The implications of cognitive processes for animal welfare

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THE IMPLICATIONS OF COGNITIVE PROCESSES FOR ANIMAL WELFARE[1]

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ABSTRACT

In general, codes that have been designed to safeguard the welfare of animals emphasize the importance of providing an environment that will ensure good health and a normal physiological and physical state, that is, they emphasize the animals' physical needs. If mental needs are mentioned, they are always relegated to secondary importance. The argument is put forward here that animal welfare is dependent solely on the cognitive needs of the animals concerned. In general, if these cognitive needs are met, they will protect the animals' physical needs. It is contended that in the few cases in which they do not safeguard the physical needs, it does not matter from a welfare point of view. The human example is given of being ill. It is argued that welfare is only adversely affected when a person feels ill, knows that he or she is ill, or even thinks that he or she is ill, all of which processes are cognitive ones. The implications for welfare of animals possessing certain cognitive abilities are discussed. For example, the extent to which animals are aware of their internal state while performing behavior known to be indicative of so-called states of suffering, such as fear, frustration, and pain, will determine how much they are actually suffering. With careful experimentation it may be possible to determine how negative they feel these states to be. Similarly, the extent to which animals think about items or events absent from their immediate environment will determine how frustrated they are in the absence of the real item or event but in the presence of the cognitive representation.

Key Words: Suffering, Animal Welfare, Perception, Memory, Learning Ability

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Introduction

We wish to start with a quotation from the discussion that took place at a recent European meeting on the behavioral needs of farm animals (Hughes, 1988):

> It was quickly agreed that animals should be able to perform behavior that was necessary for the maintenance of a normal physiological, ethological and physical state. There was then a lengthy discussion as to whether some mention of the animal's mental and psychological state should be specifically included or whether inclusion of the first three would also, by implication, adequately cover the last. A consensus emerged that it would not and therefore it was desirable to identify maintenance, and bodily, physiological and physical needs on the one hand, and mental, psychological and cognitive needs on the other.

We wish to stand this conclusion on its head. Our thesis is that animal welfare is dependent solely on the mental, psychological, and cognitive needs of the animals concerned. In general, if these mental needs are met, they will cover the physical needs. There may be a few cases in which looking after the animal's mental needs does not safeguard its physical

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needs and we would argue that, from a welfare point of view, it does not matter. We have thus extended the earlier idea, that welfare is mainly dependent on what the animal "feels" (i.e., on cognitive processes) (Duncan and Dawkins, 1983; Dawkins, 1990), to its logical conclusion.

Health and Welfare

We think that it is instructive to take the example of health and welfare. It has been said that welfare includes the notion of physical and mental well-being (Command Paper 2836, 1965). We would argue that as long as the animal's mental state is protected (i.e., as long as the animal "feels" all right) then its welfare will be all right. Now, of course, usually when an animal *is* ill, it will also *feel* ill, so that taking care of its mental state (i.e., how it feels) will automatically take care of its physical health. However, there may be cases in which the animal is not in full physical health, but feels all right, and we conclude that its welfare is all right. This line of argument is easier to follow if we take human examples. The welfare of a person with tooth decay only becomes diminished when the person becomes aware that something is wrong. This awareness can come about in two ways: directly, when the offending tooth causes discomfort, and indirectly, when, during a routine examination, the dentist points out the decay and the patient starts to fear treatment. Another example would be the case of a woman who suddenly discovers a lump in her breast. Until the moment of discovery her welfare may have been perfect. It then plummets and remains at a low level until a biopsy reveals that the lump is benign. Her welfare may then soar to the extent that she may feel quite euphoric, even though she knows she will have to enter the hospital and go through minor surgery to have the lump removed, circumstances that would normally serve to reduce welfare.

So, health, which is surely the most obvious of the physical needs, is not necessarily a prerequisite for welfare. Of course, usually there will be a close relationship between physical health and welfare and, moreover, poor health may be undesirable for other reasons such as hygienic, productivity, and aesthetic reasons. Also, it may be easier to tell if an animal is ill rather than feeling ill, but, from a welfare and suffering point of view, it is feeling ill that matters.

