

ANIMAL WELFARE SCIENCE

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Abstract

In many recent surveys in Europe, animal welfare has been shown to be an important issue for the general public. Evidence for this and information about legislation and codes of practice which influence animal welfare are presented. The concepts of welfare, need, stress, health, pain, emotion and feeling are defined and the relationships amongst these are discussed. Welfare is a broad term, of which health and feelings are important parts. There has been rapid development in recent years in the scientific assessment of animal welfare. This information has been used in formulating laws about how animals should be housed, managed and treated. Where welfare is poor, the best overall assessment of welfare is a function of the severity of effect on the individual and the duration of that effect. Efforts should be made to evaluate how good welfare is as well as the extent of any poor welfare.

1. Public opinion, codes of practice and laws

Public concern about animal welfare has increased in many countries during the last thirty years and especially in the last ten years. Evidence of this is summarized in Table 1.

Table 1 - Evidence for increased concern about animal welfare.

1. Letters from the public, media coverage.
2. References in parliamentary discussions and government statements.
3. Requests for scientific evidence concerning animal welfare.
4. Activity of scientific and other advisory committees.
5. Funding of scientific research on animal welfare.
6. Increased teaching and conferences.
7. More legislation.

(from Broom 1999)

The ethical basis of this is that we have obligations to all animals which we use, one of which is to ensure that welfare is not very poor.

In many recent surveys in Europe, animal welfare has been shown to be an important issue for the general public. For example about three quarters of people questioned in France regarded animal welfare as a problem affecting their purchasing of veal or eggs (Ouedraogo 1998) and 34% of 420 schoolgirls questioned in Dublin stated that they avoided eating meat, principally (53%) for animal welfare rather than nutrition (29%) reasons (Ryan 1997).

Legislation has effects on how people house and manage animals but several other factors also affect this. Codes of practice produced by governments, the animal production industry, or companies which purchase the products from farmers and sell them to the public have an effect. In recent years, retailers' codes of practice have had large effects internationally on farm practice. These and other factors help to form the attitudes of the people who construct animal accommodation, own animals, manage units, care for animals on a day to day basis, transport animals, handle animals in markets, or slaughter animals.

Legislation is generally initiated by pressure from voters on elected politicians. The politicians would usually seek advice from civil servants before formulating new legislation. In recent years, whenever any legislation on animal welfare is proposed, advice is sought from committees or working groups of scientists. The non-government organisations who lobby the politicians, whether they are producers' organisations or animal protection organisations, will have

some access to scientific advice so it is important for the legislators to know the latest state of scientific knowledge on the subject. As a consequence, the European Union has set up, via the European Commission, scientific committees on a range of subjects. The former committees were the Scientific Veterinary Committee, Animal Welfare Section and the Scientific Committee on Animal Health and Animal Welfare. The present committee is the European Food Safety Authority Scientific Panel on Animal Health and Welfare.

Legislation within European countries and E.U. Directives and Regulations have usually been preceded by Recommendations from Council of Europe committees such as the Standing Committee of the European Convention on the Protection of Animals Kept for Farming Purposes. This last Committee has produced Recommendations on: poultry kept for egg production, pigs, cattle, fur animals, sheep, goats, chickens kept for meat production and ducks. The information in the Convention and Recommendations has formed the basis for legislation and codes of practice in many countries.

On the world level, the O.I.E., which has formerly produced agreed recommendations on how to deal with animal disease, is now preparing to do the same for animal welfare.

2. Welfare definition

The welfare of animals is regarded as particularly important by many people and is a key factor when determining whether or not a system or procedure involving animals is sustainable (Broom 2001a). However, the term welfare requires strict definition if it is to be used effectively and consistently. A clearly defined concept of welfare is needed for use 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 assessment of welfare should be quite separate from any ethical judgement but, once an assessment is completed, it should provide information which can be used to take decisions about the ethics of a situation.

A useful definition of animal welfare 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. 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 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.

