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A Scientific Conception of Animal Welfare that Reflects Ethical Concerns

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animal welfare, ethics, health, scientific research, subjective experiences, stress, values

ABSTRACT

Scientific research on 'animal welfare' began because of ethical concerns over the quality of life of animals, and the public looks to animal welfare research for guidance regarding these concerns. The conception of animal welfare used by scientists must relate closely to these ethical concerns if the orientation of the research and the interpretation of the findings is to address them successfully.

At least three overlapping ethical concerns are commonly expressed regarding the quality of life of animals: (1) that animals should lead natural lives through the development and use of their natural adaptations and capabilities, (2) that animals should feel well by being free from prolonged and intense fear, pain, and other negative states, and by experiencing normal pleasures, and (3) that animals should function well, in the sense of satisfactory health, growth and normal functioning of physiological and behavioural systems. Various scientists have proposed restricted conceptions of animal welfare that relate to only one or other of these three concerns. Some such conceptions are based on value positions about what is truly important for the quality of life of animals or about the nature of human responsibility for animals in their care. Others are operational claims: (1) that animal welfare research must focus on the functioning of animals because subjective experiences fall outside the realm of scientific enquiry, or (2) that studying the functioning of animals is sufficient because subjective experiences and functioning are closely correlated. We argue that none of these positions provides fully satisfactory guidance for animal welfare research.

We suggest instead that ethical concerns about the quality of life of animals can be better captured by recognizing three classes of problems that may arise when the adaptations possessed by an animal do not fully correspond to the challenges posed by its current environment. (1) If animals possess adaptations that no longer serve a significant function in the new environment, then unpleasant subjective experiences may arise, yet these may not be accompanied by significant disruption to biological functioning. Thus, a bucket-fed calf may experience a strong, frustrated desire to suck, even though it obtains adequate milk. (2) If the environment poses challenges for which the animal has no corresponding adaptation, then functional problems may arise, yet these may not be accompanied by significant effects on subjective feelings. Thus, a pig breathing polluted air may develop lung damage without appearing to notice or mind the problem. (3) Where

animals have adaptations corresponding to the kinds of environmental challenges they face, problems may still arise if the adaptations prove inadequate. For example, an animal's thermoregulatory adaptations may be insufficient in a very cold environment such that the animal both feels poorly and functions poorly. We propose that all three types of problems are causes of ethical concern over the quality of life of animals and that they together define the subject matter of animal welfare science.

Introduction

Two dog-owners met one day to walk their dogs together. One owner had grown up in a small family that valued health, safety, and orderly, disciplined behaviour. The dog of this owner received regular veterinary care, two meals a day of low-fat dog food, and was walked on a leash. The other owner had grown up in a large community that valued conviviality, sharing of resources and close contact with the natural world. This dog (the owner's third - the first two had been killed by cars) had burrs in its coat, was fed generously but sporadically, and had never worn a collar in its life. Each owner, judging quality of life from very different viewpoints, felt sorry for the other's dog.

People use many different criteria in judging what constitutes a good life for animals and how animals ought to be treated. In recent decades, ethical concerns about the quality of life of animals have increasingly become the subject of public policy and controversy. Consequently, society has turned to science for guidance (Brambell 1965; Thorpe 1969) and animal welfare has become a focus of scientific study. Thus, unlike many other scientific specialties, the field of animal welfare science owes its existence not primarily to the curiosity of its scientific pioneers, but to ethical concerns extant in society.

In debating the direction of animal welfare research, scientists have proposed different conceptions and definitions of animal welfare, and these have led to different research methods and different ways of interpreting results (Duncan & Fraser 1997). These differences are not simply alternative scientific approaches to assessing an empirical entity, comparable to alternative methods of estimating the viscosity of a fluid or the metabolizable energy of a food (Fraser 1993). Any conception of animal welfare inherently involves values because it pertains to what is *better* or *worse* for animals. The different research approaches and interpretations that scientists use in assessing animal welfare reflect value-laden presuppositions about what *is* better or worse for animals (Tannenbaum 1991; Rollin 1995). Moreover, these differences cannot be turned into purely empirical issues by any known type of scientific research (Fraser 1995). But if values are so intimately involved, how are we to judge between a sound conception of animal welfare and a faulty one?

The answer becomes clearer if we view animal welfare as a 'bridging concept' which links scientific research to the ethical concerns that the research is intended to address. Thus, the conception of animal welfare used by scientists needs to be amenable to scientific study; at the same time it must relate to (and must direct scientific research toward) the relevant ethical issues. If the conception of animal welfare used by scientists is substantially different from, or narrower than, that of other people, then the research that the scientists do and the interpretation that they give to their findings may fail to address the very issues that caused the research to be undertaken in the first place. To assess the adequacy of a scientific conception of animal welfare we must, therefore, ask whether it relates appropriately to the major ethical concerns that have given rise to animal welfare research.

However, two kinds of distortion can arise when scientists conceptualize or define animal welfare. First, scientists may simply fail to recognize that value issues are involved and they may try to define animal welfare as if it were a purely empirical concept. Stafleu *et al* (1996) noted that when scientists deal with a value-related concept such as animal welfare, they are likely to redefine it so as to link it to other scientific concepts (stress, immune competence, fitness) or to available methods of measurement (cortisol levels, disease incidence). This makes the assessment of animal welfare seem like a purely empirical matter, but in fact the underlying values are merely concealed. Second, because scientists have their own values and ethical ideologies, they may define animal welfare in accordance with their particular ethical positions but not in accordance with other widely held and defensible positions. In either case, scientists may adopt such a narrow or idiosyncratic conception of animal welfare that their work does not properly address the relevant ethical concerns.

As a further complication, several kinds of issues are often intertwined in scientific conceptions of animal welfare. In addition to the value issues about what is important for the quality of life of animals, there are also operational issues about the kind of information that can validly be used in the scientific assessment of quality of life, together with semantic issues about how the term *welfare* should be used. When scientists debate different conceptions of animal welfare, the value issues, operational issues, and semantic issues are sometimes jumbled together and the true nature of the disagreement may be hard to discern.

In this paper we attempt to disentangle the various issues and we propose a conception of animal welfare intended to correspond to widely held ethical concerns about the quality of life of animals. Firstly, we briefly review what we see as the three major ethical concerns that arise in discussion of animal welfare. Then we present and criticize proposals by scientists that would restrict the scientific conception of animal welfare to one or other of these concerns. Finally, we present an integrative model which, we propose, captures the major ethical concerns that arise over the quality of life of animals.