Put another way, we are distinguishing "needs," which are those things essential for an animal's survival and reproductive success, from "wants," which are the animal's cognitive representation of its needs. Welfare is all to do with wants. Now in the natural world, an animal's wants will correspond closely with its needs; we assume that wants have evolved as a mechanism for taking care of needs. However, this is not necessarily true in the world of animal agriculture. Artificial selection has led to many instances of a divergence between needs and wants. For example, strains of broiler chickens and finishing pigs have been selected for many generations for fast growth rate. The breeding stock of these strains may have a want for food that conflicts with their need to be in good reproductive condition, and, unless they are kept on a severe food restriction regimen, they become obese and their reproductive function is impaired.

The idea of welfare depending on what the animal wants will be a difficult one for animal scientists to accept. Most scientists working in this field regard themselves as caretakers, and the caretaking attitude of "we know best what is good for our animals" dies very hard. It is certainly true that when it comes to productivity, hygiene, morbidity, and so on, the animal scientist does know best. However, when it comes to how the animal *feels*, which is what welfare is all about, then we maintain that the animal knows best.

The Cognitive Processes

The cognitive processes that might be held by farm animals and suggested by such terms as "feelings," "perception," "awareness," and so on, will now be considered. These processes were discussed in more detail by Bunge (1980) and Bunge and Ardila (1987).

First, we would like to distinguish between "sensing" or "detecting" and "feeling" and "perceiving." A sensory system of an animal is a subsystem of its nervous system, composed of neurosensors and neural pathways leading to the corresponding primary sensory cortical area in the brain. An animal is only aware of a fraction of the sensory input that is assailing its central nervous system at any particular time. Thus, when people stare into space, deep in thought, their visual and auditory sensory systems have not stopped functioning, although they may be completely unaware of the information being passed to their brains.

"Awareness" has therefore a lot to do with attention. A "sensation" or "feeling" is a specific activity in a sensory system of which an animal is aware. It is also possible that the sensory system may carry out some initial filtering of the stimuli (e.g., the frog's eye contains detectors that respond exclusively to moving insects; Lettvin et al., 1959), and this is not a cognitive process.

"Perception" is more than just sensing internal or external stimuli; it involves some processing or interpretation by other areas of the brain, the secondary and tertiary cortical sensory areas. These areas are plastic throughout the animal's life, whereas the primary sensory area is plastic only during the early stages of development. For example, in the cat, the primary sensory area has lost its plasticity by the time the animal is 3 mo old (Wiesel, 1982). It is this difference in plasticity between the primary and the other sensory areas that accounts for the difference between sensation and perception. Unfortunately, the term "perceive" is used rather loosely in everyday language to mean "be aware of sensations." We would rather restrict its meaning to those cases in which there is some processing or interpretation by secondary and tertiary cortical areas. According to this definition, it is possible to have some sensations without perceptions (e.g., feeling hot or cold, hungry or sated, tired or energetic).

So, to summarize thus far, "feeling" is sensing and being aware of bodily events and "perceiving" is detecting and interpreting signals that normally originate in external events. An animal is "aware of" (or notices) a stimulus if it "feels" it (for internal events) or "perceives" it (for external events). These are the simplest of the cognitive processes.

The next categories of cognition to be considered are "memory" and "learning." It is likely that the invertebrates have only fixed (or hard-wired) memory systems, and Bunge (1980) denied that these systems would allow cognition, although this point was disputed by Griffin (1984). The higher vertebrates have plastic (or itinerant) memory systems and activity in these systems can certainly be regarded as cognition. There are many different models of memory, but the more recent ones that seem to fit with the facts are dynamic models that involve the strengthening or weakening of synaptic connectivities (i.e., dispositions to form similar connections). This means that there is no storage of past states or events. According to Bindra (1976), whatever the detailed mechanism of remembering, it does not seem to consist in the reactivation of some fixed neural circuit, but in the fresh production or reconstruction of an item. "Learning" is the acquisition of new neural functions within a plastic neural system. A resultant ability of memory and learning is expectation or anticipation. If an animal can learn, then it has expectations, and, in turn, expecting helps learning. Animals endowed with the ability to expect can regulate the effort they put into doing something. The corollary of expectation is surprise; an animal incapable of learning is never surprised and never disappointed.

