Chapter 1. Welfare concepts

D.M. Broom
Centre for Animal Welfare and Anthrozoology, Department of Veterinary Medicine, University of Cambridge, Madingley Road, Cambridge CB3 0ES United Kingdom

Abstract

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.

Keywords: stress, welfare, feelings, health, pain

1. 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 judgment 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. 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 or accidental 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. Animals vary in the extent to which they are aware of themselves (DeGrazia, 1996) and of their interactions with their environment, including their ability to experience pleasurable states such as happiness and aversive states such as pain, fear and grief (Panksepp, 1998). This capacity may be referred to as their degree of sentience. A sentient being is one that has some ability: to evaluate the actions of others in relation to itself and third parties, to remember some of its own actions and their consequences, to assess risk, to have some feelings and to have some degree of awareness (Broom, 2006b). Awareness is defined here as a state in which complex brain analysis is used to process sensory stimuli or constructs based on memory (Broom, 1998).

If, at some particular time, an individual has no problems to deal with, that individual is likely to be in a good state, where that state includes physical condition, physiological functioning, good feelings, 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, 2001c). 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, 1991a,b, 1993, 1996; Broom and Johnson, 2000). 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. A feeling 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 (Broom, 1998). As explained later (Section 3) feelings are generally adaptive and are aspects of coping systems. The affective state of the individual (Panksepp, 1998) with its balance of positive and negative feelings, is a key point of the welfare of an individual. Suffering occurs when one or more negative, unpleasant feelings continue for more than a few seconds.

This definition of welfare has several implications (Broom and Johnson, 2000), some of which are discussed in more detail later:
1. Welfare is a characteristic of an animal, not something given to it. In recent colloquial American usage, welfare can refer to a service or other resource given to an individual, but that is entirely different from this scientific usage. Human action may improve animal welfare, but an action or resource provided should not be referred to as welfare.
2. If welfare were viewed as an absolute state that 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 (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. He uses ‘well-being’ to refer to scales of how good the animal’s condition is.
3. 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.
4. 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 (See Section 4
below). 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.

5. Fraser (1993), like Broom (1986) and Broom and Johnson (2000), draws 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’ (see section 5 below).

6. 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.

7. Pain and suffering are important aspects of poor welfare (see section 6 below). Even though some pain and suffering may be tolerated in order that some important objective to be attained, both of these involve increased difficulty in coping with the environment and hence poorer welfare.

8. 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.

The term ‘well-being’ is often used interchangeably with ‘welfare’, but well-being is often used in a looser, less precise way. Welfare is the word used in English versions of modern European legislation. Some other languages have only one word that 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 Wohlergehen, Wohlbefinden and Tiergerechtigkeit in German, welzijn in Dutch, bien-être in French, bem estar in Portuguese, bienestar in Spanish, velfaerd in Danish and dobrostan in Polish. Welzijn, bien-être, bem estar 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. Dobrostan is close in use to welfare as defined in this paper Wohlergehen and velfaerd have a wider meaning but velfaerd is used specifically in legislation.
2. 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 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, 2001a). 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, 2000).

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 is in the brain so it is not physiological or ethological. It is the fulfillment 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 Recommendations for 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’.
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 (Broom and Johnson, 2000). This range of meaning of need can be expressed in German by two words Bedarf and Bedürfnis. A Bedarf is a need which must be satisfied if life is to continue whereas a Bedürfnis is a need 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.

The term welfare is used in the European Convention for the Protection of Animals Kept for Farming Purposes (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.

Some needs are associated with feelings and these feelings are likely to change when the need is satisfied (Broom, 1999). 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. The strength of preference is best assessed using the consumer surplus index (Kirkden et al., 2003). Other information about needs is obtained by observing the abnormalities of behaviour and physiology which result when needs are not satisfied.
3. Welfare and feelings

The feelings of an animal are an extremely important part of its welfare (Broom, 1991b, 2003). However, whilst we have many measures that 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 and Johnson, 2000). 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). In the fastest acting urgent coping responses, such as avoidance of predator attack or risk of immediate injury, fear plays an important role in the immediate response and both fear and pain may facilitate future learning of such situations are encountered again. In longer time-scale coping procedures, where various risks to the fitness of the individual are involved, feelings rather than just cognitive processes 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. For example, the taste of a preferred food may lead to pleasure and this may increase the likelihood that a particular route is taken to allow a visit to the source of that food. 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, there may be unpleasant feelings. These feelings might have a role in damage limitation.
that 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, such as certain postures and absence of responses to stimuli that would normally elicit a response, 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 and 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.

4. 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 (Broom and Johnson, 2000). 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 overtaxes its control systems and reduces its fitness or seems likely to do so (Broom, 1983; 2001a; Broom and Johnson, 2000; Broom and Fraser, 2007). 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.

5. 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) and Broom (2006a).

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 Figure 1.

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.

![Diagram](image_url)

*Figure 1. Relationship between welfare and health.*
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 preamble of the Council of Europe Recommendations on pigs there is reference to ‘requirements for good welfare including good health’. When referring to developments in breeding and biotechnology, it is said that these ‘shall not adversely affect the welfare, including especially the health of pigs’.

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, the possible trade off between reduced immunosuppression and increased disease transmission risk should be carefully considered in all attempts to improve welfare. Thirdly, 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)

6. 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, 1985): ‘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. 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 an 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 that reaches a low level in the brain and can be remembered very briefly. Most authors (Blood et al., 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 processing centres in the brain. The pain system would be expected to have links between these brain centres 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 such as that mediated by endorphins and other opioids 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 (after Broom, 2001b).

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.
7. Learning to minimise future pain.
8. Involvement of some phylogenetically old parts of brain.

7. 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 (Broom, 1988a). 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 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 (Koolhaas et al., 1983; Von Holst, 1986; 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 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 (Broom and Johnson, 2000). 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 (Broom and Zanella, 2004); 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 for a human or other animal 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 because the most severe effect of poor welfare may be brief whilst there is a more prolonged milder effect. If there is a net effect of poor welfare and the severity of the poor welfare is plotted against time (Figure 2), the best overall assessment of welfare for that individual animal is the area under the curve thus produced (Broom, 2001c).

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, 2001c).
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) (adapted from Broom, 2001c).

References


