

Animal Welfare Defined in Terms of Attempts to Cope with the Environment

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The term animal welfare is used in precise scientific investigations, in legal documents and in public statements or discussion. Welfare is a characteristic of an animal rather than something given by man. The welfare of an individual is its state as regards its attempts to cope with its environment. This state includes how much it is having to do to cope, the extent to which it is succeeding in or failing to cope, and its associated feelings. Welfare will vary over a continuum from very good to very poor and studies of welfare will be most effective if a wide range of measures is used. Related concepts like need and stress are also defined. The relevance of feelings to the welfare concept is discussed with reference to the likely evolutionary origin of the mechanisms resulting in feeling.

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Introduction

It is my view, and that of many other people, that people have obligations towards animals with which they interact. These obligations concern the conservation of habitats or species, whether or not individuals should be killed and the welfare of individuals (Broom, 1989). Welfare, a term which is restricted to animals, including man, is regarded as particularly important by very many people but requires definition if it is to be used effectively and consistently. A concept of welfare is needed which can be used in precise scientific investigations, in legal documents and in public statements or discussion. It is necessary that welfare can be assessed in an objective way in studies comparing different situations or when a specific situation is encountered. The assessment of welfare should be quite separate from any ethical judgement about how animals should be treated but once an assessment is completed it should provide information which can be used to take decisions about the ethics of the situation.

The first criterion for a useful scientific definition

of welfare is that it must refer to a characteristic of the individual animal rather than something given to the animal by man. The welfare of an individual may well improve as a result of something given to it but the thing given is not itself welfare. The loose use of welfare with reference to payments to poor people is irrelevant to the scientific or legal meaning. However, it is accurate to refer to changes in the welfare of an initially hungry person who uses a payment to obtain food and then eats the food. We can use the word welfare in relation to a person, as above, or an animal which is wild or is captive on a farm, in a zoo, in a laboratory, or in a human home. Effects on welfare which can be described include those of disease, injury, starvation, beneficial stimulation, social interactions, housing conditions, deliberate ill treatment, human handling, transport, laboratory procedures, various mutilations, veterinary treatment or genetic change by conventional breeding or by genetic engineering.

We have to define welfare in such a way that it can be readily related to other concepts such as:

needs, freedoms, happiness, coping, control, predictability, feelings, suffering, pain, anxiety, fear, boredom, stress and health. The concept of needs will be considered in detail now to help to explain welfare and its relationship to some other concepts.

Needs

Animals have a range of functional systems controlling body temperature, nutritional state, social interactions etc. (Broom, 1981). Together, these functional systems allow 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 behavioural 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 is important for it to carry out an action because of some environmental situation, we say that it has a need. A need can therefore be defined as a requirement, which is a consequence of the biology of an animal, to obtain a particular resource or respond to a particular environmental or bodily stimulus (modified after Broom and Johnson, 1993).

Some needs are for particular resources, such as water or heat, but control systems have evolved in animals in such a way that the means of obtaining a particular objective has become important to the individual animal (Toates and Jensen, 1991). The animal may need to perform a certain behaviour and may be seriously affected if unable to carry out the activity, even in the presence of the ultimate objective of the activity, for example various species will work, in the sense of carrying out actions which result in food presentation, even in the presence of food. In the same way, pigs need to root in soil or some similar substratum (Hutson, 1989), hens need to dust-bathe (Vestergaard, 1980) and animals of these species need to build a nest before giving birth or laying eggs (Brantas, 1980; Arey, 1992). In all of these different examples, the need itself is not physiological or behavioural but may be satisfied only when some physiological imbalance is prevented or rectified, or when some particular behaviour is shown.

Some needs are associated with feelings and these feelings are likely to change when the need is satisfied. If the existence of a feeling increases the chances that the individual will carry out some adaptive action and hence be more likely to survive, the capacity to have such a feeling is likely to have evolved by natural selection. Further, if the state of

an individual in certain conditions is desirable from an evolutionary viewpoint, there should be a propensity for that individual to have good feelings. On the other hand, if a state is one which should be quickly altered, it should be associated with unpleasant feelings which prompt avoidance or some other action. Feelings are part of a mechanism to achieve an end, just as adrenal responses or temperature regulatory behaviour are mechanisms to achieve an end.

