

A Usable Definition of Animal Welfare

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Abstract *A definition of the welfare of an animal which can be used in scientific studies, legislation and other practical work is: the welfare of an individual is its state as regards its attempts to cope with its environment. A variety of measurements can be used to pinpoint the individual's state on a continuum from very good to very poor welfare. Welfare can be poor because the individual is having difficulty in coping or because of failure to cope. Poor welfare includes stress, which is defined as an environmental effect on an individual which overtaxes its control systems and thus reduces its fitness or appears likely to do so. It also includes situations in which behavioural, physiological or immunological measures indicate that coping is difficult even if biological fitness is not reduced. Suffering is an important aspect of poor welfare. While much of poor welfare involves suffering, examples are given of situations in which welfare is poor in the absence of suffering. If suffering occurs in addition to injury or immunosuppression, then welfare is even poorer. Scientific studies of welfare should include direct measures of poor welfare as well as measures of the strengths of preferences and aversions. Measurements should be carried out in an objective way and moral judgements about what is tolerable should be made afterwards.*

Keywords: animal welfare, stress, suffering, pain, adrenal function, immunosuppression, abnormal behaviour, animal production.

Introduction

A definition of animal welfare is needed for scientific study, for legislation and for practical use. This definition must refer to a characteristic of an individual which is measurable. The measurement should be separate from any judgement which is made concerning what is morally acceptable. Almost all possible measurements will involve variation over a range rather than something which exists or does not exist. Such variation is assumed in normal usage of the term welfare and in its origin: how

well does the individual "fare" or travel through life. Any precise scientific usage of the word welfare must be distinguished from the recent usage of welfare in the United States to mean government support for those members of a society who are below a defined standard of living.

All individuals encounter a range of problems as they go through life. They have several methods for trying to solve or cope with these problems. Coping means having control of mental and bodily stability (Fraser and Broom, 1990). Attempts to cope include the functioning of body repair systems, immunological defences and emergency physiological reactions as well as behavioural responses (including those carefully calculated by humans). Coping may be difficult or attempts to cope may fail, with the result that there is reduced biological fitness. In either of these two cases there may be suffering. Alternatively, an individual may be coping effectively with all aspects of life so that the terms happiness or contentment might be used in describing it. Using these concepts welfare has been defined as follows: *The welfare of an individual is its state as regards its attempts to cope with its environment*. (Broom 1986; 1988a; Fraser and Broom, 1990; Broom and Johnson, forthcoming). The word welfare would not be used in relation to inanimate objects or plants because they lack most of the coping mechanisms described in this paper, but it could be used for any living animal.

An individual's state as regards its attempts to cope will vary over time and according to conditions. For example, at one time it may have to do little in order to cope, at another time it may have to do more, whilst at yet another time it may have to devote most of its energy to trying to cope. Its welfare will be best at the first time and worst at the last. Hence welfare must be considered as varying over a continuum from very good to very poor. Measurements of welfare will provide information about the position on the continuum at that time. Curtis (1986) and Duncan (1987) have also emphasized that welfare is measurable and varies over a range.

Although welfare will be affected by the situation in which the individual finds itself, welfare is not situation-specific as Moberg (this volume) has suggested. Welfare can be the same in different situations. For example, the welfare of individuals may be equally poor because they are having to contend with too low an ambient temperature, intermittent aggression, or lack of food and equally good when they are socializing with a preferred companion, eating a preferred food, or basking in the sun.

It is important to relate welfare to the concept of stress (see Fraser and Broom, 1990; Broom and Johnson, forthcoming). Stress is sometimes used to refer to any perturbation of homeostasis. However, the word would then have to be used every time that body temperature or body fluid concentration changed and it would be a useless term. Stress is often equated with adrenal cortex activity, but in popular usage stress almost universally refers to something which has adverse effects on the individual. Adrenal cortex activity occurs during courtship, copulation and active food acquisition, but none of these has really adverse effects on the individual. It is useful to limit the term stress to those levels of activity at which the biological fitness of the individual is reduced, i.e. there is increased mortality or reduced production of offspring. Hence stress is an environmental effect on an individual which

overtaxes its control systems and reduces its fitness or appears likely to do so. Among the first signs that there are likely to be adverse effects on fitness are those listed by Moberg (1987, this volume) as constituting the pre-pathological state.