If, at some particular time, an individual has no problems to deal with, that individual is likely to be in a good state including good feelings and indicated by body physiology, brain state and behaviour. Another individual may face problems in life which are such that it is unable to cope with them. Coping implies having control of mental and bodily stability and prolonged failure to cope results in failure to grow, failure to reproduce, or death (Broom 2001b). A third individual might face problems but, using its array of coping mechanisms, be able to cope 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 had 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 how well the individual is faring or travelling through life and the definition refers to state at a particular time (for further discussion, see Broom, 1988a, 1991a,b, 1996; Broom & Johnson, 1993). The concept refers to the state of the individual on a scale from very good to very poor. This is a measurable state 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 may be good or poor, however, in either case, in addition to direct measures of the state, attempts should be made to measure those feelings which are a part of the state of the individual.

3. Implications of welfare definition

This definition of welfare has several implications (Broom and Johnson 1993), some of which are discussed in more detail later. Welfare is a characteristic of an animal, not something given to it. If welfare were viewed as an absolute state which either existed or did not exist then the concept of welfare would be of little use 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 (e.g. Curtis 1986, Duncan 1987). 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.

Good welfare with associated pleasure or happiness, is an essential part of the welfare concept but 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. 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.

Welfare can be measured in a scientific way that is independent of moral considerations. Welfare measurements should be based on a knowledge of the biology of the species and, in particular, on what is known of the methods used by animals to try to cope with difficulties and of signs that coping attempts are failing. The measurement and its interpretation should be objective. Once the welfare has been described, moral decisions can be taken.

An animal's welfare is poor when it is having difficulty in coping or is failing to cope. Failure to cope implies fitness reduction and hence stress. However, there are many circumstances in which welfare

is poor without there being any effect on biological fitness. This occurs if, for example, animals are in pain, they feel fear, or they have difficulty controlling their interactions with their environment because of (a) frustration, (b) absence of some important stimulus, (c) insufficient stimulation, (d) overstimulation or (e) too much unpredictability (Wiepkema 1985).

If two situations are compared, and individuals in one situation are in slight pain but those in the other situation are in severe pain, then welfare is poorer in the second situation even if the pain or its cause does not result in any long-term consequences, such as a reduction in fitness. Pain, or other effects listed above, may not affect growth, reproduction, pathology or life expectancy, but it does mean poor welfare.

Fraser (1993) follows Broom (1986) and Broom & Johnson (1993) in drawing a conceptual parallel with the term «health» which is encompassed within the term welfare. Like welfare, health can refer to a range of states and can be qualified as either «good» or «poor».

Animals may use a variety of methods when trying to cope, and there are various consequences of failure to cope. Any one of a variety of measurements can therefore indicate that welfare is poor, and the fact that a measure, such as growth, is normal does not mean that welfare is good.

Pain and suffering are important aspects of poor welfare. Pain is an aversive sensation and a feeling associated with actual or potential tissue damage (Broom 2001c). Suffering is an array of unpleasant subjective feelings which are also aversive and avoided where possible. Even though some pain and suffering may be tolerated in order that some important objective be attained, both of these involve increased difficulty in coping with the environment and hence poorer welfare. The relationship between welfare and feelings is considered again later in this chapter.

Welfare is affected by what freedoms are given to individuals and by the needs of individuals, but it is not necessary to refer to these concepts when specifying welfare.

4. Welfare and needs

Most scientists involved in welfare research would agree with Appleby (1997) that a range of components of that environment, each of which is to some extent variable, should be considered when attempting to determine what is an appropriate environment for an animal. 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. (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 must 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 part of the basic biology of an animal, to obtain a particular resource or respond to a particular environmental or bodily stimulus** (Broom 2001b). As pointed out by Broom (1997), these include needs for particular resources and needs to carry out actions whose function is to obtain an objective (Toates and Jensen, 1991; Broom, 1996). Needs can be identified by studies of motivation and by assessing the welfare of individuals whose needs are not satisfied (Hughes and Duncan, 1988a,b; Dawkins, 1990; Broom and Johnson, 1993).

Control systems have evolved in animals in such a way that the means of obtaining a particular objective have become important to the individual animal. Some needs are for particular resources, such as water or heat, the animal may also need to perform a certain behaviour. It may be seriously affected in an adverse way if unable to carry out the activity, even in the presence of the ultimate objective of the activity. For example, rats and ostriches 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 both 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 in the brain so is not physiological or ethological. It is the fulfilment of needs which requires physiological change or certain behaviour to be shown, and this has led to the use of «biological needs» or just «needs» in later Recommendations of the Council of Europe. Examples from the preamble of the Council of Europe Recommendations on Pigs are «environment and management have to fulfil the animal's biological needs rather than trying to adapt the animals to the environment by procedures such as mutilations» and there should be research «to ensure that the needs of the pigs are met and hence their welfare, including their health, is good».