When there are no needs which have to be satisfied immediately and welfare is good, there will often be good feelings. Likewise, when there are unsatisfied needs and welfare is poor, there will often be bad feelings. Feelings will usually result in changed preferences, hence preferences can give some useful information about needs. Other information about needs is obtained by observing the abnormalities of behaviour and physiology which result when needs are not satisfied.

Needs vary in urgency and the consequences if they are not satisfied range from those which are life-threatening to those which are relatively harmless in the short-term (see Hughes and Duncan, 1988; Broom and Johnson, 1993). This range of meaning is expressed in German by two words: *Bedarf*, meaning something which the individual must have if life is to continue, and *Bedürfnis*, meaning something which the individual wishes to be satisfied. Since we know that strong preferences by an individual for or against a resource or activity usually relate to something important for the biological success of that individual, a *Bedürfnis* has to be considered very carefully in relation to welfare.

Welfare definition

As discussed above, if at some particular time an individual human or other animal has no problems to deal with, it is likely to have a good state which may be indicated by body physiology, brain state, feelings and behaviour. Another individual may face problems in life which are such that it is unable to cope with them and it would eventually fail to grow, fail to reproduce or die. A third individual might face problems but, using its array of coping mechanisms, be able to cope but only with difficulty. The second and third individuals are likely to show some direct signs of their potential failure to cope or difficulty in coping and they are also likely to have bad feelings associated with their situations. The welfare of an individual is its state as regards its attempts to cope with its environment (Broom, 1986). This definition refers to a characteristic of the individual at the time. The origin of the concept is

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Table 1. Measures of good welfare

Variety of normal behaviours shown
Extent to which strongly preferred behaviours can be shown
Physiological indicators of pleasure
Behavioural indicators of pleasure

(after Broom and Johnson 1993)

how well the individual is faring or travelling through life. For further discussion see Broom (1991a, 1993), Broom and Johnson (1993). The concept refers to the state of the individual on a scale from very good to very poor. This state is measurable and any measurement should be independent of ethical considerations. When considering how to assess the welfare of an individual it is necessary to start with knowledge of the biology of the animal. The state can be good or poor but, in either case, there will often be feelings associated with the state, which we should try to measure, as well as using more direct measures.

The measurement of welfare is discussed in detail elsewhere (Broom, 1988; Fraser and Broom, 1990; Broom and Johnson, 1993) but measurement is discussed here where it helps to explain the concept. Indicators of good welfare and of poor welfare are listed in Table 1 and Table 2. Most indicators will help to pinpoint the state wherever it is on the scale from very good to very poor. 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. See Table 1 and Table 2.

The majority of indicators of good welfare which we can use are obtained by studies demonstrating positive preferences by animals. Early studies of this

Table 2. Measures of poor welfare

Reduced life expectancy
Reduced ability to grow or breed
Body damage
Disease
Immunosuppression
Physiological attempts to cope
Behavioural attempts to cope
Behaviour pathology
Self narcotization
Extent of behavioural aversion shown
Extent of suppression of normal behaviour
Extent to which normal physiological processes and anatomical development are prevented

(after Broom and Johnson 1993)

kind included that by Hughes and Black (1973) 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, van Rooijen (1980) offered them the choice of different kinds of floors which were either in pens next to another gilt or in pens further away. With the floor preference titrated against the social preference he was able to get better information about strength of preference. A final example of preference tests, in which operant conditioning with different fixed ratios of reinforcement were used, is the work of Arey (1992). Pre-parturient sows would press a panel for access to a room containing straw or one containing food. Up to two 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.