Although welfare is poorer whenever individuals fail to cope and their fitness is reduced, i.e. when they are stressed, there are many circumstances in which there are environmental effects on animals such that welfare is poorer than in other circumstances but there is no effect on biological fitness. Examples are when animals are in pain, feel fear, or have difficulty controlling their interactions with their environment because of (a) frustration, (b) absence of some important stimulus, (c) insufficient stimulation in total, (d) overstimulation or (e) too much unpredictability (Wiepken 1987; Broom and Johnson, forthcoming). If two conditions or treatments are compared and individuals in one condition are in slight pain while those in the other condition are in severe pain, then welfare is poorer in the second condition even if the pain or its cause does not result in any long-term consequences such as a reduction in fitness. Pain, or the other factors listed above, may not affect growth, reproduction, pathology or life expectancy, but they do indicate poor welfare.

The term "well-being" is often used interchangeably with "welfare," but well-being has a stronger connotation of subjective feeling in its use. It is used to refer more to the individual's perception of its state than to the state itself. Well-being can be used to mean the feelings which an individual has about both its environment and the consequences of interactions with it. These feelings are a substantial part of its welfare but are not all of it (Broom, 1991b). Welfare is the word used in English versions of modern European legislation. Some other languages have only one word which can be used to translate either welfare or well-being. The words which are equivalent to welfare in other languages, and which are used in identical legislation, have various origins: for example *Wohlbefinden* in German, *welzijn* in Dutch, *bien-être* in French, *bienestar* in Spanish, *welfare* in Danish and *dobrostan* in Polish. *Welzijn*, *bien-être* and *bienestar* are very similar to well-being in origin but are used by scientists and legislators in much the same way as English speakers use welfare. *Wohlbefinden* and *dobrostan* are close in use to welfare as defined in this paper and *welfare* has a wider meaning but is used specifically in legislation.

The Welfare Concept in Relation to Measuring How Poor Welfare Is

A range of farm animal welfare problems, many of which are relevant to other animals with which man interacts, is presented in Table 1 (see also Hurrik, this volume). The two major approaches to assessing the welfare of an individual involve making a variety of measurements of how poor the welfare is and trying to determine what conditions or treatments are likely to result in good welfare. Table 2 lists some measures that may be used to infer how poor welfare is. These are discussed further by Fraser and Broom (1990), Broom (1991a) and Broom and Johnson (forthcoming).

When using measures of activity in one kind of coping system or of the extent to which there is failure to cope, a gradation in welfare is often evident (Figure 1). An

Table 1
Areas where there are or can be farm animal welfare problems

<ul style="list-style-type: none"> Ill-treatment Neglect and poor management Disease and lack of treatment Inadequate housing Poor facilities and procedures for moving animals Transport including loading and unloading Treatment at markets Slaughter and pre-slaughter procedures Farm operations Breeding procedures Provision for emergencies
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Table 2
Measures of poor welfare

<ul style="list-style-type: none"> Reduced life expectancy Reduced ability to grow or breed Body damage Disease Immunosuppression Physiological attempts to cope Behavioural attempts to cope Behaviour pathology Self narcotisation

animal encountering a varied environment but no real problems will show occasional bouts of adrenal cortical activity. If that same individual is frequently frustrated or frightened, one of the indicators of these situations can be increased glucocorticoid production and synthetic enzyme activity (e.g., Meunier-Salaun et al., 1987). If levels of adrenal cortex activity are frequently high, a consequence may be widespread pathological changes. In this case the welfare of the animal is even poorer. Sometimes the adverse effects on the animal may be so severe that adrenal function itself is impaired.

