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# ANIMAL WELFARE: CONCEPTS AND MEASUREMENT<sup>1,2</sup>

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## ABSTRACT

The term "welfare" refers to the state of an individual in relation to its environment, and this can be measured. Both failure to cope with the environment and difficulty in coping are indicators of poor welfare. Suffering and poor welfare often occur together, but welfare can be poor without suffering and welfare should not be defined solely in terms of subjective experiences. The situations that result in poor welfare are reviewed in this study with special reference to those in which an individual lacks control over interactions with its environment. The indicators of poor welfare include the following: reduced life expectancy, impaired growth, impaired reproduction, body damage, disease, immunosuppression, adrenal activity, behavior anomalies, and self-narcotization. The uses of measures of responsiveness, stereotypies, and animal preferences in welfare assessment are discussed. The need to make direct measurement of poor welfare as well as to use sophisticated studies of animal preferences is emphasized.

Key Words: Welfare, Responses, Pain, Preference Tests, Behavior

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## Introduction

The word "welfare" can be used by the scientific community, and it can be included in laws provided that it is defined precisely and the concept of welfare can be adequately related to other concepts. In the first section of this paper, a usable scientific definition of welfare is introduced after referring to the legal and psychological term "need" and to the idea of systems for coping with difficulties during life. The concept of welfare is then discussed in relation to suffering. The major environmental effects on animals that involve poor welfare are explained as a prelude to reviewing how to measure welfare. Indicators of welfare are then discussed briefly, and the use of the measurement of life expectancy, responsiveness,

stereotypies, and preferences are considered at greater length.

## Welfare as a Scientific Term

Animals have a wide range of needs that are a consequence of the many functional systems that make life possible. A need is a deficiency in an animal that can be remedied by obtaining a particular resource or responding to a particular environmental or bodily stimulus (Fraser and Broom, 1990). Some needs are simple, such as the detectable effects of a low concentration of body fluids or a high body temperature, and require action. Others are a complex consequence of the mechanisms that have evolved in the species to promote survival and reproduction, for example the deficiencies in mental functioning resulting from too little variety in sensory input or insufficient contact with other members of the species.

If an animal has a need, its motivational state is affected so that behavioral and physiological responses that should result in remedying that need can be made. These coping responses allow the animal to control and maintain mental and bodily stability. Coping includes normal regulation of body

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state and emergency responses, such as high adrenal activity, heart rate, or flight activity, which require more energy expenditure and hence are used only when the animal predicts that normal regulatory actions will be inadequate. The animal may succeed in its attempts to cope with the conditions in which it finds itself, in which case it has adapted to those conditions. Sometimes it may succeed only with great difficulty. Alternatively, it may fail to cope, in that its fitness is reduced as evidenced by death, or failure to grow, or failure to reproduce. In this case, when control systems are overtaxed and there is an actual or potential reduction in fitness, the animal is stressed (Broom, 1988c).

The welfare of an animal is clearly affected by both failure to cope and difficulty in coping. If we consider a man whose life is so difficult during a 3-mo period that he gets severe ulcers, loses his ability to behave in a normal way socially, develops other neurotic behavior, and succumbs more readily than usual to viral infection, he has survived but his welfare during that period must be considered poor. Even if he lives normally thereafter, he was in a poor state at that time. The welfare of an individual is its state as regards its attempts to cope with its environment (Broom, 1986a). "State as regards its attempts to cope" refers to how much has to be done to cope and how well or how badly coping attempts succeed. When coping is difficult, or is not possible, this will often be recognizable by scientific study of the individual. Coping difficulty or failure to cope may be associated with pain or other suffering, and our ability to measure the effects of these is improving.

This definition of welfare has several implications: 1) Welfare is a characteristic of an animal, not something that is given to it; 2) Welfare will vary from very poor to very good, that is to say, the individual may be in a poor state at one end of the welfare continuum or in a good state at the other; 3) Welfare can be measured in a scientific way that is independent of moral considerations; 4) As explained above, measures of failure to cope and measures of how difficult it is for an animal to cope both give information about how poor the welfare is; 5) A knowledge of the preferences of an animal often gives valuable information about what conditions are likely to result in good welfare, but direct measurements of the state of the animal must also be used in

attempts to assess welfare and improve it; and 6) Animals may use a variety of methods when trying to cope. There are several consequences of failure to cope, so any one of a variety of measures can indicate that welfare is poor, and the fact that one measure, such as growth, is normal does not mean that welfare is good.