Some signs of poor welfare involve physiological measurements. Increased heart-rate, or adrenal activity, or adrenal activity following ACTH challenge, or reduced immunological response following a challenge, can all give information that welfare is poorer than in individuals which do not show such changes. Care must be taken when interpreting such results, as with many other measures described here, because some of these physiological changes can occur in wholly beneficial situations. The impaired immune system function and some of the physiological changes can indicate what Moberg (1985) has termed a pre-pathological state. Behavioural measures are also of particular value in welfare assessment. The fact that an animal avoids something, especially if it avoids it strongly, tells us about its feelings and about how poor its welfare is. An individual which is completely unable to adopt a preferred lying posture despite trying hard to do so has poorer welfare than one which can adopt the preferred posture. Other abnormal behaviour such as stereotypies, self mutilation, tail-biting in pigs, feather-pecking in hens or excessively aggressive behaviour indicates that the welfare of the perpetrator of the abnormal behaviour is poor.

In some of these physiological and behavioural measures it is clear that the individual is trying to cope with adversity and the extent of the attempts to cope can be measured. In other cases the response is pathological and the individual is failing to cope. In either case the measure indicates poor welfare.

Animal welfare defined in terms of attempts to cope with the environment

Very good	Occasional bouts of adrenal cortex activity	Occasional stereotypy caused by minor frustration	Normal growth and reproduction	Normal immune system functioning	No injury
Welfare	Frequent adrenal activity	Stereotypies for 5% of active time	Impaired growth or reproduction	Substantial immunosuppression	Injury-asleep or narcotised
	Pathological consequences of adrenal activity, eventually associated with reduced possibility of adrenal activity	Stereotypies for 40% of active time	Impaired growth or reproduction and reduced life expectancy	Substantial immunosuppression plus severe disease condition	Injury-awake and suffering
Very poor	a	b	c	d	e

Fig. 1. The significance for the welfare continuum of measurements of (a) adrenal cortex activity effects, (b) stereotypies, (c) growth, reproduction and life expectancy, (d) immune system function, disease condition and hence possible suffering, (e) injury in relation to the extent to which the individual might be suffering. Whilst each of these kinds of measure is an indicator of welfare, we do not yet know how they equate one with another (After Broom, 1993).

Disease, injury, movement difficulties and growth abnormality all indicate poor welfare. If two housing systems are compared in a carefully controlled experiment and the incidence of any of the above is significantly increased in one of them, the welfare of the animals is less good in that system. The welfare of any diseased animal is less good than that of an animal which is not diseased but much remains to be discovered about the magnitude of the effects of disease on welfare and especially about how much suffering is associated with different diseases. A specific example of an effect of housing conditions which leads to poor welfare is the consequence of severely reduced exercise for bone strength. In studies of hens (Knowles and Broom, 1990; Nørgaard-Nielsen, 1990) those birds which could not exercise their wings and legs much because they were housed in battery cages had considerably weaker bones than those in percheries which could exercise. Similarly, Marchant and Broom (1994) found that sows in stalls had leg bones only 65% as strong as sows in group-housing systems. The actual weakness of bones means that the animals are coping less well with their environment so welfare is poorer in the confined housing. If the bones are broken there will be considerable pain and the welfare will be worse. Pain may be assessed by aversion, physiological measures, the effects of analgesics (e.g. Duncan et al., 1991) or by the existence of neuromas (Gentle, 1986).

The data collected in studies of animal welfare give information on the position of the animal on a scale of welfare. For example, measures of adrenal function might give evidence like that shown in Fig. 1a. Adrenal activity, excluding that associated

with beneficial activities like mating or chasing prey, tells us how much the individual has to do in order to cope and may also indicate failure to cope. Similar information is provided by measures of stereotypy duration (Fig. 1b.) Impaired growth and reproduction indicates poor welfare and, in the extreme, there may be reduced life expectancy (Fig. 1c). Immunosuppression (Fig. 1d), and injury (Fig. 1e) also indicate poor welfare. In several of these scales of measurement, there may not always be suffering involved but welfare is poor because of the injury, immunosuppression or disease. Pain and other suffering make welfare even worse but we are often in no position to assess the extent of suffering. See Fig. 1.