Ethical concerns about the welfare of animals

First, let us be clear on the kind of ethical concern that has to do with the 'welfare' of animals. Various ethical concerns arise over the treatment of animals. We may consider that certain butterflies should be protected because the species is endangered, or that pigs should be housed in certain ways to prevent environmental pollution, or that children should not mistreat animals because such actions may make children cruel or destructive. These are ethical concerns about the treatment of animals, but the primary concern in these cases centres on genetic conservation, environmental integrity, or human virtue rather than the quality of life, *per se*, of the animals. In contrast, concerns over the *welfare* of animals arise when we consider that protecting the quality of life of animals is not only of instrumental value as a means to some external goal, but of importance in itself. In such cases we consider that the quality of life of animals has 'inherent worth' in the sense of Taylor (1986), or that animals are 'intrinsically valuable' and that their own interests are legitimate objects of moral concern (Rollin 1992). For brevity we will refer to these concerns simply as 'quality-of-life' concerns.

Social critics, ethicists and others have expressed three different but overlapping types of quality-of-life concerns (see Duncan & Fraser 1997). First are 'natural-living' concerns which emphasize the naturalness of the circumstances in which animals are kept and the ability of an animal to live according to its 'nature'. For example, Brambell (1965) criticized forms of confinement that frustrate most of the natural behaviour of animals (Table 1, a) and Lindgren (Anonymous 1989b, Table 1, b) called for animals to be raised in the sunshine and fresh air. Lindgren evidently believed that living outdoors would promote happiness, but Dawkins (1980) pointed out that some people still consider it better for animals to live freely rather than in captivity, despite the suffering and threats to health and survival that natural living

entails. Rollin (1993, Table 1, c) proposed that each animal species has an inherent, genetically encoded 'nature' (its *telos*) and that good welfare requires that an animal be allowed to live in accordance with its *telos*.

Table 1. Sample quotations indicating different positions on animal quality-of-life issues by animal care professionals, social commentators and ethicists.

| | |
|---|--|
| a | 'In principle we disapprove of a degree of confinement of an animal which necessarily frustrates most of the major activities which make up its natural behaviour ...' (Brambell 1965) |
| b | '... it might even be possible to guarantee that young animals ... get a little summertime happiness, at least a temporary reprieve from the floors of barns and the crowded spaces where the poor animals are stored until they die. Let them see the sun just once, get away from the murderous roar of the fans. Let them get to breathe fresh air for once, instead of manure gas' (in Anonymous 1989b) |
| c | 'It is likely that the emerging social ethic for animals ... will demand from scientists data relevant to a much increased concept of welfare. Not only will welfare mean control of pain and suffering. it will also entail nurturing and fulfillment of the animals' natures, which I call <i>telos</i> .' (Rollin 1993) |
| d | 'Have we the right to rob (animals) of all pleasure in life simply to make more money more quickly out of their carcasses?' (Harrison 1964) |
| e | 'The welfare of managed animals is dependent upon the degree to which they can adapt without suffering to the environments provided by man.' (Carpenter 1980) |
| f | '... there can be no moral justification for regarding the pain (or pleasure) that animals feel as less important than the same amount of pain (or pleasure) felt by humans.' (Singer 1990) |
| g | 'Good health is the birthright of every animal that we rear, whether intensively or otherwise. If it becomes diseased we have failed in our duty to the animal and subjected it to a degree of suffering that cannot be readily estimated.' (Sainsbury 1986) |
| h | '... my experience has been that more problems of animal welfare are to be found in the extensive – the open range - the old-fashioned methods and that by-and-large the standard of welfare among animals kept in the so called 'intensive' systems is higher. On balance I feel that the animal is better cared for; it is certainly much freer from disease and attack by its mates; it receives much better attention from the attendants, is sure of shelter and bedding and a reasonable amount of good food and water.' (Taylor 1972) |

A second type of concern (which we will call 'feelings-based') emphasizes the affective experiences ('feelings', 'emotions') of animals (Table 1, d-f). Thus, a good life for animals is thought to depend on freedom from suffering in the sense of prolonged or intense pain, fear, hunger and other negative states; some commentators also emphasize positive states such as comfort, contentment and pleasure.

Thirdly 'functioning-based' concerns, held especially by many farmers, veterinarians and others with practical responsibility for animal care, accord special importance to health and the 'normal' or 'satisfactory' functioning of the animal's biological systems. Thus, Sainsbury (1986, Table 1, g) wrote of protecting animal health as a duty that people owe to animals in their care, and Taylor (1972, Table 1, h) emphasized shelter, nutrition and health care as advantages that more than compensate for the unnaturalness of keeping animals in confinement.

Some scientists have proposed conceptions of animal welfare that include two or all three of the above concerns. For example the 'five freedoms' of the Farm Animal Welfare Council of the United Kingdom refer to affective experience (eg fear, hunger), biological functioning (eg injury, disease) and performance of natural behaviour (see Ewbank 1988). Others have proposed a hierarchical ordering of factors whereby certain aspects are more important than others, yet all contribute to an animal's welfare (Curtis 1987; Hurnik 1993). Yet other scientists have suggested a logical ordering whereby the animal's experience is the ultimate concern but satisfactory biological functioning is important at least partly because it influences the animal's experience (Gonyou 1993; Appleby *et al* 1996).

However, other scientists have proposed more limited conceptions of animal welfare centred on one or other of the three types of concerns. These narrower conceptions limit the scope of animal welfare research by ruling out or de-emphasizing certain measures in favour of others. However, we need to ask whether any of these narrower conceptions adequately reflects the widely held quality-of-life concerns that have given rise to scientific research on animal welfare.

Claims that welfare should be defined in terms of natural living

Some scientists have adopted a natural-living conception by proposing that an animal's welfare depends on its being allowed to perform its 'natural' behaviour and live a 'natural' life.

Among scientists, one of the earliest natural-living approaches held that welfare would be reduced if animals could not perform their full 'behavioural repertoire' (eg Kiley-Worthington 1989, Table 2, a). This approach developed in response to concerns over highly restrictive and unnatural forms of animal housing. However, the behavioural repertoire of animals includes many activities that are adaptations to cope with adverse circumstances. For example, piglets huddle in the cold, pant in the heat and give characteristic 'distress' calls when isolated from their littermates. Environments that bring out these behaviours are likely to increase suffering, not reduce it; hence, performance of the full behavioural repertoire has been widely criticized as a guide to animal welfare (Dawkins 1980; Hughes & Duncan 1988).