The concept of welfare varying over a range and being measurable using a variety of indicators has also been emphasized by Curtis (1986) and Duncan (1987). After the welfare has been measured, and hence the extent of the situation for an animal discovered, ethical decisions about whether or not this situation is tolerable can be taken. It is important that the process of welfare assessment and the process of ethical judgment be separate.

#### Welfare and Suffering

Dawkins (1990) stated that suffering occurs when unpleasant subjective feelings are acute or continue for a long time because an animal is unable to carry out the actions that would normally reduce risks to life and reproduction in those circumstances. Ideas about suffering were also discussed at length by Dawkins (1980). Suffering and poor welfare often occur together, but welfare is a somewhat wider term. Unpleasant subjective feelings will clearly affect the state of an individual as regards its attempts to cope with its environment. However, it could be that the state is affected without suffering occurring. Five examples of situations in which welfare can be poor in the absence of suffering are described briefly below.

First, an individual might be injured without feeling pain because endogenous analgesic opioids, or indeed artificial analgesics, prevent the pain. However, if injury occurs, the state of the animal is affected and welfare is poor. Welfare would be poorer still if pain accompanied the injury, but the injury itself is an indicator of poor welfare.

Second, a period of suffering, for example that resulting from an injury or disease, might be interrupted by sleep, during which the unpleasant subjective experience ceases. Because the injury or disease persists during sleep, the welfare is still poor at that time. Welfare would also be considered poor during a coma even if no subjective experience could occur.

Third, the efficiency of antibody responses and of cell-mediated immunity can be ad-

versely affected by exposing animals to difficult conditions (Kelley, 1980; Siegel, 1987). If the housing conditions or management procedures result in impaired immune system function and consequently increase susceptibility to disease, then the state of the animal is clearly affected and welfare is poor. This poor welfare occurs before any suffering, although it may well become worse as disease and associated suffering develop.

Fourth, if an animal husbandry system results in animals being unable to reproduce or in their premature death, then the welfare of such animals is poor. They cannot cope with their environment. There might be suffering associated with such effects on the animal, but the welfare is poor whether or not suffering occurs.

Fifth, suppose an animal is kept in conditions of sensory deprivation such that it develops very little normal behavior and it copes with those conditions by self-narcotizing. Because of the effects of the endogenous opioids it may not be suffering, but such an extreme modification of state in an effort to cope indicates that its welfare is very poor.

The idea that clinical signs of disease or injury can be indicators of suffering is widely accepted (e.g., Dawkins, 1988). We can obtain information about how much a diseased or injured animal is suffering (Morton and Griffiths, 1985) because there are direct behavioral measures of difficulties in trying to cope with the pain or discomfort (i.e., of poor welfare). We know little of the feelings of the animal, but we can recognize the behavioral and physiological responses, and we can measure the extent of body tissue damage. In light of this situation and of those described in the paragraphs above, it is clear that it is not useful to equate suffering with poor welfare. Suffering is a valuable term; it refers to the subjective feelings of animals and it is the most important aspect of poor welfare, but the definition of welfare encompasses some effects on animals in addition to suffering. It is neither scientifically nor practically desirable to define welfare only in terms of subjective experiences such as suffering (see the last section of this paper).

#### Environmental Effects on Animals That Involve Poor Welfare

*Pain.* Pain is a sensation that is itself extremely aversive. With reference to the

definition of welfare above, perceived pain is a part of the state of an individual; such a perception may have other effects on the state (e.g., an adrenal cortex response might be initiated), but the greater the pain, the poorer the welfare. The measurement of pain is difficult, even if recording from pain fibers in the nervous systems is possible, but, as Morton and Griffiths (1985) have pointed out, careful measurement of behavior can give a good indication of the extent of pain. Behavior disturbance when pain is experienced will disappear if adequate artificial analgesic is provided. Using a completely different approach, Rushen (1986a,b) assessed pain by quantifying the willingness of sheep to return to the place where they had experienced the sensation. Sheep that had been exposed to electrical immobilization were much less willing to be driven down a channel toward the place where this occurred than to be driven to a place where physical restraint or shearing had occurred.