Some needs are associated with feelings, which might also be called subjective experiences, and these feelings are likely to change when the need is satisfied (Broom 1999a). When there are no needs which have to be satisfied immediately and the animal's welfare is good, the animal is likely to experience positive 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.

The term welfare is used in the European Convention for the Protection of Animals Kept for Farming Purposes (Council of Europe 1976), for example Article 2 refers to «principles of animal welfare laid down in Articles 3 to 7» and Article 7 refers to what is «necessary to safeguard the welfare of the animals». The Directives and Regulations of the European Union which relate to the protection of animals, also refer to welfare, health, suffering and needs. For example, in Directive 91/630/EEC laying down minimum standards for the protection of pigs: it is stated that research must «take into account the welfare of sows in varying degrees of confinement» (Article 6). However, despite the regular use of scientific reports on animal welfare matters, the phraseology of legislation often fails to use terms like welfare and needs in an up-to-date precise way.

In all of this terminology it is important that a distinction should be made between what humans do and the effects on animals. Animal protection is a human activity and we have obligations towards animals which we use. Humans can be cruel or humane or kind towards animals. Regulation EEC 3254/91 concerning the ban on leghold traps refers to «developing humane trapping methods» (Article 3.2), implying, as most scientists do, that for a trap to be humane, the welfare of the trapped animal must be good to a certain high degree. Legislation on slaughter and transport also uses these terms.

5. Welfare and feelings

The feelings of an animal are an extremely important part of its welfare (Broom 1991b). However, whilst we have many measures which give us some information about injury, disease and both behavioural and physiological attempts to cope with the individual's environment, fewer studies tell us about the feelings of the animal. Information can be obtained about feelings using preference studies and other information giving indirect information about feelings can be obtained from studies of physiological and behavioural responses of animals.

As discussed above, feelings are aspects of an individual's biology which must have evolved to help in survival (Broom 1998), just as aspects of anatomy, physiology and behaviour have evolved. They are used in order to maximise 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 (Broom & Johnson, 1993). The coping systems used by animals operate on different time scales. Some must operate during a few seconds in order to be effectual, others take hours or months. Optimal decision-making depends not only on an evaluation of energetic costs and benefits but on the urgency of action, in other words the costs associated with injury, death or failure to find a mate (Broom 1981, p. 80). In the fastest acting urgent coping responses, such as avoidance of predator attack or risk of immediate injury, fear and pain play an important role. In longer time-scale coping procedures, where various risks to the fitness of the individual are

involved, feelings rather than just intellectual calculations are amongst the causal factors affecting what decisions are taken. In attempts to deal with very long-term problems which may harm the individual, aspects of suffering contribute significantly to how the individual tries to cope. In the organisation of behaviour so as to achieve important objectives, pleasurable feelings and the expectation that these will occur have a substantial influence. The general hypothesis advanced is that whenever a situation exists where decisions are taken which have a big effect on the survival or potential reproductive output of the individual, it is likely that feelings will be involved. This argument applies to all animals with complex nervous systems, such as vertebrates and cephalopods, and not just to humans. Feelings are not just a minor influence on coping systems, they are a very important part of them.

In circumstances where individuals are starting to lose control and fail to cope, bad feelings may exist. These feelings might have a role in damage limitation which is functional. However they might also occur when the individual is not coping at all and the feelings have no survival function then. Extreme suffering or despair are probably not adaptive feelings but an observer of the same species might benefit and a scientist might use indications of such feelings to deduce that the animal is not coping.

If the definition of welfare were limited to the feelings of the individual as has been proposed by Duncan & Petherick (1991), it would not be possible to refer to the welfare of a person or an individual of another species which had no feelings because it was asleep, or anaesthetised, 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, extreme physiological responses or various abnormalities of behaviour, 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. 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 animal welfare research it is difficult to identify the subjective experiences of an animal experimentally. 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. However, research on the best housing conditions and handling procedures for animals can benefit greatly from studies of preferences which give information about the subjective experiences of animals. Both preference studies and direct monitoring of welfare have an important role in animal welfare research. Welfare assessment should involve a combination of studies and of other factors providing information about coping.

