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# Welfare of Animals: Behavior as a Basis for Decisions

biography D.M. Broom

University of Cambridge, Cambridge, UK

Behavioral measures are of particular value in welfare assessment, especially when the effects of living conditions on welfare over a long timescale are considered. Behaviors such as stereotypies, absence of normal responsiveness, excessive aggression and avoidance behavior are direct indicators of poor welfare. Measures of the behavior of animals is also needed to interpret other welfare measures such as adrenal cortex activity and some aspects of brain function. The various strategies for coping with adversity are usually identified by their typical behavioral components. As a result of the diversity of coping methods, in most scientific studies of animal welfare, a combination of behavioral and other measures is needed. The strength of positive or negative preferences of animals, for resources or environmental impacts, is best indicated by indices of demand, such as the consumer surplus, that are assessed using behavioral experimental studies.

Behavior

Brain

Health

Pain

Welfare

Welfare assessment

## Introduction

Welfare is regarded by many people as a key factor when determining whether or not a system or procedure involving animals is sustainable. However, the term welfare requires strict definition if it is to be used effectively and consistently in precise scientific measurements, in legal documents, and in public statements or discussion. If animal welfare is to be compared in different situations or evaluated in a specific situation, it must be assessed in an objective way.

The welfare of an individual is its state as regards its attempts to cope with its environment. The definition encompasses the extent to which the individual fails to cope, or has difficulties in coping, or easily copes. The original meaning of the concept is how well the individual fares or travels through life and the definition refers to state at a particular time, ranging from very good to very poor and includes its feelings and its

health as well as the functioning of various physiological, behavioral, and other adaptive mechanisms.

## Welfare in Relation to Needs, Feelings, [Stress](#), Health, and Pain

The environment is appropriate if it allows the animal to satisfy its needs. Animals have a range of functional systems controlling body temperature, nutritional state, social interactions, etc. Together, these functional systems help the individual to control its interactions with its environment and hence to keep each aspect of its state within a tolerable range. The allocation of time and resources to different physiological or behavioral activities, either within a functional system or between systems, is controlled by motivational mechanisms. When an animal is actually or potentially homeostatically maladjusted or when it must carry out an action because of some environmental situation, we say that it has a need. A need can be defined as a requirement, which is part of the basic biology of an animal, to obtain a particular resource or respond to a particular environmental or bodily stimulus. There are needs for particular resources and needs to carry out actions the function of which is to obtain an objective. Needs can be identified by studies of motivation and by assessing the welfare of individuals the needs of which are not satisfied.

The feelings of an animal, including [pain](#), fear, and various forms of pleasure, are an extremely important part of its welfare. Information can be obtained about feelings using studies of positive or negative preference. Other information giving indirect information about feelings can be obtained from studies of physiological and behavioral responses of animals. Feelings are aspects of an individual's biology that must have evolved to help in survival, just as aspects of anatomy, physiology, and behavior have evolved. They are used in order to maximize its fitness, often by helping it to cope with its environment. It is also possible, as with any other aspect of the biology of an individual, that some feelings do not confer any advantage on the animal but are epiphenomena of neural activity. When we refer to the welfare of an individual, this does not just pertain to the feelings of that individual, as some have suggested, but also to the state of other aspects of its coping system. If welfare did not have this wider meaning, the term could not be applied to an individual that had no feelings because it was asleep, or anaesthetised, or drugged, or suffering from a disease that affects awareness. A further problem, if only feelings were considered, is that a great deal of evidence about welfare like the presence of neuromas, extreme physiological responses or various abnormalities of behavior, immunosuppression, disease, inability to grow and reproduce, or reduced life expectancy would not be taken as evidence of poor welfare unless bad feelings could be demonstrated to be associated with them. Although scientific investigation, including studies of behavior, can provide some indirect information about feelings, we can never know with any precision the feelings of any

individual other than ourselves. Other humans may tell us about their feelings but we do not know whether they are telling the truth or the extent to which their description of a feeling corresponds to ours. Hence, the measurements of behavior described here can do no more than provide useful indications about feelings and therefore about aspects of welfare.