*Fear.* Fear responses are either a preparation for danger or are a response to detectable danger. The danger may be risk of predation or risk of injury caused by a rival or a physical event. Whatever the cause, fear is aversive, but, unlike pain, it depends on higher brain activity (Archer, 1988) and is not just a sensation. It is difficult to cope with fear and, as with pain, the extent of the difficulty gives information about how poor the welfare of the individual is. Direct measurement is possible because fear is closely associated with adrenal medullary activity, and degree of behavioral aversion for stimulus situations associated with fear can also be measured. Fear during handling, transport, preslaughter procedures, or operations on farms or in laboratories may be associated with freezing behavior, tonic immobility, escape attempts, aggression, adrenal cortex activity, heart-rate elevation, and effects on meat quality (Archer, 1979; Broom, 1981).

*Lack of Control: Difficulties in Movements.* One aspect of the situations that engender fear is that they disrupt the normally well-controlled relationship between the animal and its environment. Mammals and birds, including farm species, have elaborate control mechanisms, including sophisticated responses and precise predictions of future events. As Wiepkema (1987) has emphasized, many welfare problems arise in situations in which an individual is not able to control one or more aspects of its environment.

A situation in which some basic movement or action is difficult for an animal can be detected readily by careful observation. Examples include inability to adopt normal lying postures in veal calves confined in crates (de Wilt, 1985; Ketelaar de Lauwere and Smits, 1989) and the major changes in, and prolongation of, the process of lying down in fattening bulls kept on slippery slats (Andreae and Smidt, 1982).

*Lack of Control: Frustration.* When animals know how to control their interactions with their environment but are prevented from carrying out the action, the resulting frustration causes various abnormalities of physiology and behavior that are indicators of poor welfare. When Duncan and Wood-Gush (1972) trained hens to feed in a place and then prevented them from feeding by putting a transparent cover over the food, the hens showed their frustration by stereotyped pacing and by aggressively pecking at another bird if one was present. Many hens prevented from nest-building when they are about to lay also show stereotyped pacing. Some frustration occurs in many group feeding situations in which access is available to some of the individuals but more timid subordinates would like to feed but cannot. There is also an element of frustration in many farm housing situations where space is very limited.

*Lack of Control: Absence of Specific Input.* Certain stimuli are of great importance to the survival of animals, so they may be sought very actively and their absence may result in poor welfare, as evidenced by various abnormalities of physiology and behavior. An example is the set of stimuli associated with the mother's teats in young mammals. Early weaning of calves and pigs results in vigorous teat-seeking behavior and in problems, both for the teat seeker and for other individuals whose navel, penis, scrotum, ears, and so on, are sucked (Sambraus, 1985; Fraser and Broom, 1990).

*Lack of Control: Insufficient Stimulation.* Low overall complexity of the environment is difficult for an animal to cope with if it is programmed to explore and to respond to a range of stimuli. The effects of sensory deprivation are well known (Ottoson, 1983), yet animals with elaborate behavior organization are often kept in conditions in which they have nothing to do. Humans and domestic animal species show by their behavior that

isolation in a bare pen is aversive and leads to a variety of behavioral abnormalities (Broom, 1981). Companions with whom social interactions are possible are often the best extra source of stimulation. Physical variety in the environment is generally necessary as well. For example, tail-biting and anal massage in pigs are much less frequent in conditions in which rooting in earth or straw manipulation are possible (Sambraus, 1985).

*Lack of Control: Overstimulation.* In domesticated animal species, as in humans, excessive demands on organizational capacity can result in a breakdown in control and poor welfare. An individual that has experienced only one environment and only one set of companions or no companions at all may be severely disturbed by a farm procedure that is an everyday matter to a farmer, such as grouping and moving animals. Some of the effect on the animals may be fear, but the very substantially increased requirement for processing sensory input and acting on it may be a real problem for the animal. It is not just the total amount of input to sensory processing and to decision-making centers in the brain that is important here, but the input in relation to that which is predicted. Unpredicted inputs, above a certain level of incidence, can be very disturbing.