Table 2. Sample quotations indicating different conceptions of animal welfare proposed by animal welfare researchers.

| | |
|---|---|
| a | 'If we believe in evolution ... then in order to avoid suffering, it is necessary over a period of time for the animal to perform all the behaviors in its repertoire because it is all functional...' (Kiley-Worthington 1989) |
| b | ' ... neither health nor lack of stress nor fitness is necessary and/or sufficient to conclude that an animal has good welfare. Welfare is dependent on what animals feel.' (Duncan 1993) |
| c | 'To be concerned about animal welfare is to be concerned with the subjective feelings of animals, particularly the unpleasant subjective feelings of suffering and pain' (Dawkins 1988) |
| d | 'Poor welfare occurs in situations in which ... there is reduced fitness or clear indications that fitness will be reduced' (Broom 1991b) |
| e | ' ... the only defensible measurement of well-being in animals is to determine if the animal is suffering from stress. Furthermore, I believe that the most appropriate indicator of stress is the appearance of a prepathological state.' (Moberg 1985) |
| f | 'Recently, scientists have suggested that if an animal perceives that it feels poorly (as measured primarily by behaviour) then the animal is said to be in a poor state of welfare. I dismiss this view as simplistic and inappropriate. I suggest that an animal is in a poor state of welfare only when physiological systems are disturbed to the point that survival or reproduction are impaired.' (McGlone 1993) |
| g | 'Although the animal's perception of its condition must serve as the basis for well-being, research in this area is only beginning. At the present time much can be accomplished by using more traditional approaches involving behavioural, physiological and pathological studies.' (Gonyou 1993) |
| h | 'Welfare is determined by the state of the animal's psychological processes. Each of these processes must have evolved to represent some aspect of biological fitness ... Thus, determinants of welfare can be described as psychological representations of attributes of biological fitness.' (Baxter 1983) |

However, the proposal by Rollin (1993, Table 1, c) - that a high level of welfare requires the nurturing and fulfilment of the animal's genetically encoded 'nature' - provides a more general and potentially more useful conception if it can be interpreted operationally in a biological context. We suggest that the genetically encoded 'nature' of an animal can be viewed as (1) the set of adaptations that an animal possesses as a result of its evolutionary history, perhaps as modified through domestication and the

animal's own experiences; and (2) the set of genetically encoded instructions that guide the animal's normal ontogenic development. Thus, to say that animals should be allowed to live according to their 'natures' would mean that animals should be allowed to live in a manner that corresponds to their adaptations and to have the type of ontogenic development that is normal for the species. For 'higher' animals at least, the adaptations produced by natural selection constitute not simply a behavioural repertoire of actions each with a characteristic frequency of performance, but a set of conditional rules that govern the performance of behaviour. For example, the adaptations possessed by a pig include not simply the actions of panting and huddling but the conditional rules to pant when hot and huddle when cold. Thus, to keep a pig in accordance with its adaptations does not necessarily require that it must pant and huddle, but that it should be able to use these adaptations when circumstances require them.

This conception of welfare is generally compatible with feelings- and functioning-based interpretations, but it tends to be more inclusive. The pig that cannot exercise its adaptation of huddling in the cold may suffer as a result (a feelings-based criterion) and become ill (a functioning-based criterion). In addition, however, some people may consider that the pig's quality of life is reduced if it cannot 'be a pig' by rooting in a forest, or if a bird cannot fly, or if a ruminant is fed a diet that does not allow it to ruminate. Concerns of this type are clearly covered by the view that animals should be allowed to live according to their natural adaptations, whereas they are not so obviously covered by an emphasis on health, survival, or subjective feelings.

Nonetheless, living in a natural manner is no guarantee that the full range of ethical concerns over the quality of life of animals will be satisfied. Even if an animal is kept in a natural environment where it can live according to its adaptations, it may still suffer and become ill if its adaptations are insufficient to meet the challenges to which it is exposed. Furthermore, the concept provides little guidance on many important animal welfare issues such as the use of analgesia, euthanasia and medication. And despite the general biological interpretation that we propose above, significant empirical and conceptual problems remain in defining the 'nature' of a given animal (Duncan & Fraser 1997). Thus, while a natural-living conception is a useful way to expand our notion of animal welfare, it does not by itself provide a sufficient criterion for defining the concept.

Claims that welfare should be defined in terms of the feelings of animals

The capacity of animals to experience affective states (feelings, emotions) plays a singularly important role in ethical concern over the quality of their lives. Most of the writers quoted in Table 1, although emphasizing different aspects of animal care, relate their concerns in some way to animals experiencing states such as suffering or pleasure. In line with these views, many scientists have put particular emphasis on the subjective experience of animals in developing scientific conceptions of animal welfare (Table 2, b-c).

But should scientists restrict their conception of animal welfare (and hence the orientation of their research) *only* to the affective experience of animals? Duncan (1993, 1996) made a proposal of this type. He noted that plants can function well or poorly, and can be healthy or unhealthy, yet he suggested that the term *welfare* cannot 'be applied sensibly' to plants (Duncan 1993). Rather, Duncan suggested that we apply *welfare* only to entities that we believe to have subjective feelings and he concluded that for something to be said to affect an animal's welfare it must influence how the animal feels (Table 2, b).

However, the link between the subjective experience of animals and concern over their welfare can be viewed in three different ways.

1) The term 'welfare' should be used only where feelings are involved

Duncan's proposal could be construed as a purely semantic claim about how the term *welfare* ought to be used. We have suggested (above) that an animal welfare concern is a concern about the quality of life of an animal where quality of life is viewed as having inherent worth. The semantic claim that the term *welfare* should be applied only to situations involving subjective experience would not alter or limit the scope of quality-of-life concerns, but it would limit the use of the term *welfare* in discussing these concerns. We might, for example, still consider that normal functioning of the body and natural living can be of inherent worth independently of any influence on suffering and pain, but we would consider it a semantic error to apply the term *welfare* to these quality-of-life concerns.

Such restricted use of the term could lead to confusion. According to established usage, *welfare* and *well-being* refer more broadly to 'good fortune, health, happiness and prosperity', 'the state of being or doing well', 'thriving or successful progress in life'. and 'a good or satisfactory condition of existence' (Anonymous 1984, 1989a). Thus, current usage does not restrict welfare only to subjective feelings. Furthermore, limiting welfare only to feelings separates welfare from health in a manner contrary to common usage. For example, in a habitual cigarette smoker, smoking causes pleasure and relieves distress; the resulting lung damage causes little or no suffering in the short term and even if it does so in the future, there are no solid grounds to conclude that the future suffering will outweigh the pleasure. Thus, a strictly feelings-based definition of welfare might lead us to say that cigarettes reduce the health of smokers but may improve their welfare. As Duncan (1996) noted, limiting the term *welfare* to subjective feelings produces 'anomalies' of this type.

In terms of animal welfare science, a purely semantic proposal would have no implications for the types of research needed to address ethical concerns over the quality) of life of animals; it would merely affect the language we use to describe this research.

2) Concerns about animal welfare arise because of the capacity of animals for subjective experience

Alternatively, the relationship between subjective experience and welfare can be viewed as a claim about the kinds of organisms to which we should apply quality-of-life concerns. According to this view, the belief that certain kinds of animals can experience subjective feelings creates a morally relevant similarity between them and ourselves. Consequently we accord to those animals moral considerations that we might otherwise apply only to humans. This view does not limit welfare concerns to the actual subjective experience of animals. We might, for example, consider that the health of sentient animals is a legitimate quality-of-life concern whether or not it affects suffering and pleasure.