The word stress should be used for that part of poor welfare that involves failure to cope. A definition of stress as just a stimulation or an event that elicits adrenal cortex activity is of no scientific or practical value. A precise criterion for what is adverse for an animal is a reduction in biological fitness. Stress can be defined as an environmental effect on an individual that overtaxes its control systems and reduces its fitness or seems likely to do so.

The word 'health,' like 'welfare,' can be qualified by 'good' or 'poor' and varies over a range. However, health refers to the state of body systems, including those in the brain, which combat pathogens, tissue damage, or physiological disorder. Health may be defined as 'an animal's state as regards its attempts to cope with pathology.' In this statement, animals include humans. Welfare is a broader term than health, covering all aspects of coping with the environment and taking account of a wider range of feelings and other coping mechanisms than those that affect health, especially at the positive end of the scale. Health is a part of welfare and hence disease always has some adverse effect on welfare.

The pain system and responses to pain are part of the repertoire used by animals, including humans, to help them to cope with adversity during life. Pain is clearly an important part of welfare. Pain is defined here as an aversive sensation and a feeling associated with actual or potential tissue damage.

## **Welfare Assessment: The Range of Measures**

Welfare assessment involves direct indicators of the extent of any failure to cope, any difficulty in coping, and signs of good welfare. One method of attempting to cope is to show behavioral or physiological responses that are part of the appropriate functional system such as regulation of the body fluid concentration. A second method is to utilize a more complex behavioral strategy than those that are normally part of the functional system in order to minimize risks such as those of predator attack, disease, or other injury. A third method of coping is to use emergency behavioral and physiological responses, which include fleeing, freezing, activation of the hypothalamic-pituitary-adrenal (HPA) axis, and activation of the sympathetic nervous system-adrenal medulla pathways. A fourth coping method is to use the immune system, principally but not entirely in combating invasion by pathogens. A fifth coping method involves cellular responses to tissue damage or tissue invasion, such as the action of the wound-healing system and apoptosis as a defence against tumor cell proliferation. A list of measures of poor welfare is presented in [Table 1](#). Some measures are most relevant to short-term

problems, such as those associated with human handling or a brief period of adverse physical conditions, whereas others are more appropriate to long-term problems. The needs of animals can also be investigated by studies of avoidance and positive preferences. For a detailed discussion of measures of welfare, see references quoted at the end of this article.

Table 1.  
Measures of welfare

Physiological indicators of pleasure
Behavioral indicators of pleasure
Extent to which strongly preferred behaviors can be shown
Variety of normal behaviors shown or suppressed
Extent to which normal physiological processes and anatomical development are possible
Extent of behavioral aversion shown
Physiological attempts to cope, including pain, fear, pleasure, etc. responses
Immunosuppression
Disease prevalence
Behavioral attempts to cope, including pain, fear, pleasure, etc. responses
Behavior pathology
Brain changes associated with coping attempts and pleasure
Body damage prevalence
Reduced ability to grow or breed
Reduced life expectancy

The measures of welfare in [Table 1](#) may not be independent of one another. As mentioned in the following section, measures that do not directly involve recording behavior often require observations of behavior for their interpretation. When an individual decides to show an adaptive response, for example to change physiological or immunological function, there may be a parallel behavioral change or a behavioral consequence. For long-term welfare problems, behavioral measures are usually the most important means of attempting to cope, and hence the best welfare indicators, but the behaviors will change various other aspects of the biology. When the environmental challenge is short-lived, initial responses commonly include physiological components and these may facilitate appropriate behavioral responses. Changes in behavior can result in modified physiological or immune system responses, for example where there is feedback on cytokine production mechanisms or stimulation of opioid production and

effects of opioids via receptors on lymphocytes. Brain mechanisms for coping with environmental change normally lead to a range of adaptive responses. For example, the behavioral components of active escape or fighting responses are associated with sympathetic adrenal medullary responses while passive responses such as freezing may be associated with adrenal cortex activity. Hence, the division into physiological, behavioral, and immunological responses may have been convenient for some scientists but it does not reflect biological reality. An integrated range of measures is needed in order to evaluate coping and assess welfare.