6. 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. The use of the term stress should be restricted to the common public use of the word to refer to a deleterious effect on an individual (see Broom & Johnson, 1993). However, the usage of the term stress to refer to an environmental change which affects an organism, a process affecting the organism or the consequences of effects on the organism (Selye 1950, 1976) has been confusing. Stress has been limited to one kind of physiological response mechanism, or to mental rather than physiological responses or has been regarded as a much more wide ranging phenomenon. A definition of stress as just a stimulation or an event which elicits adrenal cortex activity is of no scientific or practical value (Mason 1971, Broom 2001c). 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 can be defined as an environmental effect on an individual which over-taxes its control systems and reduces its fitness or seems likely to do so.** (Broom & Johnson, 1993, see also Broom 1983, Fraser and Broom 1990, Broom 2001b). 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 refers only to situations where there is failure to cope but poor welfare refers to 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, as well as the occasions when an animal is stressed, is included as part of poor welfare. For instance, if a person is severely depressed or if an individual has a debilitating disease but there is complete recovery with no long term effects on fitness then it would still be appropriate to say that the welfare of the individuals was poor at the time of the depression or disease.

7. Welfare and health

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**» (Broom 2000). In this statement, animals include humans. The meaning of pathology is discussed at length by Broom and Kirkden (2004).

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 which affect health, especially at the positive end of the scale. Although people regularly refer to poor health, they sometimes use the word to mean absence of illness or injury in the same way that people refer to welfare when they mean good welfare. However the precise and scientific use of both health and welfare must refer to states varying from very good to very poor. «Health» is encompassed within the term «welfare», and indeed is a very important part of welfare.

Health is a part of welfare and hence disease always has some adverse effect on welfare (Broom and Corke 2002). There can also be effects in the other direction because specific aspects of health may be made worse when welfare in general is poor (Broom 1988b). These relationships are summarised in Fig. 1.

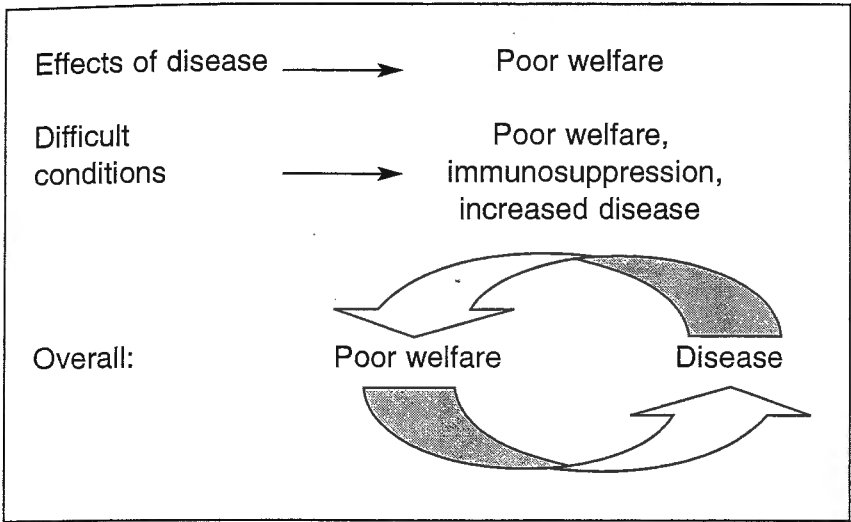


Figure 1 The relationships between poor welfare and disease.

The sequence could start with infectious disease which then causes poor welfare. Alternatively, inadequate housing conditions could lead to poor welfare and hence to increased disease susceptibility. If animals became diseased as a consequence, this would result in worse welfare than that caused directly by the housing conditions.

When an animal's health is poor, so is its welfare, but poor welfare does not always imply poor health. There are many circumstances where behavioural or physiological coping mechanisms are activated, indicating that welfare is poor, but the animal's health remains good. These include: situations where the coping mechanisms are successful, such as when body temperature is maintained despite extreme ambient temperatures; circumstances where failure to cope has consequences for psychological, but not physical, stability, such as in the development of non-injurious pathological behaviours; and where detrimental effects upon physical stability are compensated for by management practices, such as the routine use of antibiotics.

