously even in a world where
490 much needs to be done to improve the lot of many humans and where many people see
491 human food security and human welfare as having much higher priority than the welfare of
492 non-human animals.

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

506 CONCLUSIONS:

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

522 Although I have stressed the difficulties of studying consciousness in other species,
523 this does not mean that we should abandon the search for consciousness and
524 understanding the baffling problem of the relationship between brains and experience in
525 other species. On the contrary, facing up to the difficulties fairly and squarely could set us
526 free to be more objective about what we do and do not understand. We can investigate the
527 mechanisms of behavior and whether or not they involve conscious pathways without the
528 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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