#### Measures of Welfare

The measurement of welfare has been discussed at length elsewhere (Broom, 1986a, 1988a, 1990; Fraser and Broom, 1990), so only a brief summary of most measures is presented here. If the biological fitness of the animals in a housing or management system is impaired because of some effect of the conditions, then welfare is poorer than in another system in which there is no such impairment. Our best estimate of biological fitness is lifetime reproductive success. Impaired reproductive success is indicated by delayed onset of reproduction during development, lengthened intervals between successive breedings, reduced litter size, and early death. Such measures can be used directly for wild animals, but where humans control breeding opportunities they can be used to say that welfare is poor in situations in which reproduction proves impossible or used in comparisons of management systems. For example, two sets of sows kept in different housing conditions and given the same breeding oppor-



tunities might differ in some measure of reproductive success. Comparisons might also be made between breeding bulls kept in poor conditions or in good conditions and balanced for breeding opportunity. A clear reduction in reproductive success in these controlled conditions indicates poorer welfare. The question of life expectancy or duration of productive life is of particular interest in relation to farm animal management, so it will be discussed in more detail below.

Measures of body damage are clearly relevant to welfare assessment. Broken bones or wounds can be identified and their frequency assessed. For example, it has recently been discovered that 27% of hens from battery cages have at least one bone broken between removal from the cage and stunning (Gregory and Wilkins, 1989). The major cause of this is that hens in battery cages have little exercise and as a consequence their bone strength is less than that of hens kept in conditions in which more exercise is possible (Knowles and Broom, 1990). Another measure of damage is frequency of stomach ulcers.

Disease level is of considerable importance in welfare assessment because the welfare of diseased animals is almost always poorer than that of healthy animals. Susceptibility to disease is also an important indicator of welfare. If animals are kept in such a way that their immune systems are less effective in combating disease, there is clearly some inadequacy in the management and housing system (Broom, 1988b; Fraser and Broom, 1990).

One reason for impaired immune system function is too frequent high activity of the adrenal cortex. Adrenal activity can occur during beneficial activities such as mating, but in general it indicates that the animal has some difficulty in trying to cope, so measurements of levels of adrenal products or of the activities of adrenal enzymes are useful welfare indicators (Dantzer and Mormède, 1979; Moberg, 1985). Measurements of other hormones and enzymes in body fluids give similar information. When animals are disturbed by a situation they often substantially change their heart rate in preparation for action, so heart rate measurement is also of value in assessing welfare.

Behavior is changed in response to many environmental difficulties. It is a component of both regulatory and emergency responses.

Some measurements of behavioral responses to difficulties are of actions that help the animal to cope, whereas others are of behavior pathologies that may have no beneficial effect, sometimes harming the perpetrator or others. Both kinds of behavior are indicators of welfare. Grooming or feeding behavior that is effective and easy indicates better welfare than these behaviors when they are very prolonged or are modified because of difficulty in achieving objectives. Abnormal behavior is behavior that differs in pattern, frequency, or context from that which is shown by most members of the species in conditions that allow a full range of behavior (Fraser and Broom, 1990). An abnormal behavior might help an individual to cope, but it is still an indicator that the animal's welfare is poorer than that of another animal that does not have as much difficulty in coping. Other abnormal behavior might be wholly pathological in that it serves no function and is caused by mental or physical disorder. The more that such behavior pathologies are shown, the poorer is the welfare. Behavior measurements are discussed in detail later in this paper.

Studies of behavior have suggested that withdrawal from normal responding might be a way of trying to cope. It is possible that endogenous analgesic opioids in the brain might be used as a coping method (Broom, 1988a). Measurement of the action of such opioids are therefore relevant to the assessment of welfare. An individual that needs to self narcotize to cope clearly has poor welfare.

As emphasized in the publications quoted above, although one measurement can indicate that an individual is having severe difficulties in coping with conditions, it is essential that a variety of welfare indicators be used if an adequate assessment of animal housing and management systems is to be obtained. Individuals vary in the methods that they use to attempt to cope with a single environmental problem, and comparisons of housing conditions always involve several aspects that are potentially difficult for the animals. Hence, the measurement of welfare necessitates the evaluation of a range of indicators, such as those mentioned above, to obtain information from each about how poor or how good welfare is. This information must be combined in an overall assessment of welfare. Sometimes this will be easy, for example, when one method of loading animals onto a vehicle results in very

high heart rate, plasma glucocorticoid level, and injury incidence, whereas another method results in much lower values for each of these measures. On other occasions the measurement of welfare will be more difficult, for example, when one method of housing results in higher incidences of stereotypies than another in which there is a greater frequency of clinical disease. In this case the scientist must evaluate each of these measures and any others carefully and come to a conclusion about the welfare in each condition. Our ability to do this will undoubtedly improve as the scientific study of animals experiencing difficult conditions progresses. However, we must use the information that we can obtain now as best we can rather than saying that it is all too difficult or merely considering the relative values of the two systems to humans.