Something must now be said about "recognition," the process by which memory is revealed. There are different classes of recognition, the simplest of which is being able to categorize items as familiar or novel. Most of the higher animal species can do this quite well. Monkeys shown a series of 25 pictures twice in a random order are able to recognize with more than 90% accuracy whether a picture is being presented for the first or second time (Davis and Fitts, 1976). A class of recognition that animals find more difficult is being able to categorize equally familiar items according to whether they have previously been associated with a reward or not. With a list of 16 items, monkeys only reached an accuracy of 60% (Davis and Fitts, 1976). A more complicated process is that of recognizing previously unseen items as belonging to a familiar class of items. The whole process involves generalization, concept formation, and discrimination. For example, Hermstein (1979) has shown that, after training, pigeons can identify previously unseen pictures of trees as "trees." Individual recognition is the process by which an item is identified by some form of unique label and is usually used with regard to conspecifics. Of course, all the domestic species seem to have the ability to recognize at least some of their conspecifics individually. However, it should be pointed out that incontrovertible proof of this does not come from the existence of social hierarchies (because automata can be designed that will arrange themselves in hierarchies). Evidence for individual recognition comes from experiments that commonly use operant conditioning techniques. For example, Ryan (1982) demon-

strated clearly that domestic cocks were able to recognize each other individually from photographic slides. Moreover, they were able to identify other cocks from views of them that they had never seen before, which is conclusive evidence that they had formed concepts of the others as individuals.

Finally, a word about "recall." Recall usually takes the form of describing verbally a mental representation of past items or events and so is only possible for human beings. However, presumably it is also possible to draw a mental representation (if it is a visual image), and one wonders whether Desmond Morris's artistic chimps (Morris, 1962) could ever draw what they were recalling!

Welfare Implications

The implications for welfare of the possession of any of these cognitive capacities is as follows. Most of the studies of "suffering" in animals have involved exposing them to "frightening," "frustrating," or "painful" situations (defined operationally) and making catalogs of the elicited behavior patterns. These catalogs can then be used as indicators of "fear" or "frustration" or "pain" in commercial conditions. However, the conclusions that can be drawn from such studies are only of the following type: if animals perform a particular set of responses they are frightened, and if they perform another set they are frustrated. Nothing can be said of their mental state. It can be inferred that because human beings find states of fear or frustration unpleasant or aversive (usually), then by analogy (and perhaps by homology) so will animals. However, the possibility exists that the animals are acting automatically with little or no awareness of what is happening. Awareness, then, is crucial in this debate. If it can be shown that animals are aware of their internal state while performing behavior patterns known to be indicative of fear, frustration, or pain, then conclusions about suffering are much more sound.

Of course the argument can be put forward that although animals are feeling *something* that does not mean to say that they are experiencing anything similar to a human being who feels fright, frustration, or pain. Although that is true, we can get some idea of the general nature of the feeling, whether it is positive or negative, by making use of another cognitive process, learning.

For example, medium hybrid hens are able to learn to avoid a frightening stimulus in a shuttle box, a piece of equipment composed of two chambers joined by a doorway. Food and water are provided in both chambers of the box. The test bird can be given a fright by remotely inflating a balloon situated over the food container at the front of each chamber. A rapidly inflating balloon has been shown to be a reliably frightening stimulus to hens (Duncan and Filshie, 1980), probably because it is perceived as a looming stimulus. When the balloon is inflated, the bird gets a fright, dashes about, often giving alarm calls, and eventually escapes from the frightening stimulus by moving into the other chamber. However, there is also a balloon that can be inflated there, so there is no "safe" place. The experiment that demonstrates that being frightened is an unpleasant experience for a hen consists in warning it that the balloon is going to be inflated by switching on a small signal lamp 20 s before inflation. When this was done in an experiment involving 15 hens, all of them learned quite quickly to move to the other chamber before the balloon was inflated and so avoid being frightened. The criterion for learning was six successive successful avoidances. The birds learned to avoid after a median of 20 pairings of the warning signal with the inflating balloon with a range of 7 to 30 pairings. Not only did the birds learn, but as they learned they became less frightened. Eight birds gave high-intensity ground predator alarm calls when the balloon was inflated, and the duration of alarm calling fell from 2.6 to .3 min during the six successive successful avoidances (Kendall's coefficient of concordance = .65; $P < .01$). This suggests that chickens are not simply acting reflexly when they get a fright. They also have an unpleasant mental experience and, if given the opportunity, they will learn to avoid being frightened.