There are some indicators of poor welfare which are classified as pathology and, as such, will also indicate poor health. These include body damage and infectious disease. The prevention of normal physiological processes and anatomical development will also indicate

poor health, where these phenomena can be shown to be symptoms of an infectious, metabolic or nutritional disease. Mortality rate is usually also an indicator of welfare in general and health in particular in the individuals in a population. When animals are close to death, their welfare including their health will often be very poor.

Since health is a part of welfare, it is incorrect to refer to health and welfare as if these were separate non-overlapping concepts (Broom 2001a). Hence, in the most recent Council of Europe Recommendations, such as those on pigs and turkeys, there is reference to «requirements for good welfare including good health» (Preamble (4)). When referring to developments in breeding and biotechnology, it is said that these «shall not adversely affect the welfare, including especially the health of turkeys» (Preamble (7)).

The general conclusions about the inter-relationships between welfare improvement attempts and disease are: firstly that disease is an aspect of poor welfare and many actions will be of benefit in both respects. Secondly, that the possible trade off between reduced immunosuppression and increased disease transmission risk should be carefully considered in all attempts to improve welfare. Thirdly, that there are differences between production or system related diseases and dangerous infectious diseases. Whilst we have quite a lot of information about the former, the latter should also be borne in mind when developing new systems for housing and managing animals. Our overall aim should be to improve welfare in total and we should always include consideration of the effects on individuals of any disease which they might contract (Broom 1992)

8. Welfare and pain

The pain system and responses to pain are part of the repertoire used by animals, including man, to help them to cope with adversity during life. Pain is clearly an important part of welfare. It can be an indicator that the environment outside the control systems in the brain is having an impact such that, the individual is having difficulty in coping. Pain may also indicate that there is likely to be a failure to cope in the long term.

Pain is defined here as an aversive sensation and a feeling associated with actual or potential tissue damage (Broom 2001b). This is an improvement on a previous definition used by the author and is similar to that of the International Association for the Study of Pain (Iggo 1984): «Pain is an unpleasant sensory or emotional experience associated with actual or potential tissue damage, or described in terms of such damage». One difference from Iggo's definition is that «aversive» is used instead of «unpleasant» because aversion is more readily recognised and assessed than unpleasantness, particularly in non-human species. Aversive behaviour is not always shown and sometimes the feeling of aversion is overcome in the individuals concerned, for example in those who choose to inflict pain on themselves, but the aversion and hence the pain are still present.

A second difference is the reference to feelings rather than emotion because feeling implies some degree of awareness. A feeling, (Broom 1998) is a brain construct involving at least perceptual awareness which is associated with a life regulating system, is recognisable by the individual when it recurs and may change behaviour or act as a reinforcer in learning. An emotion is a physiologically describable electrical and neurochemical state of particular regions of the brain which may result in other changes in the brain, hormone release or other peripheral changes but which need not involve awareness (Broom 1998, Sommerville and Broom 1998). Hence as emotion may involve feelings but need not do so, it is better to refer to feelings when defining pain.

The third difference from Iggo's definition is that pain is a «sensation *and* a feeling» rather than a «sensory *or* emotional experience» because a sensory experience could be as little as a sensory input which reaches a low level in the brain and can be remembered very briefly. Most authors (for example Blood and Studdert 1988) consider that a feeling is involved in pain and that input which does not involve some awareness is not pain.

The fourth difference is that Iggo refers to the possibility of pain being described in terms of damage. Because damage can do no more than indicate the likelihood of pain, this is not included in the definition used here.

In order to feel pain, animals need to have receptor cells in appropriate places in the body, peripheral and central neural pathways with neuro-transmitters and adequate brain analysers. The pain system would be expected to have links between these brain analysers and an output system which can initiate a behavioural or other response. Acute pain could result in behavioural avoidance, repeated risk of acute pain could result in learning so that potential damage could be avoided and chronic pain could result in suppression of activity and behaviour which ameliorates adverse effects. A mechanism for switching off the feeling of pain would also be expected because if pain has a great effect on behaviour, such an effect would sometimes be dangerous. All vertebrate animals have the general characteristics of pain systems detailed in Table 1.

