Animal welfare: future knowledge, attitudes and solutions.

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Abstract

Animal welfare is a factor which affects public acceptability of animal usage systems and hence sustainability. The concepts of welfare, need, stress, health, pain, emotion and feeling are defined and the relationships amongst these are discussed. The scientific assessment of animal welfare, including animal health, has developed rapidly in recent years and the sophistication of this will improve further. Methods of assessment of welfare on-farm and in other animal keeping places is also developing and will provide better tools for animal keepers and inspectors in future. Public concern about the welfare of animals has increased and is increasing rapidly. This has occurred, in part, because of new knowledge about animal abilities and an expansion in the concept of which individuals are sentient. Legislation has an effect on animal welfare if adequately enforced. Recent welfare legislation in Europe and prospects for new legislation are reviewed. Legislation is needed in relation to animal breeding and some aspects of system manufacture as well as in defining how animals should be treated by those responsible for them. The impact of the O.I.E. on world standards is becoming more significant. At present, the greatest effects on animal welfare are the standards set by bulk purchasers of animal products, principally supermarkets and fast food chains. The actions of farmers and others involved in animal usage also have major effects on animal welfare. These actions are affected by financial considerations but also by pressure from purchasers, legislation and the attitudes of family, friends, visitors, other users and the general public. Inclusion of scientific information about animal welfare in university and training courses changes attitudes and practices, generally resulting in improved welfare.

Introduction

Whilst the human concepts of what are and are not moral actions have probably changed little over many millennia, ideas about which individuals should be the subject of such actions have changed with: (i) increasing knowledge of the functioning of humans and other animals and (ii) improved communication in the world (Broom,

2003). We all have obligations towards other individuals, including those of other species. If we keep or otherwise interact with animals, we then have obligations in relation to their welfare. Assertions of rights and freedoms can cause problems.

One of the big pressures for laws has been the view that it is uncivilised to: allow people to become sick, animals to be treated badly, or the environment to be damaged. A system or procedure is sustainable if (i) it and its effects are acceptable now and (ii) its future effects are acceptable and are expected to continue to be acceptable, in particular in relation to: resource availability, consequences of functioning and morality of action. Animal welfare is one of the criteria used by the public when deciding whether a procedure or system is acceptable so it is a necessary consideration for sustainability. 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. Welfare should refer to a characteristic of the individual animal rather than something given to the animal by man. 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.

The first aim of this paper is to explain the concepts used in animal welfare science. Some of the recent and future changes are then described.

Coping, welfare, feelings, suffering

Animals have an array of coping systems with components including organ physiology, cellular mechanisms such as the immune system, brain mechanisms and behaviour. 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. However an individual may face challenges in life and be unable to cope with them or able to cope only with difficulty. *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, 2001a). Failure to cope or difficulty in coping, are likely to be evident from signs associated with bad feelings. *The welfare of an individual is its state as regards its attempts to cope with its*

environment (Broom, 1986). 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 (Broom, 1991; Broom and Fraser, 2007; Broom and Johnson, 2000). The concept refers to the state of the individual on a scale from very good to very poor (Curtis, 1986; Duncan, 1987). 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 (Fraser, 1993) including its ability to adapt (Broom, 2006a). The state may be good or poor, however, in either case, attempts should be made to measure those feelings that 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). *Suffering occurs when one or more negative, unpleasant feelings continue for more than a few seconds.*

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).

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 that 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 and about other welfare measures must be considered in welfare assessment.

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, 2001a). This is an improvement on a previous definition used by the International Association for the Study of Pain (Iggo, 1985).

Sentience

Poor welfare is one of the factors that can lead to an animal husbandry system or procedure being unacceptable to the public and hence unsustainable. However, which animals should be protected and what degree of protection is required? 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, 2006c). *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).

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.* These include needs for particular resources and needs to carry out

actions whose function is to obtain an objective (Broom and Fraser, 2007; Toates and Jensen, 1991). Needs can be identified by studies of motivation and by assessing the welfare of individuals whose needs are not satisfied (Broom and Johnson, 2000; Dawkins, 1990; Hughes and Duncan, 1988a; Hughes and Duncan, 1988b). Some needs are for particular resources, such as water or heat, but 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, 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 (Arey 1992, Brantas 1980). In all of these different examples, the need itself is not physiological or behavioural but in the brain.