Some animal welfare scientists appear to take this view by considering that for sentient animals, good biological functioning is important in and of itself, not merely as a means of affecting the animal's subjective experience. Ewbank (1988) stressed freedom from *both* malnutrition (a term that implies biological functioning) *and* hunger (a term that implies feelings). Hughes (1976) and Hurnik (1993) stressed the importance of physical *and* mental harmony between animals and their environment. In these cases, there may be an unspoken assumption that malnutrition and physical disharmony will necessarily lead to suffering. However, Hurnik (1993) proposed explicitly that what the animal 'needs' (a term with connotations of biological functioning) is more important than what it 'desires' (a term with connotations of subjective feelings); and Broom (1991a,b) proposed that injury and disease involve reduced welfare whether or not the animal is aware of the problem.

Ethicists have developed this idea more explicitly. For Regan (1983), the well-being of an animal depends not only on its 'preference interests' (eg what it likes or dislikes), but also its 'welfare interests' which include things that 'benefit' the animal whether or not the animal consciously desires or pursues them. Rollin (1992) noted that while pain and pleasure are very important in our perception of moral duties toward other humans, they are not the only considerations; rather we may consider that normal health, education, and development of a person's natural capabilities are of value independent of their influence on pleasure and suffering. Regarding other species, Rollin (1992) proposed that moral concern for sentient animals extends 'beyond pleasure and pain to the essential characteristics of conscious life itself' and he saw pleasure and pain as 'tools' that enable the animal to achieve the broader goals of fulfilling its 'needs' and 'nature'. With captive chimpanzees, for example, we may consider that giving the animal enough freedom to develop normal perceptual and cognitive capabilities is a quality-of-life issue (much like encouraging the intellectual development of children) even though we might believe we could better eliminate pain, hunger and other forms of suffering in a more limiting environment.

In summary, this approach views the capacity for subjective experience as a trait that identifies the kinds of animals that qualify for quality-of-life concerns, but it does not limit these concerns to the actual subjective experience of animals.

3) Concerns about animal welfare are concerns about the subjective experience of animals

Thirdly, the link between welfare and subjective experience may be seen as the more restrictive claim that concerns about the quality of life of an animal *are* concerns about its subjective experience (Table 2, b-c). According to this view, changes in physiology, behaviour, or even health cannot legitimately be viewed as quality-of-life concerns unless they affect how the animal feels. If a disease causes pain, we should prevent the disease in order to prevent the pain; but if a disease (say, painless lung damage) does not affect how an animal feels, then it is not a quality-of-life issue any more than a disease of carrots or the malfunctioning of a machine, although we may still wish to prevent it for some other reason such as more efficient animal production.

This conception of animal welfare reflects the ethical position of Utilitarianism (Singer 1990) which relates all ethical decisions to the principle of minimizing suffering and maximizing pleasure. Such a restricted conception of animal welfare does not appear (initially, at least) to cover the broader ethical concerns described above, such as protecting the health of animals and allowing them to live and develop according to their natures.

Perhaps, however, even these broader concerns over natural living and biological functioning might, on careful analysis, turn out to be proximate concerns that people hold because of an ultimate concern about the subjective experience of animals. Thus, perhaps an animal's 'needs' (Hurnik 1993) or 'welfare interests' (Regan 1983), although not consciously desired or pursued by the animal, are seen as important for its welfare precisely because they will lead to greater feelings of satisfaction or pleasure in the long term. However, even if we were to adopt the philosophical stance that all quality-of-life concerns are ultimately concerns about subjective experience, it does not follow that animal welfare research should be limited to the subjective experience of animals, because of the following distinction.

Some questions about the subjective experience of animals can plausibly be addressed by scientific research. For example, we might ask whether surgical castration of calves causes less pain than rubber-band castration (Molony *et al* 1995), or whether mechanical capturing of chickens causes less fear than manual capturing (Duncan *et al* 1986). In these cases the concern involves a particular subjective state (eg pain) over a limited time, and scientists have proposed plausible empirical means of answering the questions.

However, other ethically important questions about subjective experience cannot be answered empirically for either technical or fundamental reasons. For example, we might ask (a) whether keeping a bird in a cage reduces its welfare by depriving it of the pleasure of flying, or (b) whether prolonging the life of a sick dog reduces its welfare because its suffering outweighs its enjoyment of living, or (c) whether keeping a cow in a barn improves its welfare because the protection from cold, hunger and possible injury outweighs the frustration and other negative experiences caused by confinement. These questions about animal welfare are indeed questions about the animal's subjective experience, but in these cases scientists are unable to provide empirical answers. This inability arises because there is not yet any accepted method to quantify the pleasure experienced by an animal (example a), or because there is no purely empirical means to balance suffering against enjoyment (example b) or to combine different negative states into overall indices (example c). In such cases we often resort to other types of information (biological functioning, natural living) using assumptions about how the subjective experience of animals is likely to be influenced, perhaps based on analogies with ourselves (Stafleu *et al* 1992).

Thus, even if we consider that concerns about animal welfare are, in reality, concerns about subjective experience, animal welfare research cannot be limited to the subjective experience of animals because science cannot yet, and perhaps cannot in principle, give empirical answers to many ethically relevant questions regarding the subjective experience of animals. The net result for animal welfare science is much the same as in subsection 2: moral concern about the quality of life of animals arises because of the animals' capacity for subjective experience, but the study of subjective experience will not provide all the necessary answers.

Claims that welfare should be defined in terms of the functioning of animals

Disease, injury, malnutrition and other disturbances to normal biological functioning have been a common element in ethical concerns over the treatment of animals (eg Taylor 1972, Sainsbury 1986, see Table 1). In line with these concerns, some scientists have based their conception of animal welfare on the biological functioning of animals, often linking welfare to biological concepts such as fitness and stress (Table 2, d-f).

This approach, however, raises an unresolved issue. An animal's responses to environmental challenge can be seen as a continuum ranging from minor, routine adjustments, through to significant disturbance and abnormality. For example, an animal *that* is exposed to cold will undergo certain (probably unconscious) physiological adjustments in blood flow and perspiration rate. If these are inadequate, the animal may begin to *feel* cold and this may motivate a behavioural response such as seeking warmth. If the problem is very persistent, more deleterious changes may occur such as depressed immune competence and greater risk of infectious disease. A key issue in conceptualizing animal welfare is how to decide where, in this continuum, the animal's welfare can be said to be affected (Barnett & Hemsworth 1990; Mendl 1991).