Other measures can also make it possible for the position of an individual on the welfare scale to be identified. Stereotypies are repeated, relatively invariant sequences of movements which have no obvious function. Stereotypies like bar-biting or sham-chewing in sows, tongue-rolling in calves, crib-biting in horses, or route-tracing in many zoo animals are shown in conditions where the individual is frustrated or otherwise lacking in control over the world which impinges on it. The range of welfare of individuals which show stereotypies occasionally or for varying amounts of time is indicated in Figure 1. It is possible that a stereotypy that has been shown for a long time gives more information about an earlier state than about the present state (Mason, 1991). However high levels of stereotypies, self-mutilation or other abnormal behaviour do show that the individual has difficulty coping with its external or internal environment at the time of observation, so that the welfare of an individual which shows such behaviour is clearly poorer than that of an in-

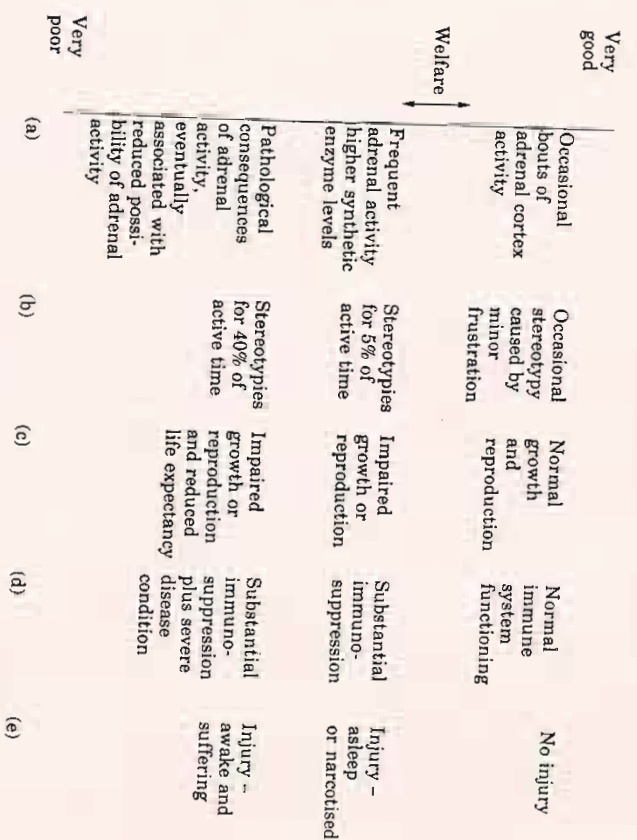


Figure 1 The significance for the welfare continuum of measurements of (a) adrenal cortex activity effects, (b) stereotypies, (c) growth, reproduction and life expectancy, (d) injury in relation to the extent to which the individual might be suffering, and (e) immune system function, disease condition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

dividual which does not (for further discussion see Broom, 1991a; Broom and Johnson, forthcoming). Another behavioural response to difficult conditions is to become inactive and unresponsive (Broom, 1987). It may be that unresponsiveness in such conditions is associated with increased endogenous opioid activity in the brain, since it is linked with μ receptor density in the cerebral cortex (Zanella, Broom and Hunter, 1991).

A general problem where different measures of welfare are used is in relating the scales used for these measures. The scales for adrenal function measures and for stereotypy measures have both been shown in Figure 1, but although both kinds of measures can indicate that welfare is better or poorer, we cannot say at present that a certain amount of adrenal activity is equivalent to a certain duration of stereotypy. It is important that a variety of measures be used when assessing welfare since individuals vary in both the kind of coping methods used and in the consequences of failing to cope (Broom, 1988a; Fraser and Broom, 1990). Analogy with human responses suggests that the welfare is better when the individual is responding and expecting to succeed than when no control over environmental events seems possible. Work on learned helplessness in dogs and man also suggests that welfare is particularly poor when the animal lacks control and aversive events cannot be