Stress

The word stress is best 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 common public use of the word stress refers to a deleterious effect on an individual (Broom and Johnson, 2000). 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; Selye, 1956) has been confusing. A definition of stress as just a stimulation or an event which elicits adrenal cortex activity is of no scientific or practical value (Broom, 2001b; Mason, 1971). 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 that over-taxes its control systems and reduces its fitness or seems likely to do so* (Broom, 1983; Broom and Johnson, 2000). 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.

Health

Health refers to the state of body systems, including those in the brain, which combat pathogens, tissue damage or physiological disorder and *health may be defined as an animal's state as regards its attempts to cope with pathology*. In this statement, animals include humans. The meaning of pathology is discussed by Broom (2006b). 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. When an animal's health is poor, so is its welfare, but poor welfare does not always imply poor health. There are many circumstances where behavioural or physiological coping mechanisms are activated, indicating that welfare is poor, but the animal's health remains good. These include: situations where the coping mechanisms are successful, such as when body temperature is maintained despite extreme ambient temperatures; circumstances where failure to cope has consequences for psychological, but not physical, stability, such as in the development of non-injurious pathological behaviours; and where detrimental effects upon physical stability are compensated for by management practices, such as the routine use of antibiotics. There are some indicators of poor welfare which are classified as pathology and, as such, will also indicate poor health. These include body damage and infectious disease. The prevention of normal physiological processes and anatomical development will also indicate poor health, where these phenomena can be shown to be symptoms of an infectious, metabolic or nutritional disease. Mortality rate is usually also an indicator of welfare in general and health in particular in the individuals in a population. When animals are close to death, their welfare including their health will often be very poor.

Recent and expected changes

The changing attitudes of people to animals that they use are discussed in a separate paper (Broom in prep). Some of the species that are now considered for protection are categorised in this way because of increased knowledge of the sophistication of their brain function and coping systems. It is clear that some bird brain structure, learning and awareness are as complex as those of mammals and that all groups of vertebrates include species with behavioural and physiological response systems indicating sentience (Clayton and Dickinson, 1999; Broom 2003). Fish and some invertebrates are also complex enough to justify arguments for their protection (Broom 2007a).

Consumer demands are the major drivers of change in animal production systems and many of the changes now demanded involve effects on animal welfare. In the E.U., there is a range of Directives referring to animal welfare. These concern housing, management, genetic selection, transport and slaughter. Major issues which are the subject of reports by the European Food Safety Authority Scientific and on Animal Health and Welfare include affects of close confinement, management of animals in groups, space allowance, genetic selection for increased productivity, handling procedures and human animal interaction.

The traceability of animals has a significant effect on animal welfare, both in relation to the control of disease and in order to find out who has treated animals badly. This is an important area for future research. Traceability of animal feed can help to reduce the risk of poor welfare because of the effects of toxins or pathogens. The sources of important diseases such as foot and mouth disease and bovine spongiform encephalopathy can be traced and, since these diseases cause very poor welfare in infected animals, the traceability can improve animal welfare as well as reducing costs to farmers.

Traceability of animals can help to reduce disease, injuries caused by bad handling or transport of animals and poor housing conditions. If the farms where bad conditions caused carcass lesions, and the animal handlers or drivers who caused such lesions can be traced, the bad conditions and practices can be improved with consequent benefits for animal welfare.

The welfare of animals in relation to housing, transport and slaughter is widely studied for the main farm species. In future, there will be work on more species. One aspect of husbandry whose study has been in pioneered Australia is the work of Hemsworth, Barnett, Coleman and colleagues on the beneficial effects of appropriate human contact on welfare and production in farm animals (Hemsworth and Coleman 1998). Further work in this area is occurring.