#### Life Expectancy as a Welfare Indicator

If animals are caused to have high metabolic rates and to convert feed to meat, milk, eggs, and so on, in a particularly efficient way, there may be an effect on their life expectancy. For example, high total food intake, high-protein diet, steroid growth promoters, and injected somatotropins may all increase production within a genetic strain but may reduce the duration of productive life that can be expected. Dairy farmers are aware of the reduction in the number of lactations for which the average dairy cow is kept now compared with the number before the recent increases in feed conversion efficiency. Cows are culled because of lameness, mastitis, failure to conceive, a rapid waning of milk output, and so on, but many of these animals would die early anyway if kept on the feeding and management regimen used. Their potential for long life is reduced (Webster, 1987). Cows, or rats in laboratory experiments, in which feed intake is limited, live longer. If the management of a cow results in an expectation that only four or five calves will be produced, then the stress level is higher and the welfare is poorer than that of a cow whose management is such that she can calve 10 or more times successfully. Reduced life expectancy indicates that the animal has been stressed and that its welfare, at some time or times during its life, has been poor (Broom, 1988c; Hurnik and Lehman, 1988). It is worth considering whether there is a trade-off between length of life and quality of life. If life expectancy is

reduced, what do other welfare indicators tell us? Again, cattle can be used as an example, but other species, including humans, could also be used. Cows that have high metabolic rates may be healthy throughout their lives and may show no real sign of poor welfare. However, on average, this is not so. High production is often associated with increased likelihood of lameness, mastitis, damaged udder ligaments, and problems at parturition. There may be greater susceptibility to other diseases and some abnormalities of behavior. Hence, reduced life expectancy is often associated with signs of poor welfare during life. The fact that reduced life expectancy is itself an indicator of poor welfare does not mean that efficiency in animal production is necessarily bad. Helping an animal to achieve its productive potential seems wholly desirable provided there are no signs of poor welfare. The effects on welfare of current and future attempts to increase production efficiency should be assessed before the methods are accepted for general use on farms. The assessment should be carried out by persons who have no financial involvement in the development. For example, it may be possible to use synthesized somatotropins in certain ways without any adverse effect on the welfare of the animals, but this should be checked by an independent body carrying out studies that last for at least as long as the normal productive life of the animals concerned.

#### Responsiveness as a Welfare Indicator

Some individuals in close confinement show substantial activity, albeit sometimes rather abnormal, but others are inactive for long periods. Such differences are reported for human prisoners and mentally disturbed people. The two different kinds of responses are also apparent in situations in which environmental control by rats or tree shrews is severely lacking (von Holst, 1986). Prolonged inactivity has been described on various occasions in confined sows (Wiepkema et al., 1983), but does inactivity tell us anything about welfare? Extreme inactivity is regarded as suggestive of psychiatric disorder in humans but it is failure to respond to those stimuli that would normally elicit a response that is considered most indicative of disorder.

The measurement of responsiveness requires carefully controlled experiments, for responsiveness varies according to the activity

that is occurring at the time of stimulus presentation (Culshaw and Broom, 1980; Forrester and Broom, 1980) and any response must be distinguished from the behavior that would have occurred had no stimulus been presented. Broom (1986b, 1987) found that sows housed in stalls responded to food but were unresponsive to events in their environment that elicited an investigatory response from group-housed sows. The behavioral response of becoming apathetic and shutting out most environmental stimuli is an indicator in pigs, as in humans, that the individual is having difficulty coping with its environment (i.e., that welfare is poor).

#### Stereotypies as Welfare Indicators

A stereotypy is a repeated, relatively invariable sequence of movements that has no obvious purpose, and the occurrence and causation of stereotypies has been the subject of much discussion (Ödberg, 1978; Broom, 1981, 1983; Dantzer, 1986; Mason, 1991). Route-tracing, bar-biting, tongue-rolling, and so on are described by Fraser and Broom (1990). Stereotypies are shown in situations in which the individual lacks control of its environment, especially in those that are obviously frustrating, threatening, or severely lacking in stimulation. Their widespread occurrence in confined animals, such as in sows in stalls or tethers, calves in crates, and mink in cages, is of great importance in relation to welfare assessment.