## Welfare Assessment: Direct Physiological and Behavioral Measures

Some signs of poor welfare are usefully indicated by physiological measurements. For instance, increased heart-rate, adrenal activity, adrenal activity following ACTH challenge, increases in some acute-phase proteins, or reduced immunological response following a challenge can all indicate that welfare is poorer than in individuals that do not show such changes. Care must be taken when interpreting such results, as with many other measures described here. Observation of behavior often provides a means to determine how to interpret physiological measures. Adrenal activity can occur during courtship, mating, and active hunting for food so in this case, an increase in plasma cortisol concentration does not indicate poor welfare. Lack of normal adrenal cortex activity can be a consequence of depression or inanition and reduce the efficacy of learning. As a result of the range of function of cortisol, increases in plasma cortisol have to be interpreted in the context of previous behavior. Impaired immune system function and some physiological and behavioral changes can indicate what has been termed a prepathological state.

Behavioral measures are of particular value in welfare assessment. If any animal with a potential for awareness avoids an object or event strongly, this gives information about its feelings and hence about its welfare. The stronger the avoidance, the worse the welfare while the object continues to be present or the event continues to occur. For example, an individual that is completely unable to adopt a preferred lying posture despite repeated attempts will have poorer welfare than one that can adopt the preferred posture. Such an individual may show abnormalities of behavior. Other abnormal behavior such as stereotypies, self-mutilation, tail-biting in pigs, feather-pecking in hens or excessively aggressive behavior indicates that the perpetrator's welfare is poor.

Stereotypies, which are repeated relatively invariable sequences of movements without obvious function, were first described in humans with neurological disorders and those imprisoned in isolation for long periods. More recently, stereotypies have been described in animals confined in zoos and on farms, for example crate-housed calves, sows in stalls, and mink in fur-farm cages. In all of these cases and in stabled horses, it

seems that the stereotypy arises because the animal lacks control over important aspects of its environment. Some stereotypies persist after the animal moves from its adverse environment. However, fully functional individuals do not show prolonged stereotypies and these abnormal behaviors always indicate poor welfare.

Some of the most dramatic stereotypies are shown in confined sows. It seems that sows' needs are not met at all well in stalls and tethers so they show either substantial amounts of stereotypy or apathetic, unreactive behavior. In a study of sows that show high levels of stereotyping, they were found, after slaughter, to have low  $\mu$  and  $\kappa$  receptor densities and low dopamine concentrations in the frontal cortex. Inactive, unresponsive sows, on the other hand, had more  $\mu$  receptors in the frontal cortex. Other brain studies of animals showing stereotypies include those of housed horses. Those that performed more stereotypies such as crib-biting and pacing had more dopamine (D1) receptors in the nucleus accumbens than those housed horses that performed few stereotypies.

The welfare of any animal that shows self-mutilation, such as some zoo, laboratory, fur farm, and pet animals, is poor because of the behavior abnormality itself, as well as because of any direct pain or lost usage effects. Similarly, injurious behavior indicates that the welfare of the perpetrator is poor as well as having an affect on the welfare of others. Much of the injurious behavior that occurs in farm animals, for example, tail-biting in pigs and feather-pecking in hens, is not aggressive behavior. True aggressive behavior can sometimes also indicate that the welfare of the aggressor is poor because of some environmental inadequacy and coping difficulty. Again, the welfare of the subject of the aggression will usually be poor also. The assessment of pain often involves measures of behavior, perhaps combined with the use of analgesics. Confined animals may be inactive and unresponsive to stimuli, rather like depressed humans. When people are depressed, there are various negative effects on hippocampal and other brain function, as well as impairment in immune system function. Those who study animal welfare have much to learn from the literature on human depression and those who investigate, or try to treat, human depression have much to learn from work on the welfare of confined, defeated, or seriously frustrated pigs, cows, dogs, rats, and hens.