Another aspect of cognition that may affect welfare is the animal's perception of the time it is living in. It is generally accepted that human beings spend much time thinking about past events and possible future events. Compared to this, it has been suggested that animals live very much in the present, affected only, or to a large extent, by the external and internal stimuli that are impinging at that particular time. If this is true, then there will be consequences for welfare. For example, an animal may not have the cognitive capacity to

think about pain in its absence and in the absence of any conditioned stimuli. However, the corollary of this is that when real pain is present, it may be all-important because the animal has not the cognitive capacity to foresee its end or to think about other things.

The same may be true for items in space as for events in time. Human beings spend much time thinking about things absent from their immediate environment. Animals may be much more stimulus-bound. For example, although a courting cock may be a very potent stimulus for eliciting sexual behavior in the hen, and although the hen may be aware of what she is experiencing during courtship, and even although this experience may be positive, nevertheless, in the absence of a cock, the hen may not think about sex at all.

In an experiment designed to measure sexual motivation in cocks and hens, a small room was divided by wire mesh so that the test bird could be placed on one side and a target bird on the other side, in sight of the test bird. The two sides were joined by a one-way push door. Domestic fowl do not like anything touching their body-surface, and so pushing open a door is to some extent aversive and a measure of motivation. Cocks and hens with previous sexual experience were deprived of the opportunity to perform sexual behavior for a week and then were tested. Cocks were prepared to push through the door to get to both familiar and strange females with which they courted and copulated. The hens did not push through to get to familiar or strange cocks.

In the second part of this study only the behavior of cocks toward hens was investigated. Half the cocks were trained to push through a red door and half through a blue door to get to a hen. This was repeated many times. A black plastic sheet was then lowered over the wire mesh so that the cocks could not see what was on the other side of the room. Much to our surprise, the cocks did not push through either door. The tentative conclusion from this is that sexual behavior is very much under visual control and that when hens are out of sight they are also out of mind.

We have also used a Y-maze to carry out similar work on dust-bathing behavior. Hens were deprived of the opportunity to dust-bathe for 4 d. They were then run in a Y-maze with the two goal-boxes in sight of the choice point and immediately behind a blue or red doorway. We had previously shown that peat was a highly preferred substrate for dust-bathing (Petherick and Duncan, 1989), so one goal box contained a few centimeters of peat in the bottom. The other goal box had a wire floor. For half the birds the peat was paired with the red doorway and for half it was paired with the blue doorway. The peat was presented on the right and left in a balanced but unpredictable way. The birds chose peat when it was in sight of the choice point. However, they had difficulty in choosing when the runway was lengthened and they had to rely solely on the colored cue. This suggests that although access to peat may be rewarding, domestic fowl may have no cognitive representation of it when it is out of sight. Nevertheless, there was some evidence that the birds had reward expectation, because they ran faster in the Y-maze if, on the previous test, they had chosen peat (Petherick et al., 1990).

The possibility seems to exist, therefore, that some behavior (at least in domestic fowl) may be very stimulus-bound. Of course, in all these cases in which this was suspected, the properties of the stimulus would have to be examined very carefully. To what extent will the animal generalize to suboptimal stimuli in the absence of the "normal" stimulus? Also, before concluding that "out of sight is out of mind" the possibility would have to be excluded that there might be specific factors constraining learning. In this respect, there are advantages in working with visual animals such as birds; proving that "out of smell is out of mind" with other farm livestock is going to be even more difficult!

Implications

Our thesis is that animal welfare is dependent solely on the cognitive needs of the animals concerned. If we are correct, then only when much more is known of the cognitive abilities of each domestic species will it be possible to assess accurately the effects of husbandry methods on welfare.

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