For scientists taking a feeling-based approach, the body's responses to challenge are relevant to welfare only when the animal's conscious experience becomes involved, and the more intense and prolonged the unpleasant or pleasant experience, the greater the relevance to the animal's welfare. For those who conceptualize animal welfare in terms of biological functioning, however, there is no such obvious point in the continuum of bodily responses where welfare can be said to be affected. Some scientists have proposed solutions based on quantitative measures such as certain degrees of change in endocrine responses (Barnett & Hemsworth 1990) or certain amounts of stereotyped behaviour (Broom & Johnson 1993). Moberg (1985) proposed a more general solution. Moberg noted that stressors (eg cold or crowding) can lead to impaired health and survival, but that these severe effects are preceded by 'pre-pathological states' (eg reduced immune competence) predictive of some tangible harm to the health of

the animal. Moberg (1985, Table 2, e) proposed that pre-pathological states are the most appropriate indicators of impaired well-being in that they identify (at an early stage) conditions that threaten tangible harm to the normal functioning of animals.

But can an emphasis on threatened or actual disturbance to biological functioning give a fully satisfactory conception of animal welfare for use in science? Three such positions have been proposed.

1) All that matters is that animals function well

McGlone (1993, Table 2, f) proposed that an animal's welfare can be considered poor 'only when physiological systems are disturbed to the point that survival or reproduction are impaired'. Thus, states such as pain, fear and hunger would not be seen as relevant to welfare unless accompanied by some tangible threat to health or survival. This position is, in essence, an ethical stance; in fact, McGlone (1993) suggested that it provides a way of distinguishing between 'acceptable' and 'unacceptable' welfare, and he felt that it would bring decisions about animal welfare into line with human welfare assistance programs in the United States. However, if animal welfare research were to be limited in this manner, it obviously would not respond to the widely held ethical concerns over animals' subjective experiences (suffering, enjoyment) which are commonly seen as being of moral relevance in themselves (eg Brambell 1965; Carpenter 1980; Midgley 1983; Singer 1990; Rollin 1992).

2) We must study functioning because we cannot study feelings

Scientists have also advanced two operational proposals that tend to focus animal welfare research on measures of biological functioning by declaring research on the subjective experience of animals to be impossible or unnecessary.

One such position holds that the subjective experience of animals, not being open to direct observation, falls outside the realm of scientific enquiry (van Rooijen 1981; Kennedy 1992); therefore, if we are to study animal welfare scientifically, we must conceptualize welfare in terms of biological functioning (or possibly natural living) because scientific study cannot be applied to subjective feelings. (Previously we proposed that *some* ethically relevant questions about the subjective experience of animals cannot be answered empirically; here we are discussing the stronger claim that all subjective experience of animals is, in principle, beyond scientific enquiry).

This position is derived from Positivism which has influenced science for over a century. According to Positivist thinking, scientists should concern themselves with the observable phenomena of nature (as opposed to metaphysical questions or immaterial forces) and should avoid theorizing about processes that cannot be observed directly (Kolakowski 1968). In ethology and comparative psychology, Positivist thinking led to the view that feelings and emotions should not be used as explanatory concepts in the study of behaviour, and in some cases to the stronger view that science cannot help us to understand the subjective experiences of animals at all (Rollin 1990).

This Positivist position is not a 'theory' in the traditional sense, because it is not ultimately testable or refutable. Rather it is a 'stance' in the sense of Dennett (1987): a conceptual framework that scientists adopt to interpret observations and guide further empirical study. The legacy of Positivism in the study of animal behaviour has been widely criticized by Midgley (1983), Dawkins (1990), Griffin (1992), Rollin (1992) and many others. Today many animal welfare scientists have tacitly jettisoned the Positivist stance simply by presuming that animals do have subjective experiences such as fear, pain and frustration, and that an animal's actions, preferences, vocalizations and physiological changes can shed light on these subjective experiences.

Drawing valid inferences about the subjective experiences of animals from behavioural and physiological measures involves many pitfalls, and scientists who attempt this will require rigorous thinking and carefully conceived research methods to ensure that they do not simply fall prey to the errors that Positivism helped to avoid (see Dawkins 1980, 1990, 1993). However, attempts to use the methods of science to improve our understanding of the subjective experiences of animals cannot be dismissed as impossible simply because such attempts depart from the influential Positivist stance.

3) We can study functioning instead of feelings because the two are intimately related

A second operational argument holds that the functioning of animals provides a fully satisfactory reflection of their subjective feelings. Feelings (fear, pain, pleasure) are commonly viewed as adaptations that motivate an animal to behave in ways that promote good biological functioning (Dawkins 1980). Thus, injury causes pain and pain is viewed as adaptive because it encourages the animal to avoid further injury. In line with this view many scientists, although believing that the subjective experiences of animals are of primary concern in animal welfare, advocate studies of biological functioning as a less problematic form of research which reflects subjective experience (Gonyou 1993, Table 2, g). Some scientists have proposed the similar but stronger view that the link between feelings and functioning is so close that the subjective experiences of animals will be adequately reflected by measures of biological functioning.

Baxter (1983) outlined a proposal of this type by suggesting close links between the subjective feelings of animals, their agricultural productivity and their 'biological fitness' (roughly, their ability to leave viable offspring - see 'fitness' in McFarland 1981). Baxter (1983) took the feelings-based view that animal welfare 'is determined by whether the animal is hungry, thirsty, sexually frustrated, bored, physically uncomfortable and many other experiences.' He suggested that these feelings evolved because they motivate the animal to take the actions needed to promote a high level of functioning. Thus, subjective feelings (which determine an animal's welfare) are 'psychological representations of attributes of biological fitness' (Table 2, h). Furthermore, Baxter suggested that the main features of fitness (such as the number and quality of offspring produced) are also the key elements of agricultural productivity. Therefore, 'biological fitness and agricultural productivity are in general correspondence' and each should be closely linked to animal welfare. This proposal would allow us to assess animal welfare using measures of biological functioning - or even productivity in the case of agricultural animals - as an adequate reflection of the animal's subjective experiences.

This view clearly has merit in some situations. For example, we expect chronically malnourished animals to have low rates of survival and reproduction, low agricultural productivity and to experience the unpleasant feelings of hunger or malaise. By solving the nutritional problem we expect to improve both functioning and subjective experience.