Stereotypies occur in normal, healthy people at times when control over events is lacking, for example, when a person is late for a meeting and waiting for transport or when an expectant father is waiting outside a room in which his wife is about to give birth. The person has a short-term problem and the stereotypy is evidence for this. People in solitary confinement in prisons show stereotypies, as do those with certain psychological disorders, especially autistic children (Hutt and Hutt, 1965). A person who shows a stereotypy on several occasions is considered to have some psychological problem, even if the stereotypy occurs at quite a low frequency. People take particular notice of someone showing a stereotypy, and there are some descriptions of zoo and farm animals also taking notice. For example, a young elephant that arrived at a zoo was housed with an older animal that had previously been chained to a

post for long periods and showed a head-weaving stereotypy. Whenever the older elephant showed this stereotypy, the other elephant would come to it and interact socially, thus tending to stop the stereotypy (S. Platt, personal communication).

It may be that some stereotypies help individuals to cope with their environment. Cronin et al. (1985) suggested that this may be via the action of analgesic opioids, although subsequent studies give no support to this hypothesis (Rushen et al., 1991). However, it seems likely that on other occasions stereotypies are useless and energetically costly signs of brain function pathology (Dantzer, 1986). Whatever their causation, stereotypies are shown in situations that are difficult, sometimes extremely difficult, for the animal, and so they indicate that the welfare of the animal is poor. A great deal of stereotypy indicates poorer welfare than an occasional stereotypic action. In humans we start to recognize a problem if the action lasts for a minute. What is the mental state of a sow that spends hours showing a stereotypy?

Animals housed in groups with a variety of actions possible may sometimes be frustrated and may show occasional stereotypic actions, but the incidence of stereotypies is much lower in such conditions than in close confinement.

#### The Value of Preference Tests In Relation to Welfare

To develop good systems for the housing and management of animals it is of particular importance that studies of the preferences of animals be carried out. We need to know what animals prefer if we are to treat them in a humane way. Observations of how animals spend their time when they are in a rich environment are a useful preliminary guide in designing accommodation. However, it is necessary to know how strong a preference is to use such information. An animal might consistently prefer one kind of food to another, but both might be nutritionally adequate and the extent of suffering if the nonpreferred food is given might be minute.

Techniques are available to assess the importance of preferences, for example those described by Dawkins (1983, 1990), Duncan (1987), and Duncan and Kite (1987). Pigs can be required to press a lever for temperature modification or for access to earth for rooting



or straw for nest-building. The number of presses for reward then indicates the value of the reward. Duncan and Kite's hens pushed a door with weights on it to gain access to a resource. Dawkins' hens had to choose between feeding and litter access. Such studies allow new systems to be designed that can then be compared with existing systems. Many aspects of farm animal management need to be looked at in this way, but as Dawkins (1990) described, the experiments must be carefully designed. Preference studies cannot give all the answers to questions about animal welfare, even though they give a great deal of information about the likelihood that animals will suffer. When an animal shows preference for a certain food or level of eating, for example, it may be mistaken in its choice and its welfare may become poor. Anorexic girls have a very strong preference not to eat, to the detriment of their welfare. Rats in cafeteria experiments, or indeed some people, may eat chocolate bars exclusively, with the result that they become short of some nutrients and obese, so their welfare gets poorer. People may choose to take drugs that damage them and masochists may deliberately injure themselves. In several of these cases the individual is choosing for short-term reward, but is making the wrong choice for the long-term. As Mendl (1990) has pointed out, choices may depend very much on the experience of the individual during development and may not improve welfare. Preferences will also change with physical conditions, so a pig may prefer to lie on straw in cold conditions but may prefer a wet floor in hot conditions.

There are some important welfare problems in which preference tests are difficult to use. Long-term housing conditions may be difficult to assess in this way because the animal may be substantially modified psychologically by the conditions. When an animal is ill, how do you find out how poor its welfare is using preference tests? Such methods might tell us how hard the animal will work to avoid some initial signs of illness, such as nausea, but they are unlikely to give information about welfare after several days of illness. Direct measurement of behavior, as mentioned above in relation to pain, is more appropriate.

The statement that animal welfare involves only the subjective feelings of animals is not correct when measurements of either good or poor welfare are being made. The welfare of a

sleeping individual may be very good or very poor, but its subjective feelings will not tell us this. Welfare assessment must include direct measurement of the indicators of poor welfare as well as sophisticated studies of animal preferences.