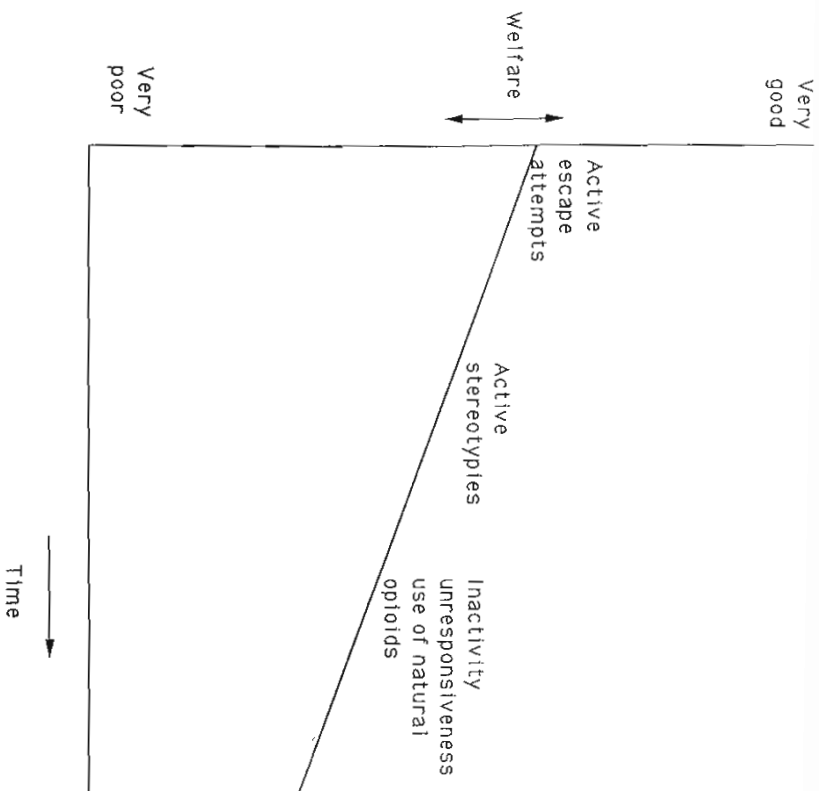


Figure 2 The possible significance for the welfare continuum of the various responses of sows to close confinement during a period of several months

predicted or prevented (Seligman, 1975; Abramson and Sackheim, 1977). Hence, a sequence of different welfare measurements in a sow during the period following confinement might be interpreted as a gradual decline in welfare, as shown in Figure 2.

Production measurements such as growth rate, reproductive output, or duration of productive life are also welfare indicators. If growth or reproduction are impaired then welfare is poorer (Figure 1) and again a scale of welfare based on measurements can be drawn up. Some modern farming practices result in reduced life expectancy. For example, milking cows live for a shorter time if fed and managed in such a way that production is very high. Figure 3 shows that the culling rate for dairy cows in Denmark doubled between 1960 and 1982 (Agger, 1983). Some of this culling is because there was an increase in the extent to which farmers culled less productive

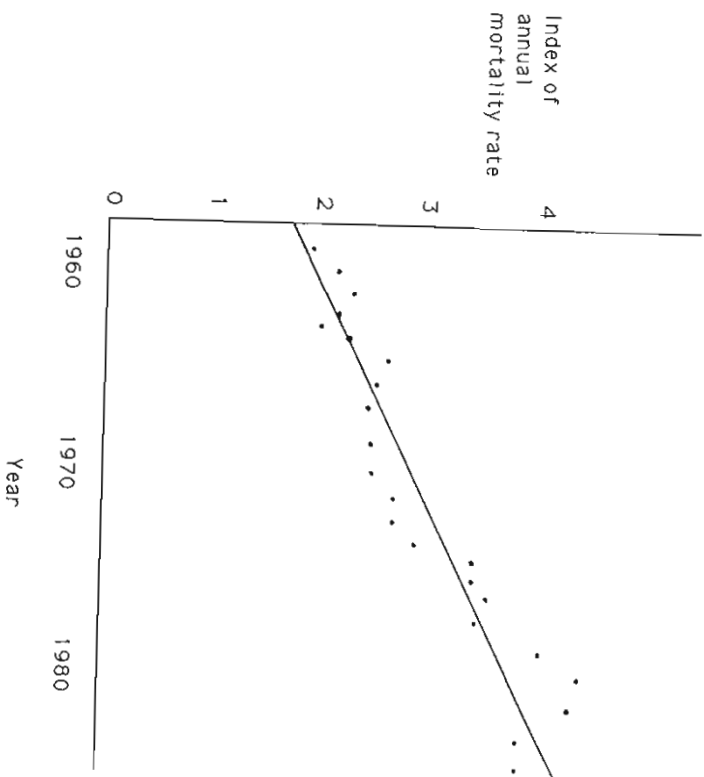


Figure 3 An index of the annual mortality rate of Danish dairy cows calculated from slaughter-house data over a 22 year period (data from Agger 1983)