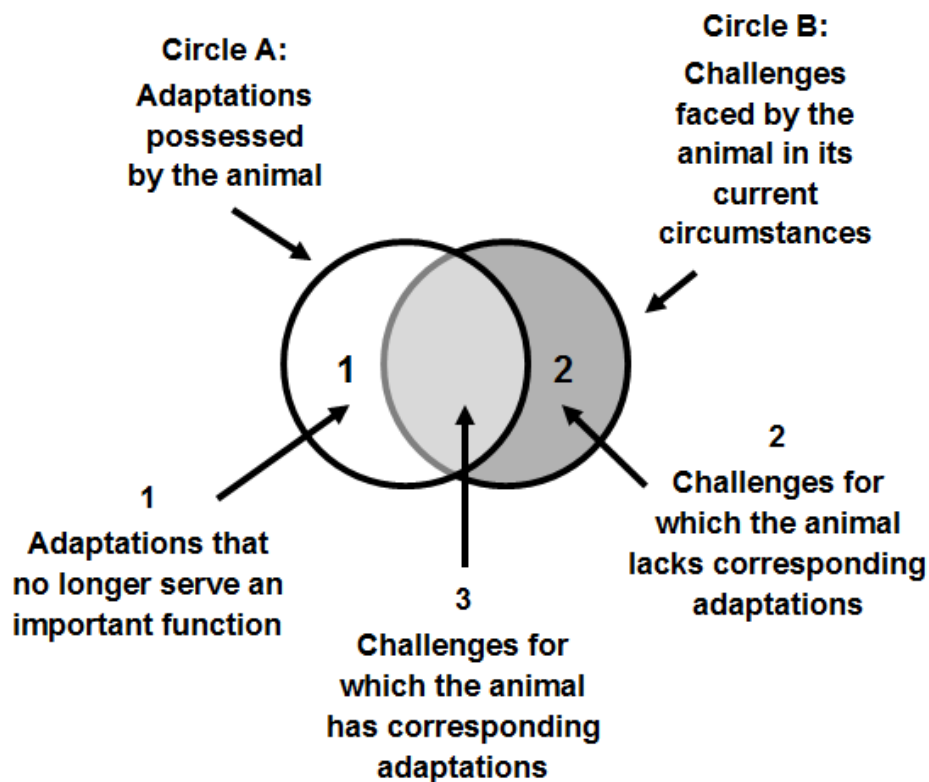
However, as Baxter himself noted, there may be important differences between the environment in which an animal is kept and the environment in which the animal's ancestors evolved, leaving the animal motivated to perform activities that no longer contribute to fitness or agricultural productivity. Baxter (1983) made minimal mention of such cases (escape from predators was his only example), but in reality non-functional adaptations are common problems in the management of captive or domestic animals. For example, domestic pigs confined in a barren environment may show restless, destructive behaviour before parturition, probably reflecting a high level of motivation to find and prepare a nest (Widowski & Curtis 1990); prolonged stereotyped behaviour, seen when restrained sows are fed limited rations, possibly indicating thwarted motivation to escape, forage, or explore (Rushen *et al* 1993); and sucking and chewing behaviour redirected to the bodies of penmates, probably reflecting normal food-finding motivation redirected in abnormal ways (Smith & Penny 1986). These various activities are arguably derived from motivations that served important functions in the environment in which the ancestors of pigs

evolved and that persist in confinement even though the activities no longer serve their original function. These are, furthermore, among the most commonly cited animal welfare concerns in pig production. The presumption in these cases appears to be that animals will suffer if they experience a high and persistent motivation to perform actions that the environment does not permit. This presumption, if correct, provides important exceptions to the view that unpleasant feelings are reliably connected to disturbed health, survival or agricultural productivity.

An integrative model

In summary, none of the above conceptions of animal welfare relates in a fully satisfactory manner to the major ethical concerns over the quality of life of animals. We propose that these concerns can be better conceptualized using the model shown in Figure 1. Circle A in the figure represents the set of adaptations possessed by an animal mainly as a result of its evolutionary history and perhaps modified and augmented by genetic changes during domestication and the individual's own learning and experiences. Adaptations can involve the animal's anatomy (growing thick fur in winter), physiology (catabolizing glycogen under cold conditions), or behaviour (moving to a warm environment). Some adaptations involve subjective feelings such as hunger, cold and pain that motivate animals to act in certain ways or that stimulate certain forms of learning. Circle B represents the challenges faced by the animal in its current circumstances. Challenges may include cold temperatures, exposure to pathogens, and aggression from pen mates.

Figure 1. Conceptual model illustrating three broad classes of problems that may arise when the adaptations possessed by the animal (circle A) make an imperfect fit to the challenges it faces in the circumstances in which it is kept (circle B). We propose that the different classes of problems, taken together, cover the major ethical concerns that arise over the quality of life of animals and constitute the subject matter of animal welfare research.



In general, if an animal's current circumstances correspond closely to the circumstances in which the genotype evolved and the individual developed, then we expect close correspondence between the adaptations that the animal possesses and the challenges it faces. This would be represented by a large area of overlap in Figure 1. For most captive or domestic animals in artificial environments, we expect imperfect correspondence between the adaptations and the challenges, producing the three areas in Figure 1. In each of these areas, a distinct class of problems may arise; and we propose that these three classes of problems together cover the major types of quality-of-life concerns that constitute the subject matter of animal welfare research.

In area 1 to the left of the overlap, we find adaptations possessed by the animal which no longer serve an important function, often because the original function is now achieved in some other way. Some such adaptations (eg the camouflaging stripes of a zebra) can be nonfunctional in a captive environment without having any obvious impact on the animal's quality of life. However, if an adaptation involves a strong affective experience (hunger, pain, desire to escape) that motivates some form of behaviour, then preventing the behaviour may leave the animal experiencing a strong motivation to perform an action that cannot be carried out, and/or failing to experience the positive feeling associated with performing the behaviour. For example, a calf that is fed milk from a bucket may make persistent attempts to suck on neighbouring animals (de Passille *et al* 1992), presumably because a strong motivation to suck was important for adequate milk intake in the environment of evolution. Preventing the behaviour may leave the calf with a strong, unfulfilled desire to suck. However, because the behaviour's original function (milk intake) is now met in other ways, prevention of the behaviour may not lead to clear impairment of biological functioning (malnutrition), although other detrimental effects may sometimes arise if the animal is prevented from using its natural means of achieving the outcome (de Passille *et al* 1993). Similarly, various forms of stereotyped behaviour may reflect persistent motivation to perform actions that are no longer needed for health and survival in the animal's current environment (Rushen *et al* 1993). In such cases, animals may experience negative subjective feelings, or fail to experience positive ones, without necessarily showing any impairment of biological functioning. Sambras (1981) referred to such problems as 'immaterial suffering'.