#### Implications

We should use the word "welfare" in a scientific way so that it is useful when considering animal management or when phrasing legislation. Welfare is a characteristic of an animal, not something given to it, and can be measured using an array of indicators. When evaluating systems for housing, transport, slaughter, and so on, we need precise measurements of how poor the welfare is. Such studies are complementary to those in which the subjective experiences of animals are assessed using measures of preference. The scientific study of animal welfare should be promoted so that decisions are made on factual rather than emotional grounds.

#### Literature Cited

- Andrae, U. and D. Smidt. 1982. Behavioral alterations in young cattle on slatted floors. In: W. Bessei (Ed.) *Disturbed Behaviour in Farm Animals*. Hohenheimer Arbeiten 121:51. Eugen Ulmer, Stuttgart, FRG.
- Archer, J. 1979. Behavioral aspects of fear in animals and man. In: W. Sluckin (Ed.) *Fear in Animals and Man*. Van Nostrand Reinhold, Princeton, NJ.
- Archer, J. 1988. *The Behavioral Biology of Aggression*. p 49. Cambridge Univ. Press, Cambridge, UK.
- Broom, D. M. 1981. *Biology of Behaviour*. Cambridge Univ. Press, New York.
- Broom, D. M. 1983. Stereotypies as animal welfare indicators. In: D. Smidt (Ed.) *Indicators Relevant to Farm Animal Welfare*. *Curr. Top. Vet. Med. Anim. Sci.* 23:81. Martinus Nijhoff, The Hague.
- Broom, D. M. 1986a. Indicators of poor welfare. *Br. Vet. J.* 142:524.
- Broom, D. M. 1986b. Responsiveness of stall-housed sows. *Appl. Anim. Behav. Sci.* 15:186 (Abstr.).
- Broom, D. M. 1987. Applications of neurobiological studies to farm animal welfare. In: P. R. Wiepkema and P.W.M. van Adrichem (Ed.) *Biology of Stress in Farm Animals: An Integrated Approach*. *Curr. Top. Vet. Med. Anim. Sci.* 42:101. Martinus Nijhoff, Dordrecht, Netherlands.
- Broom, D. M. 1988a. The scientific assessment of animal welfare. *Appl. Anim. Behav. Sci.* 20:5.
- Broom, D. M. 1988b. The relationship between welfare and disease susceptibility in farm animals. In: T. E. Gibson (Ed.) *Animal Disease - A Welfare Problem*. pp 22-29. BVA Animal Welfare Foundation, London.
- Broom, D. M. 1988c. Les concepts de stress et de bien-être. *Rec. Med. Vet.* 164:715.
- Broom, D. M. 1990. The importance of measures of poor welfare. *Behav. Brain Sci.* 13:14.