There are still some factors that affect animal welfare greatly but are insufficiently studied. For example, animals supposedly cared for by people may starve (Agenäs et al 2006). *Starvation occurs when there is a shortage of nutrients or energy such that the animal starts to metabolise functional tissues rather than food reserves,* (Broom and Fraser 2007). More measurements of starvation are needed and management that animals starvation should be development. The effects of extreme temperatures and their effects on welfare also require study and changes in management practice.

Amongst those working with companion animals and carrying out veterinary treatment on them, many people express concern about the quality of life of the individual (Broom 2007b, Timmins et al 2007). 'Quality of life' is essentially the same in meaning as 'welfare'. However, whilst welfare can be considered over the short-term or the long-term, quality of life usually refers to a characteristic of an individual over a time-scale longer than a few days. It is a state of the individual that will vary from good to bad.

Scientific studies of welfare in relation to caring for pet animals are likely to be more widespread in the future. The links between disease and welfare are an area for more research in all species used by people. As a results of these various areas of interest in the scientific study of animal welfare, courses on the subject for students of veterinary medicine, animal management, biology and psychology (Hewson et al 2005; Broom 2005) will be demanded in future.

References

Agenäs, S., Heath. M.F., Nixon, R.M., Wilkinson, J.M. and Phillips, C.J.C., 2006. Indicators of undernutrition in cattle. *Animal Welfare,* (15): 149 – 160.

Appleby M.C., 1997. Life in a variable world: behaviour, welfare and environmental design. *Applied Animal Behaviour Science*, (54): 1-19.

Arey D.S., 1992. Straw and food as reinforcers for prepartal sows. *Applied Animal Behaviour Science*, (33): 217-226.

Brantas G.C., 1980. The pre-laying behaviour of laying hens in cages with and without laying nests. *In* Moss R. (ed.), *The Laying Hen and its Environment.* Current Topics in Veterinary Medicine and Animal Science (Vol. 42), The Hague (The Netherlands), Martinus Nijhoff, 129-132.

Broom D.M., 1981. *Biology of Behaviour.* Cambridge (UK), Cambridge University Press, 320 p.

Broom D.M., 1983. The stress concept and ways of assessing the effects of stress in farm animals. *Applied Animal Ethology*, (1): 79.

Broom D.M., 1986. Indicators of poor welfare. *British Veterinary Journal*, (142): 524-526.

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

Broom D.M., 1998. Welfare, stress and the evolution of feelings. *Advances in the Study of Behavior*, (27): 371-403.

Broom D.M., 2001a. Evolution of pain. In *Pain: its Nature and Management in Man and Animals.* International Congress and Symposium Series - Royal Society of Medicine, (246): 17-25.

Broom, D.M., 2001b. Coping, stress and welfare. *In* Broom D.M. (ed.), *Coping with Challenge: Welfare in Animals Including Humans.* Berlin (Germany), Dahlem University Press, 1-9.

Broom D.M., 2003. *The Evolution of Morality and Religion*. Cambridge (UK),
Cambridge University Press, 259 p.

Broom, D.M. 2005. Animal welfare education: development and prospects. *J. Vet. Med.
Educ.,* 32, 438 – 441.

Broom, D.M., 2006a. Adaptation. Berl. Münch. Tierärztl. Wochenschr., 119, 1 – 6.

Broom D.M., 2006b. Behaviour and welfare in relation to pathology. *Applied Animal
Behaviour Science*, (97): 71-83.

Broom D.M., 2006c. The evolution of morality. *Applied Animal Behaviour Science*,
(100): 20-28.

Broom, D.M. 2007a. Cognitive ability and sentience: which aquatic animals should be
protected? *Dis. Aquat. Org.,* 75: 99-108.

Broom, D.M. 2007b. Quality of life means welfare: how is it related to other concepts
and assessed? *Animal Welfare,* (16): 45-53.

Broom D.M. 2008. (in press) Consequences of biological engineering for resource
allocation and welfare. In: W. M. Rauw (Editor) *Resource Allocation Theory
Applied to Farm Animal Production.* Wallingford: CABI.

Broom, D.M. (in prep) The roles of science and industry in improving animal welfare.
(This paper).