In area 2 to the right of the overlap (Figure 1), we find challenges in the environment for which the animal lacks corresponding adaptations. For example, most animals, having evolved in unpolluted environments, show little avoidance of some types of environmental contamination. Some species of fish fail to avoid certain contaminants (phenol, selenium) even at levels that cause serious damage or death (Giattina & Garton 1983; Hartwell *et al* 1989). Similarly pigs show little avoidance of sustained exposure to ammonia at levels that cause damage to the respiratory system (Morrison *et al* 1993; Jones *et al* 1996). These animals, like human smokers, appear to suffer no significant discomfort until the damage is far advanced. Similarly, animals may be poorly equipped to avoid becoming obese if concentrated food is readily available, to avoid losing physical condition in housing systems where exercise is not required, and to avoid pathogens when kept in close contact with other animals. These problems may seriously impair the biological functioning of animals, yet the animals may show no evidence of motivation to avoid the harm, nor any clear sign of suffering, at least until pathological changes are well established. In such cases, animals may undergo impaired *biological functioning without necessarily showing evidence of effects on subjective feelings*.

In the central area (area 3), the animal faces challenges for which it has corresponding adaptations. For example, the environment may impose fluctuating temperatures and the animal will have certain thermoregulatory adaptations. In some cases, these adaptations will include an affective experience (eg feeling cold) that motivates corrective action. Problems may arise in area 3 when the adaptations prove

inadequate for the degree of challenge. In such cases there is likely to be substantial correspondence between feelings and functioning. For example, if cold temperatures are too severe for an animal's thermoregulatory responses, then we expect the animal to *feel* cold as well as showing corresponding disturbance of bodily functioning.

We propose that the model shown in Figure 1 provides a way of conceptualizing the range of quality-of-life concerns that animal welfare research needs to address. Concerns about the subjective experience of animals will arise mainly in area 1 where an otherwise well functioning animal may be highly motivated to behave in ways that the environment prevents, and in area 3 where negative subjective experience is more likely to be correlated with impaired biological functioning. Concerns about biological functioning will arise especially in area 2, where problems of biological functioning may arise without the subjective experience of the animal being involved, and in area 3. Natural-living concerns will arise in areas 1 and 2 where the animal's adaptations are not well matched to the challenges it faces.

Animal welfare implications and conclusions

The conception of animal welfare that scientists adopt has a determining influence on the type of animal welfare research they undertake (Duncan & Fraser 1997) and, hence, on the type of information available to society for deciding animal welfare issues. In fact, scientists advocating restrictive conceptions of animal welfare sometimes propose corresponding restrictions on the scope of animal welfare research. Thus, Kiley-Worthington (1989), using a natural-living conception of animal welfare, suggested that research on animals' environmental preferences is not needed; McGlone (1993) suggested that his functioning-based conception eliminated the need for behavioural research to understand the subjective experience of animals; and Duncan (1996) proposed that because an animal's feelings 'govern' its welfare, 'it is feelings that should be measured in order to assess welfare.' We suggest, instead, that if animal welfare research is to address major ethical concerns about the quality of life of animals, then the conception of animal welfare used by scientists needs to reflect the full range of major ethical concerns extant in society.

Different conceptions of animal welfare can, of course, lead to conflicting conclusions about how animals ought to be treated. Observer A, favouring a functioning-based conception, may conclude that the welfare of a group of sows tethered in stalls is high because the animals are well fed, reproducing efficiently and free from disease and injury. Observer B, using a feelings-based conception, concludes that the welfare of the same animals is poor because they give vocalizations that are thought to indicate frustration, and they escape from the stalls whenever the chance arises. Observer C, relying on a natural-living conception, agrees that the sows' welfare is poor because stalls are unnatural environments which prevent the animals' natural behaviour.

It would be comforting to think that science could arbitrate such disagreements by showing, either empirically or logically, that the quality of life of animals really depends only on biological functioning, or only on subjective experience, or only on natural living. We have argued instead that the positions taken by scientists do not demonstrate that one of these positions is correct and the others are not. Rather, these disagreements stem from value-laden presuppositions about what is important for the quality of life of animals. In such cases, science may provide relevant empirical information, but science cannot turn such disagreements into purely empirical matters by adopting a particular conception of animal welfare to the exclusion of others.

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References

Anonymous 1984 *The Random House College Dictionary, revised edition*. Random House: New York, USA

Anonymous 1989a *The Oxford English Dictionary, 2nd edition*. Clarendon Press: Oxford, UK

Anonymous 1989b *How Astrid Lindgren Achieved Enactment of the 1988 Law Protecting Farm Animals in Sweden*. Animal Welfare Institute: Washington, USA

Appleby M C, Mellor D and Roberts C 1996 Towards a consensus definition of animal welfare. In: Duncan I J H, Widowski T M and Haley D B (eds) *Proceedings of the 30th International Congress of the International Society for Applied Ethology* p 73. Colonel K L Campbell Centre for the Study of Animal Welfare: Guelph, Canada

Barnett J Land Hemsworth P H 1990 The validity of physiological and behavioural measures of animal welfare. *Applied Animal Behaviour Science* 25: 177-187

Baxter M R 1983 Ethology in environmental design for animal production. *Applied Animal Ethology* 9: 207- 220

Brambell F W R 1965 *Report of the Technical Committee to Enquire into the Welfare of Animals kept under Intensive Livestock Husbandry Systems*. Her Majesty's Stationery Office: London, UK

Broom D M 1991a Assessing welfare and suffering. *Behavioural Processes* 25: 117-123

Broom D M 1991b Animal welfare: concepts and measurement. *Journal of Animal Science* 69: 4167-4175

Broom D M and Johnson K G 1993 *Stress and Animal Welfare*. Chapman & Hall: London. UK

Carpenter E 1980 *Animals and Ethics. A report of the working party convened by Edward Carpenter*. Watkins & Dulverton: London. UK

Curtis S E 1987 Animal well-being and animal care. *Veterinary Clinics of North America* 3 (*Farm Animal Behavior*): 369-382

Dawkins M S 1980 *Animal Suffering*. Chapman & Hall: London, UK

Dawkins M S 1988 Behavioural deprivation: a central problem in animal welfare. *Applied Animal Behaviour Science* 20: 209-225

Dawkins M S 1990 From an animal's point of view: motivation, fitness, and animal welfare. *Behavioral and Brain Sciences* 13: 1-61

Dawkins M S 1993 *Through Our Eyes Only? The Searchfor Animal Consciousness*. W H Freeman; Oxford. UK

Dennett D C 1987 *The Intentional Stance*. MIT Press: Cambridge. USA

de Passillé A M B, Christopherson R J and Rushen J 1993 Nonnutritive sucking and the postprandial secretion of insulin, CCK and gastrin in the calf. *Physiology and Behavior* 54: 1069-1073

de Passillé A M B, Metz J H M, Mekking P and Wiepkema P R 1992 Does drinking milk stimulate sucking in young calves? *Applied Animal Behaviour Science* 34: 23-36

Duncan I J H 1993 Welfare is to do with what animals feel. *Journal of Agricultural and Environmental Ethics* 6, Supplement 2: 8-14