A wide range of environmental impacts have specific consequences for brain function. Stressful events have been shown to lead to impaired learning ability, impaired memory, damage to hippocampal neurons, remodeling of hippocampal dendrites, suppression of neurogenesis, changes in neurotransmitter distribution, and disorganization of brain function. All of these brain measures can be associated with changes in behavior. Disease in animals can have effects on behavior and these may be of great value in diagnosis, for example of particular pathogens and parasites, and hence in the improvement of welfare.

In some of these physiological and behavioral measures, it is clear that the individual tries to cope with adversity and the extent of the attempts to cope can be measured. In other cases, however, some responses are solely pathological and the individual fails to cope. In either case, the measure indicates poor welfare.

## **Welfare Assessment: Direct Indicators of Good Welfare**

Good welfare is sometimes detectable from the occurrence of certain behaviors although there may be more than one explanation for the occurrence of a particular behavior, such as tail-wagging in dogs. Physiological changes may also indicate pleasure. Oxytocin concentrations in blood are elevated during several pleasant experiences, such as during milk ejection and suckling in mammalian mothers, other maternal care, and social bonding. Oxytocin binds to receptors that regulate HPA axis activity and increases in plasma oxytocin are associated with decreases in glucocorticoids and adrenocorticotrophic hormone (ACTH), proliferation of lymphocytes, increased gamma-amino-butyric acid (GABA), and increased vagal tone. Investigations including measurement of such changes will involve behavior observation in preliminary studies and evaluation of the meaning of the measures will be aided by measuring behavior at the same time.

## **Welfare Assessment: Strength of Preference Measures**

The majority of indicators of good welfare which we can use are obtained by studies demonstrating positive preferences by animals. Early studies of this kind included that showing that hens given a choice of different kinds of floor to stand on did not choose what biologists had expected them to choose. As techniques of preference tests developed, it became apparent that good measures of strength of preference were needed. Taking advantage of the fact that gilts preferred to lie in a pen adjacent to other gilts, they were offered the choice of different kinds of floors that were either in pens next to another gilt or in pens further away. With the floor preference titrated against the social preference, better information was obtained about strength of preference. In a further example of strength of preference tests, operant conditioning with different fixed ratios of reinforcement was used. Preparturient sows would press a panel for access to a room containing straw or one containing food. Up to 2 days before parturition, they pressed, at ratios of 50–300 per reinforcement, much more often for access to food than for access to straw. At this time, food was more important to the sow than straw for manipulation or nest-building. However on the day before parturition, at which time a nest would normally be built, sows pressed just as often, at fixed ratio 50–300, for straw as for food. Another indicator of the effort which an individual is willing to use to obtain a resource is the weight of door that is lifted. In a study of the floor preferences of laboratory rats, it was found that rats would lift a heavier door to reach a solid floor on which they could rest than to reach a grid floor.

Preference tests require an animal to make a sacrifice of some kind whenever it gains access to some quantity of a resource or spends a given amount of time consuming it. In operant tests, a cost is imposed upon access to the resources by requiring the subject to perform a task. Performance of the task requires time and effort, which could otherwise have been spent doing other things. The task may also be unpleasant to the subject. Choice tests involve choosing between resources that satisfy the same motivation to different extents. The resource that an animal consumes more, or spends more time interacting with, is the one that satisfies that motivation more fully but identification of this resource does not mean that strength of motivation is measured. Simple choice tests are not suitable for comparing resources that satisfy different motivations. These may vary not only in their strength, but also in other properties, such as the rate at which subjects can be satisfied and the quantities of the resources required to satiate them. Terminology used in motivational strength estimation is described in [Table 2](#).