animals when monitoring their production, but much of it must have been due to greater levels of the disorders associated with high feed conversion efficiency and high protein diets. If two systems are compared and the life expectancy is four years in one system but seven years in the other then the welfare would be poorer in the first system (Broom, 1991a). Even for farm animals which would normally be killed long before they die of natural causes a reduction in potential life expectancy is a relevant measure of welfare.

Welfare and Suffering

Before continuing with other examples it is desirable to consider the relationship between suffering, or other subjective feelings, and welfare. M. Dawkins (1990) said "Suffering occurs when unpleasant subjective feelings are acute or continue for a long time because the animal is unable to carry out those actions which would normally reduce risks to life and reproduction in those circumstances." There is no doubt that subjective feelings are an important part of the welfare of an individual. Suffering is one of the most important aspects of poor welfare. We should all be concerned

with identifying suffering and trying to prevent it. If there is suffering then welfare will always be poor. However, there are occasions where welfare is poor without suffering, so welfare should not be defined solely in terms of subjective experiences. Some examples of situations in which the state of an individual can be affected without suffering occurring are described below.

If an individual is injured, for example by a bone breakage, a cut in the skin or an ulcer in the stomach, health and welfare are poorer than in an individual which is not injured (Figure 1). Even if the individual with the injury is asleep or anaesthetized, and hence not suffering, there is an effect on welfare. If there is suffering as well as injury then welfare is even poorer. Very few people would feel that a severe injury has no effect on welfare during sleep but that welfare suddenly becomes poor because of awakening and consequent perception. It is difficult to see how the term welfare is to be used if there is such an extreme adherence to Duncan's concept (Duncan 1987, Duncan and Petherick 1991) that only feelings count when welfare is being assessed. As pointed out by McGlone (personal comment), the welfare of a person who is close to dying from a disease but who has a temporary good feeling should not be considered wholly good.

Then conditions are encountered which are difficult for the animal because of inappropriate ambient temperature, physical effects associated with transport, or disturbing social encounters, a consequence may be immunosuppression (Kelley, 1980; Broom, 1988b; Fraser and Broom, 1990; McGlone, this volume). This may be mediated via hyperactivity of the adrenal cortex, but in some situations it is not. Such immunosuppression can be preceded or accompanied by behavioural indicators of poor welfare. When welfare is good the immune system can work effectively to counteract pathogen challenge. If there is immunosuppression, however, then the individual will have greater difficulty in coping with environmental effects and must show some of the pre-pathological effects discussed by Moberg (1987; this volume). These effects also have the potential to reduce fitness so for both of these reasons the welfare is poorer than in an unaffected individual. It may well be that the immunosuppressed individual does not suffer because it is not challenged by pathogens but the immunosuppression itself means that there is an effect on its welfare. If successful pathological attack occurs as well, with consequent morbidity and suffering, then the welfare is even poorer (Figure 1). As mentioned earlier, we cannot as yet be sure how to equate these different measures of welfare, but measurements of the severity of effects may be similar during injury and disease.

Suffering is a valuable concept which is of great importance when considering the effects of conditions and procedures on animals, but it is not necessary to try to equate it with poor welfare. While it is not possible to make direct measurements of the feelings of animals (see below), the measures of poor welfare referred to above can be made and should be used.

A further method for finding out which conditions and treatments result in poor welfare is to investigate aversion in animals. As described and reviewed by Rushen (1986a, 1986b, 1990), the extent to which an individual finds a situation aversive can be measured both by assessing the extent of immediate avoidance and by measuring how difficult it is to make the animal return to the place where the aversive event

occurred. The latter measure gives us some idea of the animal's own concept of how unpleasant the previous event was. This is valuable information, additional to that which can be obtained from direct measures of physiology, behaviour, etc.