In all welfare assessment it is necessary to take account of individual variation in attempts to cope with adversity and in the effects which adversity has on the animal. When pigs have been confined in stalls or tethers for some time, some of the individuals show high levels of stereotypies whilst others are very inactive and unresponsive (Broom, 1987). There may also be a change with time spent in the condition in the amount and type of abnormal behaviour shown (Cronin and Wiepkema, 1984). In rats, mice and tree shrews it is known that different physiological and behavioural responses are shown by an individual confined with an aggressor and these responses have been categorised as active and passive coping (von Holst, 1986; Koolhaas et al., 1983). A study of the strategies adopted by gilts in a competitive social situation showed that some sows were aggressive and successful, a second category of animals defended vigorously if attacked and a third

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avoided social confrontation if possible. These categories of animals differed in their adrenal responses and in reproductive success (Mendl et al., 1992). As a result of differences in the extent of different physiological and behavioural responses to problems in life it is necessary that any assessment of welfare should include a wide range of measures (Duncan, 1978; Dawkins, 1980; Broom, 1986). We also have to improve our knowledge of how the various measurements combine to indicate the severity of the problem.

Welfare: deduced from measurements and varying over a range

If the welfare were viewed as an absolute state which either existed or did not exist, then it would be of little use as a concept when discussing the effects on individuals of various conditions in life or of potentially harmful or beneficial procedures. It is essential that the concept be defined in such a way that welfare is amenable to measurement. Once the possibility of measurement is accepted, welfare has to vary over a range. If there is a scale of welfare and the welfare of an individual might improve on this scale, it must also be possible for it to go down the scale. There are many scientists assessing the welfare of animals who accept that welfare can get better or can get poorer. It is therefore illogical to try to use welfare as an absolute state or to limit the term to the good end of the scale. Welfare can be poor as well as good.

The view of welfare as referring only to something good or "conducive to a good or preferable life" (Tannenbaum, 1991) is not tenable if the concept is to be practically and scientifically useful. Fraser (1993), referring to well-being as the state of the animal, advocates assessing it in terms of level of biological functioning such as injury or malnutrition, extent of suffering and amount of positive experience (see also Hurnik and Lehman, 1988). However, despite using well-being to refer to scales of how good the animal's condition is, some of his statements explaining well-being imply only a good state of the animal, a limitation which is neither logical nor desirable. Fraser (1993) does, however, follow Broom (1986) and Broom and Johnson (1993) in drawing a conceptual parallel with the term health which is encompassed within the term welfare. Health can refer to a range of states and can be qualified by the words good or poor. Health can also imply absence of illness or injury. Welfare has the same range of colloquial meaning but when the term is used precisely, it must mean the range of states and it must be possible to refer to poor welfare and good welfare.

Welfare assessment and ethics

Where scientific measurement is used in an investigation of welfare, for example in a comparison of different animal transport procedures, to what extent can or should the steps in the process depend upon ethical considerations? Tannenbaum (1991) argues that welfare is a concept in which values are inextricably involved and concludes that no separation between what does and does not involve ethics is possible. This argument does not convincingly deny the premise that welfare can be assessed in an objective scientific way, indeed it fails to provide a basis for welfare investigation.

The first of four components in a study, like that of methods of transport of farm animals, is to decide that there is a problem. Ethical considerations are involved here. It is considered that welfare of farm animals should not be very poor and that welfare may be worse during one transport method than during another. The second component in the procedure may be to make a scientific comparison of these methods of transport. In this step, the only ethical consideration is that the scientist should be as objective as possible in selecting measurements and in carrying out the study. If only one measurement was made and this was known to be likely to bias the result, the study would be scientifically inadequate and ethically questionable. However, if the scientist takes care to use all possible information about the biology of the animal and the likely environmental effects on the animal when selecting measures, this is good science. Similarly, the third component which is to make and analyse the measurements, must be carried out objectively and independently of any ethical view about which method of transport is desirable. When the scientific process is completed and the results are presented, ethical decisions can be taken. This is the fourth component. Ethical values are involved in the first and fourth components of the process but only scientific values should be involved in components two and three. Where measurement and ethics are inextricably linked, this is bad science.

