

WellBeing International

WBI Studies Repository

10-2006

The changing concept of animal sentience

Ian J. H. Duncan
University of Guelph

Follow this and additional works at: <https://www.wellbeingintludiesrepository.org/sentie>



Part of the [Animal Studies Commons](#), [Comparative Psychology Commons](#), and the [Other Animal Sciences Commons](#)

Recommended Citation

Duncan, I. J. (2006). The changing concept of animal sentience. *Applied Animal Behaviour Science*, 100(1-2), 11-19. DOI: <https://doi.org/10.1016/j.applanim.2006.04.011>

This material is brought to you for free and open access by WellBeing International. It has been accepted for inclusion by an authorized administrator of the WBI Studies Repository. For more information, please contact wbisr-info@wellbeingintl.org.





The changing concept of animal sentience

Ian J.H. Duncan *

Department of Animal and Poultry Science, University of Guelph, Guelph, Ont., Canada N1G 2W1

Available online 18 May 2006

Abstract

A brief history of the concept of sentience is given. It is pointed out that the idea of sentience, at least in the mammals and birds, was accepted by lay people by the time of the Renaissance and before it was acknowledged by philosophers. It was not until the Enlightenment of the 18th century that philosophers started to accept the notion that animals have feelings. Towards the end of the 19th century, scientists and philosophers had developed a fairly sophisticated concept of sentience. Little consideration was given to sentience by scientists through much of the 20th century due to the inhibiting influence of Behaviourism. In the last quarter of the 20th century, there was a surge of interest in animal sentience, and animal welfare scientists quickly realised that welfare problems can be better tackled with an understanding of how animals feel. Methods to investigate indirectly how animals feel are described and areas requiring further elucidation are listed.

© 2006 Published by Elsevier B.V. Open access under [CC BY-NC-ND license](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Keywords: Animal welfare; Feelings; History; Methodology; Sentience

1. Sentience—a brief history

The concept of animals being sentient, or capable of experiencing positive and negative affective states, has suddenly become, in the last 30 years, a topic of great interest to biologists. However, a more detailed examination of history reveals that the change has actually not been so sudden; some acceptance of sentience, at least in the mammals, has been present for hundreds of years. By the time of the Renaissance, there is good evidence from the writings of Leonardo da Vinci, Erasmus, Thomas More, Montaigne, Shakespeare, Francis Bacon and others, that animal sentience was accepted as part of secular knowledge (Preece, 2002). Many of the great artistic

* Tel.: +1 519 824 4120x53652; fax: +1 519 836 9873.

E-mail address: iduncan@uoguelph.ca.

works of this age also portray people treating animals as if they were sentient. But of course, philosophers did not follow the views of the masses and there is a clear line of philosophic argument for non-sentience from Aristotle through Thomas Aquinas and René Descartes to Immanuel Kant. Of all the philosophers, Descartes is usually singled out for special blame for introducing the idea of animals as ‘automata’. However, in a more considered review of Descartes’ works, [Kenny \(1970\)](#) translates Descartes as saying “Similarly of all the things that which dogs, horses and monkeys are made to do, are merely expressions of their fear, their hope, or their joy; and consequently they can do these things without any thought.” Present-day scholars continue to argue about what he really meant by this. The fact that he was a vivisectionist, and did not treat animals as if they were sentient, suggests that he thought that ‘fear’, ‘hope’ and ‘joy’ were in some way unconscious emotions. ‘Unconscious emotion’ is a difficult concept to understand and is currently being debated (e.g. [Óhman et al., 2000](#); [Winkelman and Berridge, 2004](#)).

During the Enlightenment, the arguments of Aristotle, Aquinas, Descartes and Kant that animals were non-sentient were challenged. For example, the Scottish philosopher David Hume wrote “Is it not experience, which renders a dog apprehensive of pain, when you menace him or lift up the whip to beat him?” ([Hume, 1739](#)). However, it was Bentham, the English social reformer, who got right to the nub of the issue when he wrote “The question is not, Can they *reason*? nor, Can they *talk*? but, Can they *suffer*?” ([Bentham, 1823](#)).

There also seems to have been fairly wide acceptance of sentience within the scientific community of the early 19th century. For example, the English veterinarian, Youatt, wrote that animals have senses, emotions and consciousness; they demonstrate sagacity, docility, memory, association of ideas and reason; they also have imagination and the moral qualities of courage, friendship and loyalty ([Youatt, 1839](#)). Surprisingly, in making these statements, Youatt did not claim to be proposing anything very novel; he wrote as if these were commonly accepted facts. He also emphasised that, with regard to sentience in human beings and animals, “. . . the difference between them in one of the most essential of all points, is in degree, and not in kind”.