Broom D.M. and Fraser, A.F. 2007. *Domestic Animal Behaviour and Welfare*.
Wallingford (UK), CAB Int., 437 p.

Broom D.M. and Johnson K.G., 2000. *Stress and Animal Welfare*. Dordrecht (The
Netherlands), Kluwer, 211 p.

Clayton, N.S. and Dickinson, A.D. 1999. Scrub jays (*Aphelocoma coerulescens*)
remember when as well as where and what food items they cached. *Journal of
Comparative Psychology,* 113, 403-416.

Curtis S.E., 1986. Perception of thermal comfort by farm animals. *In* Baxter S.H.,
Baxter M.R., MacCormack J.A.C. (eds.), *Farm Animal Housing and Welfare*.
The Hague (The Netherlands), Martinus Nijhoff, 59-66.

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

DeGrazia D., 1996. *Taking Animals Seriously: Mental Life and Moral Status.*
Cambridge University Press: New York, USA.

Duncan I.J.H., 1987. The welfare of farm animals: An ethological approach. *Science
Progress*, (71): 317.

Duncan I.J.H. and Petherick J.C. 1991. The implications of cognitive processes for
animal welfare. *Journal of Animal Science*, (69): 5017-5022.

Fraser D., 1993. Assessing animal well-being: common sense, uncommon science. *In*

Food Animal Well-Being. West Lafayette (USA), USDA and Purdue University, 37-54.

Hewson, C.J., Baranyiova, E., Broom, D.M., Cockram, M.S., Galindo, F.A., Hanlon, A.J., Hanninen, L., Lexer, D., Mellor, D.J., Molento C.F.M., Odberg, F.O., Serpell, J.A., Sisto, A.M., Stafford, K.J., Stookey, J.M. and Waldau, P. 2005. Approaches to teaching animal welfare at 13 veterinary schools world wide. *J. Vet. Med. Educ.,* 32, 422 – 437.

Hemsworth, P.H. and Coleman, G.J. (1998). *Human-Livestock Interaction: the Stockperson and Productivity ad Welfare of Intensively Farmed Animals.* CAB International, Wallingford, UK.

Hughes B.O., Duncan I.J.H., 1988a. Behavioural needs: can they be explained in terms of motivational models? *Applied Animal Behaviour Science*, (20): 352-355.

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

Hutson G.D., 1989. Operant tests of access to earth as a reinforcement for weaner piglets. *Animal Production*, (48): 561-569.

Iggo A. 1985. *Pain in Animals.* Potters Bar (UK), Universities Federation for Animal Welfare.

Mason J.W., 1971. A re-evaluation of the concept of 'non-specificity' in stress theory. *Journal of Psychiatric Research*, (8): 323-33.

Panksepp, J. 1998. *Affective Neuroscience*: The Foundatoins of Human and Animal Emotions. Oxford (UK): Oxford University Press

Selye H., 1950. *The Physiology and Pathology of Exposure to Stress*. Montreal (Canada), MD Publ.

Selye H., 1956. *The Stress of Life*. New York (USA), McGraw-Hill.

Timmins, R.P., Cliff K.D., Day, C.T., Hart, B.L., Hart, L.A. Hubrecht, R.C., Hurley, K.F., Phillips, C.J.C., Rand, J.S., Rochlitz, I., Serpell, J.A. and Zawistowski, S.L. 2007. Enhancing quality of life for dogs and cats in confined situations. *Anim. Welfare,* **16** (Suppl.), 83-87.

Toates F. and Jensen P., 1991. Ethological and psychological models of motivation: towards a synthesis. In Meyer J.A., Wilson S. (eds), *Farm Animals to Animals.* Cambridge (UK), MIT Press, 194-205.

Vestergaard K., 1980. The regulation of dustbathing and other behaviour patterns in the laying hen: a Lorenzian approach. In Moss R. (ed.), *The Laying Hen and its Environment.* Current Topics in Veterinary Medicine and Animal Science (Vol. 42), The Hague (The Netherlands), Martinus Nijhoff, 101-113.