Welfare and feelings

The subjective feelings of an animal are an extremely important part of its welfare (Broom, 1991b). Suffering should be recognized and prevented wherever possible. However, whilst we have many measures which give us some information about various aspects of the state of an individual as regards its attempts to cope with its environment, fewer studies tell us about one aspect of this state: the feelings of the animal. Hence, although we

should use information about feelings, we have to use other information about welfare in the broader sense as well. As discussed above, feelings are aspects of an individual's biology which must have evolved to help in survival, just as anatomy, physiology and behaviour have evolved, so it is not logical to concentrate on feelings to the exclusion of other mechanisms when defining welfare. 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 (Broom and Johnson, 1993). If the definition of welfare were limited to the feelings of the individual, it would not be possible to refer to the welfare of a person or an individual of another species which was asleep, or anaesthetized, or drugged, or suffering from a disease which affects awareness. A further problem, if only feelings were considered, is that a great deal of evidence about welfare, like the presence of neuromas, or extreme physiological responses or various abnormalities of behaviour, or immunosuppression, or disease, or 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. Evidence about feelings must be considered for it is important in welfare assessment but to neglect so many other measures is illogical and harmful to the assessment of welfare, and hence to attempts to improve welfare. In some areas of research we have particular difficulty in recognizing feelings. For example, it would be difficult to assess the effects of different stunning procedures using preference tests. Disease effects are also difficult to assess using preference tests. There are also problems in interpreting strong preferences for harmful foods or drugs. We should do much more work on the assessment of animal feelings but should not depend exclusively on such studies when assessing welfare.

Welfare and stress

The word stress should be used for that part of poor welfare which involves failure to cope. If the control systems regulating body state and responding to dangers are not able to prevent displacement of state outside the tolerable range, a situation of different biological importance is reached. As discussed in detail by Broom and Johnson (1993), the use of the term stress should be restricted to the common public use of the word to mean something which is bad for the individual. A definition of stress as just a stimulation or as something which elicits adrenal cortex activity is of no scientific or practical value. A precise criterion for what is adverse for an animal is difficult

to find but one indicator is whether there is, or is likely to be, an effect on biological fitness. Stress is an environmental effect on an individual which overtaxes its control systems and reduces its fitness or seems likely to do so. This definition (Broom and Johnson, 1993), has been developed from earlier versions (Broom, 1983; Fraser and Broom, 1990). Using this definition, the relationship between stress and welfare is very clear. Firstly, whilst welfare refers to a range in the state of the animal from very good to very poor, whenever there is stress, welfare is poor. Secondly, stress concerns situations where there is failure to cope but poor welfare includes the state of the animal, both when there is failure to cope and when the individual is having difficulty in coping. It is very important that this latter kind of poor welfare is included in the definition of welfare as well as the occasions when an animal is stressed. If a person is depressed to the point of feeling that life is not worth living or if an individual has a severe debilitating disease but in each case there is complete recovery with no long term effects on fitness, we would still say that the welfare of the individuals was poor at the time of the depression or disease.

The word welfare in different languages

In English the two words welfare and well-being overlap considerably in meaning. Whilst, as mentioned earlier, welfare refers to how well the individual fares in life, well-being refers to how well the individual is. Welfare is normally used in legislation and in most scientific writing on the topic because it is considered to have a rather more precise meaning. The equivalent terms in Dutch, German and Polish are *welzijn*, *Wohlbefinden* and *dobrostan* and these can easily be used as a direct translation of welfare. In French, Spanish, Portuguese and Danish, the words *bien-être*, *bien star*, *be mestar* and *velførd* tend to have a greater emphasis on the good side of welfare but they are used as equivalent to welfare in Council of Europe and EU conventions, recommendations, directives and regulations, so the idea that welfare can be poor and not just good is already acknowledged. The concept of welfare is of great importance. However, for all who have to use the concept, it would be best if there was a word with a consistently understood scientific and legal meaning in each language (Broom and Johnson, 1993).

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