Duncan I J H 1996 Animal welfare defined in terms of feelings. *Acta Agriculturae Scandinavica Section A, Animal Science, Supplement 27*: 29-35

Duncan I J H and Fraser D 1997 Understanding animal welfare. In: Appleby M C and Hughes B O (eds) *Animal Welfare* pp 19-31. CAB International: Wallingford, UK

Duncan I J H, Slee G, Kettlewell P, Berry P and Carlisle A J 1986 Comparison of the stressfulness of harvesting broiler chickens by machine and by hand. *British Poultry Science* 27: 109-114

Ewbank R 1988 Animal welfare. In: Universities Federation for Animal Welfare (eds) *Management and Welfare of Farm Animals* pp 1-12. Bailliere Tindall: London, UK

Fraser D 1993 Assessing animal well-being: common sense, uncommon science. In: *Food Animal Well-Being* pp 37-54. Purdue University Office of Agricultural Research Programs: West Lafayette. USA

Fraser D 1995 Science, values and animal welfare: exploring the 'inextricable connection'. *Animal Welfare* 4: 103-117

Giattina J D and Garton R R 1983 A review of the preference-avoidance responses of fishes to aquatic contaminants. *Residue Reviews* 87: 43-90

Gonyou H W 1993 Animal welfare: definitions and assessment. *Journal of Agricultural and Environmental Ethics* 6, Supplement 2: 37-43

Griffin D R 1992 *Animal Minds*. University of Chicago Press: Chicago, USA

Harrison R 1964 *Animal Machines*. Vincent Stuart Ltd: London, UK

Hartwell S I, Jin J H, Cherry D S and Cairns J Jr 1989 Toxicity versus avoidance response of golden shiner, *Notemigonus crysoleucas*, to five metals. *Journal of Fish Biology* 35: 447-456

Hughes B O 1976 Behaviour as an index of welfare. In: *Proceedings of the Fifth European Poultry Conference, Malta*. pp 1005-1018

Hughes B O and Duncan I J H 1988 The notion of ethological 'need', models of motivation and animal welfare. *Animal Behaviour* 36: 1696-1707

Hurnik J F 1993 Ethics and animal agriculture. *Journal of Agricultural and Environmental Ethics* 6, Supplement 1: 21-35

Jones J B, Wathes C M and Webster A J F 1996 Behavioural adaptation of pigs to the irritant effects of atmospheric ammonia. In: Duncan I J H, Widowski T M and Haley D B (eds) *Proceedings of the 30th*

International Congress of the International Society for Applied Ethology p 103. Colonel K L Campbell
Centre for the Study of Animal Welfare: Guelph, Canada

Kennedy J S 1992 *The New Anthropomorphism*. Cambridge University Press: Cambridge, UK

Kiley-Worthington M 1989 Ecological, ethological, and ethically sound environments for animals: toward symbiosis. *Journal of Agricultural Ethics* 2: 323-347

Kolakowski L 1968 *The Alienation of Reason. A History of Positivist Thought*. (Guterman N, translator).
Doubleday: New York, USA

McFarland D (Ed) 1981 *The Oxford Companion to Animal Behaviour*. Oxford University Press: Oxford,
UK

McGlone J J 1993 What is animal welfare? *Journal of Agricultural and Environmental Ethics* 6.
Supplement 2: 26-36

Mendl M 1991 Some problems with the concept of a cut-off point for determining when an animal's
welfare is at risk. *Applied Animal Behaviour Science* 31: 139-146

Midgley M 1983 *Animals and Why They Matter*. University of Georgia Press: Athens, USA

Moberg G P 1985 Biological response to stress: key to assessment of animal well-being? In: Moberg G P
(ed) *Animal Stress* pp 27-49. American Physiological Society: Bethesda, USA

Molony V, Kent J E and Robertson I S 1995 Assessment of acute and chronic pain after different
methods of castration of calves. *Applied Animal Behaviour Science* 46: 33-48

Morrison W D, Pirie P D, Perkins S, Braithwaite L A, Smith J H, Waterfall D and Doucett C M 1993 Gases
and respirable dust in confinement buildings and the response of animals to such airborne contaminants.
In: Collins E and Boon C (eds) *Livestock Environment IV* pp 734-741. American Society of Agricultural
Engineers: St Joseph, USA

Regan T 1983 *The Case for Animal Rights*. University of California Press: Berkeley, USA

Rollin B E 1990 *The Unheeded Cry*. Oxford University Press: Oxford, UK

Rollin B E 1992 *Animal Rights and Human Morality*. Prometheus Books: Buffalo, USA

Rollin B E 1993 Animal welfare, science, and value. *Journal of Agricultural and Environmental Ethics* 6.
Supplement 2: 44-50

Rollin B E 1995 *Farm Animal Welfare: Social, Bioethical, and Research Issues*. Iowa State University
Press: Ames, USA

Rushen J, Lawrence A B and Terlouw E M C 1993 The motivational basis of stereotypies. In: Lawrence A
Band Rushen J (eds) *Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare* pp 41-64.
CAB International: Wallingford. UK

Sainsbury D 1986 *Farm Animal Welfare. Cattle, Pigs and Poultry*. Collins: London, UK

Samraus H H 1981 Abnormal behavior as an indication of immaterial suffering. *International Journal for
the Study of Animal Problems* 2: 245-248

Singer P 1990 *Animal Liberation, 2nd edition*. Avon Books: New York, USA

Smith W J and Penny R H C 1986 Behavioral problems, including vices and cannibalism. In: Leman A D, Straw B, Glock R D, Mengeling W L, Penny R H C and Scholl E (eds) *Diseases of Swine, 6th edition* pp 762-772. Iowa State University Press: Ames, USA

Stafleu F R, Rivas E, Rivas T, Vorstenboseh J, Heeger F and Beynen A C 1992 The use of analogous reasoning for assessing discomfort in laboratory animals. *Animal Welfare* 1: 77-84

Stafleu F R, Grommers F J and Vorstenbosch J 1996 Animal welfare: evolution and erosion of a moral concept. *Animal Welfare* 5: 225-234

Tannenbaum J 1991 Ethics and animal welfare: the inextricable connection. *Journal of the American Veterinary Medical Association* 198: 1360-1376

Taylor G B 1972 One man's philosophy of welfare. *Veterinary Record* 91: 426-428

Taylor P W 1986 *Respect for Nature - A Theory of Environmental Ethics*. Princeton University Press: Princeton, USA

Thorpe W H 1969 Welfare of domestic animals. *Nature* 224: 18-20

van Rooijen J 1981 Are feelings adaptations? The basis of modern applied animal ethology. *Applied Animal Ethology* 7: 187-189

Widowski T M and Curtis S E 1990 The influence of straw, cloth tassel, or both on the prepartum behavior of sows. *Applied Animal Behaviour Science* 27: 53-71