- Cronin, G. M., P. R. Wiepkema and J. M. Ree. 1985. Endogenous opioids are involved in abnormal stereotyped behaviours of tethered sows. *Neuropeptides* 6: 517.
- Culshaw, A. D. and D. M. Broom. 1980. The imminence of behavioural change and the startle response of chicks. *Behaviour* 73:64.
- Curtis, S. E. 1986. The case for intensive farming of food animals. In: M. W. Fox and L. D. Mickley (Ed.) *Advances in Animal Welfare Science 1986/87*, p 245. The Humane Society of the United States, Washington, DC.
- Dantzer, R. 1986. Behavioral, physiological and functional aspects of stereotyped behavior: A review and a re-interpretation. *J. Anim. Sci.* 62:1776.
- Dantzer, R. and P. Mormède. 1979. *Le Stress en Élevage Intensif*. Masson, Paris.
- Dawkins, M. 1980. *Animal Suffering*. Chapman and Hall, London and New York.
- Dawkins, M. 1983. Battery hens name their price: consumer demand theory and the measurement of animal needs. *Anim. Behav.* 31:1195.
- Dawkins, M. 1988. Behavioral deprivation: a central problem in animal welfare. *Appl. Anim. Behav. Sci.* 20:209.
- Dawkins, M. 1990. From an animal's point of view: motivation, fitness and animal welfare. *Behav. Brain Sci.* 13:1.
- Duncan, I.J.H. 1987. The welfare of farm animals: An ethological approach. *Sci. Prog.* 71:317.
- Duncan, I.J.H. and V. G. Kite. 1987. Some investigations into motivation in the domestic fowl. *Appl. Anim. Behav. Sci.* 18:387.
- Duncan, I.J.H. and D.G.M. Wood-Gush. 1972. Thwarting of feeding behaviour in the domestic fowl. *Anim. Behav.* 20:444.
- Forrester, R. C. and D. M. Broom. 1980. Ongoing behaviour and the startle response of chicks. *Behaviour* 73:51.
- Fraser, A. F. and D. M. Broom. 1990. *Farm Animal Behaviour and Welfare*. Saunders, New York.
- Gregory, N. G. and L. J. Wilkins. 1989. Broken bones in chickens 1. Handling and processing damage in end of lay battery hens. *Br. Poult. Sci.* 30:555.
- Hurnik, J. F. and H. Lehman. 1988. Ethics and farm animal welfare. *J. Agric. Ethics* 1:305.
- Hutt, C. and S. J. Hutt. 1965. Effects of environmental complexity on stereotyped behaviour of children. *Anim. Behav.* 13:1.
- Kelley, K. W. 1980. Stress and immune function: A bibliographic review. *Ann. Rech. Vet.* 11:445.
- Ketelaar de Lauwere, L. L. and A. C. Smits. 1989. Onderzoek naar de uit ethologisch oogpunt minimal gewentst boxmaten voor vleeskalvaren met een gewicht van 175 tot 300 kg. IMAG Rapport, 100. IMAG, Wageningen, Netherlands.
- Knowles, T. G. and D. M. Broom. 1990. Limb bone strength and movement in laying hens in different housing systems. *Vet. Rec.* 126:354.
- Mason, G. J. 1991. Stereotypies: A critical review. *Anim. Behav.* 41:1015.
- Mendl, M. 1990. Developmental experience and the potential for suffering: does "out of experience" mean "out of mind"? *Behav. Brain Sci.* 13:28.
- Moberg, G. P. 1985. Biological response to stress: key to assessment of animal well-being. In: G. P. Moberg (Ed.) *Animal Stress*, p 27. Am. Physiol. Soc., Bethesda, MD.
- Morton, D. B. and P.H.M. Griffiths. 1985. Guidelines on the recognition of pain, distress and discomfort in experimental animals and an hypothesis for assessment. *Vet. Rec.* 116:431.
- Ödberg, F. O. 1978. Abnormal behaviours: Stereotypies. Proc. 1st Wld. Cong. Ethol. Appl. Zootech., Madrid, Spain.
- Ottoson, D. 1983. *Physiology of the Nervous System*, p 503. MacMillan, London.
- Rushen, J. 1986a. The validity of behavioral measures of aversion: A review. *Appl. Anim. Behav. Sci.* 16:309.
- Rushen, J. 1986b. Aversion of sheep for handling treatments: paired choice experiments. *Appl. Anim. Behav. Sci.* 16:363.
- Rushen, J., W. Schouten., A.M.B. de Passillé and J. Ladewig. 1991. Are stereotypies in pigs coping mechanisms? *Appl. Anim. Behav. Sci.* (In press)
- Samraus, H. H. 1985. Mouth-based anomalous syndromes. In: A. F. Fraser (Ed.) *Ethology of Farm Animals*, p 391. Elsevier, Amsterdam.
- Siegel, H. S. 1987. Effects of behavioural and physical stressors on immune responses. In: P. R. Wiepkema and P.W.M. van Adrichem (Ed.) *Biology of Stress in Farm Animals: An Integrated Approach*. Curr. Top. Vet. Anim. Sci. 42:39. Martinus Nijhoff, Dordrecht, Netherlands.
- von Holst, D. 1986. Vegetative and somatic components of tree shrews' behaviour. *J. Autonomic Nerv. Syst. Suppl.* 657.
- Webster, J. 1987. *Understanding the Dairy Cow*, p 173. BSP Professional Books, Oxford, UK.
- Wiepkema, P. R. 1987. Behavioural aspects of stress. In: P. R. Wiepkema and P.W.M. van Adrichem (Ed.) *Biology of Stress in Farm Animals: An Integrative Approach*. Curr. Top. Vet. Med. Anim. Sci. 42:113. Martinus Nijhoff, Dordrecht, Netherlands.
- Wiepkema, P. R., D. M. Broom, I.J.H. Duncan and G. van Putten. 1983. *Abnormal Behaviour in Farm Animals*. Commission of the European Communities, Brussels, Belgium.
- Wilt, J. G. de. 1985. Behavior and welfare of veal calves in relation to husbandry systems. Ph.D. Thesis. Univ. of Wageningen, Netherlands.

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