Assessing Good Welfare

The assessment of good welfare is difficult at present. Direct measurement of contentment or happiness by recording from "pleasure centres" in the brain has not, as was once expected, become possible. Some behaviours appear to indicate to one human that another human feels pleasure, but there is much doubt about how to interpret behaviours which might do so in other species. Even the tail-wagging of a dog has some component of the response of a subordinate to a dominant individual. It is possible to recognize that an individual is showing a wide range of comfort and investigative behaviours and this indicates better welfare than that of an individual which is unable to show such behaviours. The welfare of the individual which does not show comfort and investigative behaviour may also be poor, but several factors, not necessarily related to contentment, could affect the number of such behaviours shown. The most useful source of information concerning resources necessary for good welfare is the carefully controlled preference test. As Duncan and Petherick (1991) and Fraser (this volume) describe, several sophisticated methods are now available to determine the strengths of preferences of animals. If the importance of a resource to animals can be assessed then appropriate modifications to conditions and procedures can be made and tested. Care must be taken both because animals can choose things which result in poor welfare, as a heroin addict does, and because strong positive choices give no information about suffering. Nevertheless, much valuable information concerning how to design better conditions for farm animals has been gained by using this experimental method.

There are some circumstances where it is difficult to carry out studies of animal preferences. If we want to assess the effect on welfare of a procedure which damages body tissues considerably and causes pain, the procedure may be unrepeatable, so preference studies are not possible. This could be the case because the procedure is too severe to repeat or it could be because, as in castration, the tissue is removed. In such cases the only possibility for assessing preferences is to measure the reluctance of the individual to approach or respond to an associated stimulus, as in Rushen's experiments mentioned earlier. The effects of some other laboratory procedures cannot be assessed because the procedures themselves make any preference testing impossible. In other circumstances the animal is so adversely affected by its environment that it is no longer able to show clear preferences or the extent of aversiveness of stimuli. If welfare is very poor, direct measurements of the state at, or only just before, that time may be the only possible method of investigation.

When people are asked what they mean by good welfare, contentment, or happiness, they usually make reference to absence of problems. Absence of any indication of poor welfare and evidence for the effective functioning of all life control systems is often our best means of recognizing good welfare. The difficulty with this approach is that the measures used have to be comprehensive and we may be missing one

which is important. It is for this reason that we are much better at recognizing poor welfare, which can be indicated by any single measure, than at identifying good welfare. Even if an animal shows very strong preferences for something, we cannot be sure that welfare will be good when that resource is provided.

Using the Concept of Welfare

One important consequence of the concept, presented here, of welfare as a state which can vary over a wide range and can be measured, is that we can talk about smaller or larger differences in welfare in an objective way. The moral judgement of how poor welfare has to be before it is considered to be intolerable can be made separately from the scientific measurement. The scientist and the non-scientist can have an opinion of where to draw the line between the morally tolerable and the morally intolerable. Most of the measures of welfare, including those of immunology and growth, will describe a range of environmental consequences from those that have no adverse effect on biological fitness to those where there is a very clear effect. As mentioned above, severe depression in man or severe pain is almost universally recognized as meaning poor welfare whether or not there is an effect on fitness. Hence it is not logical to suggest that some pathology or production impairment must always occur before welfare can be considered poor. As mentioned earlier, severe pathology or reproductive inhibition indicate very poor welfare. However some behavioural or physiological changes which do not reduce fitness may also indicate poor welfare. Abnormal behaviour in a person about to commit suicide may not in itself mean a reduction in fitness but it does provide important information about welfare.

Our present knowledge allows us to recognize very poor welfare and often to measure how poor welfare is, using several measures. Further study is needed in order that the relationships between these various measures can be better understood. Attempts must be made to find out how good welfare is by studying preferences and the use of measures of poor welfare together in order to obtain the best possible information about welfare.

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