Table 1 - Characteristics of pain systems

1. Long-lasting output from specialised nociceptors with high thresholds and with little adaptation to repeated or continuing stimulation.
2. Output from other highly stimulated receptors.
3. Sensitisation of nociceptors (threshold lowered) possible.
4. Neurotransmitters such as substance P and glutamate.
5. Possibility for rapid response, e.g. by reflex.
6. Behaviour change in response to pain.
7. Learning to minimise future pain.
8. Involvement of some phylogenetically old parts of brain.

(after Broom 2001b)

9. Welfare concepts in relation to assessment

Most welfare indicators will help to pinpoint the state of the animal 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. Tests of avoidance and positive preference help in the design of better conditions and procedures for pigs.

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, a proportion of 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 & 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, Benus, 1988). Active animals fight vigorously whereas passive animals submit. 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 whilst a third category of sows 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 it is necessary that any assessment of welfare should include a wide range of measures. Our knowledge of how the various measurements combine to indicate the severity of the problem must also be improved.

The assessment of welfare (Broom and Johnson 1993) should be carried out in an objective way, taking no account of any ethical questions about the systems, practices or conditions for individuals which are being compared. Once the scientific evidence about welfare has been obtained, ethical decisions can be taken.

Much of the evidence used in welfare assessment indicates the extent of the problems of individuals but it is also important to recognise and assess good welfare, i.e. happiness, contentment, control of interactions with the environment and possibilities to exploit abilities. We should try to assess the specific functioning of the brain when welfare is good in humans and other animals; the methods of recognising when welfare is, or is likely to be, good; and the factors which contribute to good welfare in man and other species.

Good welfare in general, and a positive status in each of the various coping systems, should have effects which are a part of a positive reinforcement system, just as poor welfare is associated with

various negative reinforcers. There should be various recognisable effects on individuals of good welfare. We need to identify these so that the assessment of welfare is as effective at the good end of the range as at the bad end.

Each assessment of welfare will pertain to single individual and to a particular time range. In the overall assessment of the impact of a condition or treatment on an individual, a very brief period of a certain degree of good or poor welfare is not the same as a prolonged period. However, a simple multiplicative function of maximum degree and duration is often not sufficient. If there is a net effect of poor welfare and everything is plotted against time (Fig 2), the best overall assessment of welfare is the area under the curve thus produced (Broom 2001b).

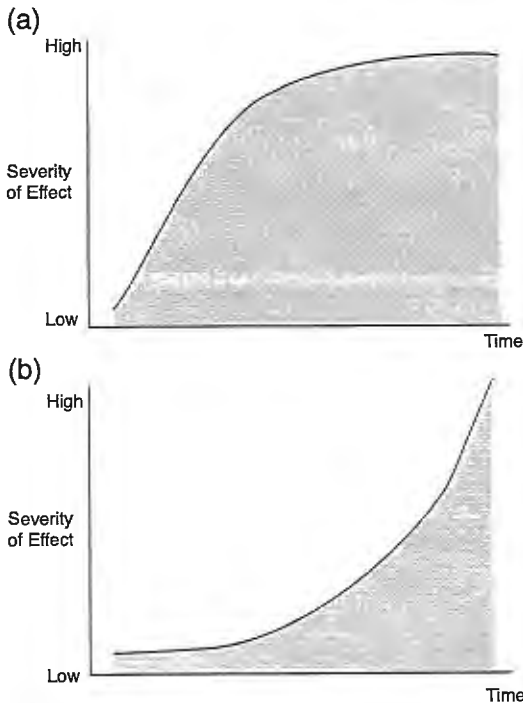


Figure 2 The overall effect on welfare up to a certain time is the area under the curve when severity of effect is plotted against time. This is greater in (a) than in (b). (From Broom 2001b).

A subject which is ethical rather than scientific is the policy which should be adopted in relation to the number of individuals affected. When many subjects are used in a study of the effects of a condition or treatment on welfare, a larger number of individuals with poor welfare overall indicates a greater problem than a smaller number. Hence if a million broiler chickens have a problem, this is more important than one thousand chickens or one thousand cows or dogs with the same degree of problem. However, most people would consider that any individual whose welfare is very poor merits consideration so decisions about policy are not just taken on the basis of the overall severity of the problem multiplied by the numbers of individuals concerned (Broom 2001b).

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