Table 2.  
Terminology in strength of preference studies

Resource – a commodity or an opportunity to perform an activity
Demand – the demonstrated amount of action that enables resources to be obtained
Price – the amount of that action required for unit of resource
Income – the amount of time or other variable limiting that action
Price elasticity of demand – the proportional rate at which consumption or demand changes with price
Consumer surplus – a measure of the largest amount that a subject is prepared to spend on a given quantity of the resource. It corresponds to an area beneath an inverse demand curve

In operant tests, the sacrifice required from an animal in order to get a resource is manipulated by varying the duration, difficulty, or unpleasantness of the task. The consumption level or time is recorded and the price paid for a fixed quantity of the resource measured. Motivational strength is calculated from the observed relationship between price and consumption, or between income and consumption.

It has sometimes been assumed that animals strive to maintain their consumption of important resources in the face of increasing access or consumption costs. One proposal was that the more strongly motivated an animal was to consume a given resource, the less its demand should be observed to decline when the price of the resource was increased or when its income was reduced, that is, the less elastic its demand should be with respect to price or income.

Some shortcomings of elasticity of demand indices are as follows:

- 1. The fitness cost of being prevented from performing an activity is not correlated with price elasticity.
- 2. The sacrifice that a subject makes when attempting to maintain an initial level of consumption is not accounted for.
- 3. Readiness to defend a preferred consumption level is confused with the tendency to become satiated with a resource.
- 4. Single elasticity values are seldom generally valid for a resource.

These shortcomings do not apply to the consumer surplus index, for example, the area under the curve when the price such as the number of lever presses needed to open a door and get to a resource is plotted against the demand which is the frequency of opening the door, so this should be used instead of price elasticity.

## Decisions About Welfare

Concerns about animals may be affected by whether or not the animal is considered to be sentient. Decisions about this will depend upon a range of observations of the animal, largely observations of its behavior in controlled circumstances. Nonetheless, the term welfare applies to both sentient and nonsentient animals, so welfare assessment does not require determination of sentience. One kind of decision that has to be taken in relation to welfare assessment concerns the quality of the evidence. This is part of the normal scientific process of deciding whether or not the data are methodologically and statistically robust enough to use. After this, the way in which different kinds of measurement can be considered together has to be decided in order to form an overall evaluation of welfare. Some of the relationships among direct measures of welfare were mentioned earlier. Measures of what is important to animals as estimated by their strengths of preference are of particular value when designing systems for keeping and managing animals. All of such information has to be evaluated in relation to the impact of something preferred on the animal species concerned. An individual might choose to eat inappropriate foods, or eat too little, or self-administer a harmful drug, so the consequences of showing the preference must be considered in properly controlled studies. The assessment of welfare should be quite separate from any ethical judgement but once an assessment is completed, it should provide information that can be used to take decisions about the ethics of a situation. There is no doubt that this final ethical decision will depend greatly on behavioral evidence.

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Donald Broom (M.A., Ph.D., Sc.D.) has been professor of Animal Welfare, Department of Veterinary Medicine, Cambridge University, since 1986. His Centre for Animal Welfare and Anthrozoology has developed concepts and methods of scientific assessment of animal welfare and studied cognitive abilities of animals, the welfare of calves, pigs, chickens, laboratory animals, zoo animals, etc. in relation to housing and transport, behavior problems of pets, attitudes to animals, and ethics of animal usage. He has published over 380 papers, lectured on animal welfare in 37 countries, served on UK (FAWC and APC) and Council of Europe committees, and has been chairman or vice chairman of EU Scientific Committees on Animal Welfare since 1990. At present, he is vice chairman of the European Food Safety Authority Scientific Panel on Animal Health and Welfare. He chaired the O.I.E. group on Welfare of Animals during Land Transport. Among his eight books are *Stress and Animal Welfare* (Broom and Johnson 1993/2000, Kluwer), *Coping with Challenge: Welfare in Animals Including Humans* (Broom ed. 2001, Berlin: Dahlem University Press), *The Evolution of Morality and Religion* (2003, Cambridge University Press), and *Domestic Animal Behaviour and Welfare*, 4th edition (Broom and Fraser 2007, CABI).