By the middle of the 19th century, [Spencer \(1855\)](#) had postulated that ‘feelings’ are adaptations. He suggested that feelings combine with memory and reason to form a flexible mechanism by which an animal can react adaptively to environmental change. Then, following Darwin, feelings came to be viewed as adaptations to pressures of natural selection. For example, the physiologist and psychologist [Romanes \(1884\)](#) wrote that “Pleasures and Pains must have been evolved as the subjective accompaniment of processes which are respectively beneficial or injurious to the organism, and so evolved for the purpose or to the end that the organism should seek the one and shun the other.”

So, 120 years ago, it was commonly accepted by scientists that animals were sentient and this was also the commonsense view held by the community. However, through much of the 20th century, behavioural scientists eschewed any study of animal feelings. The reason is that a branch of psychology called “Behaviourism” had a huge effect on the way that behavioural scientists thought about the mind, consciousness and feelings through the first 70 years of the 20th century. The seeds were sown by James, the psychologist who is generally regarded as the founder of functionalism, when he wrote “Consciousness . . . is the name of a nonentity, and has no right to a place among first principles. Those who still cling to it are clinging to a mere echo, the faint rumour left behind by the disappearing ‘soul’ upon the air of philosophy . . . It seems to me that the hour is ripe for it to be openly and universally discarded” ([James, 1904](#)). With this idea, Watson founded the discipline of Behaviourism and wrote “The behaviourist sweeps aside all medieval conceptions. He drops from his scientific vocabulary all subjective terms such as

sensation, perception, image, desire and even thinking and emotion” (Watson, 1928). Behaviourism flourished in North America through much of the 20th century. As late as 1975, Skinner wrote “We seem to have a kind of inside information about our behaviour—we have feelings about it. And what a diversion they have proved to be! . . . Feelings have proved to be one of the most fascinating attractions along the road of dalliance” (Skinner, 1975).

James, Watson and Skinner were powerful figures and their influence was widespread, to the extent that there was little consideration of consciousness and feelings in North American schools of psychology. Of course there were notable exceptions. For example, McDougall (1926) proposed a theory of motivation based on feelings. He suggested that an animal’s subjective experiences such as fear, sexual desire, and maternal tenderness, which he called ‘emotions’, could motivate activities such as escaping from danger, courtship and copulation, and caring for young. Young (1959) was another scientist who suggested that affective subjective states have a central role in regulating and directing behaviour.

Even the European-founded discipline of ethology was influenced by behaviourism; ethologists generally restricted their considerations to observable behaviour. However, their use of terms such as ‘hunger’, ‘pain’, ‘fear’ and ‘frustration’ (McFarland, 1981) suggests that affective states were still guiding their thinking on behaviour although the subjective component was not openly discussed. This pattern was broken by Griffin when he gave a paper on subjective feelings at the International Ethology Conference in Parma, Italy in 1975, and published a book on the topic a year later (Griffin, 1976). Since then, animal sentience has become an important topic in its own right and there has been an ever-increasing flow of publications (e.g. Radner and Radner, 1989; Ristau, 1991; Damasio, 1999). In addition, of course, our understanding of animal sentience will have a huge effect on how we deal with animal welfare.

2. Sentience and animal welfare science

As scientific investigations into animal welfare gradually increased in the late 1960s, following the publication of Harrison’s book “Animal Machines” (Harrison, 1964) and the follow-up British Government investigation published as the so-called “Brambell Report” (Command Paper 2836, 1965), it was generally assumed that welfare would be intimately connected with the physiological stress response (e.g. Bareham, 1972; Bryant, 1972; Wood-Gush et al., 1975; Freeman, 1978). An animal that was stressed would have poor welfare and an animal that was not stressed would have good welfare. Assessing welfare would simply be a matter of finding a reliable indicator of stress. However, it is worth pointing out that it was the suffering of animals in intensive agriculture, in biomedical research and in product testing that spurred Harrison to write her book (Harrison, 1964). It was not just the fact that these animals were stressed that troubled her; it was the fact that they were sentient and could *feel* stressed. The Brambell Committee also acknowledged that sentience was important. They stated, “Welfare is a wide term that embraces both the physical and mental well-being of the animal. Any attempt to evaluate welfare, therefore, must take into account the scientific evidence available concerning the feelings of animals that can be derived from their structure and functions and also from their behaviour” (Command Paper 2836, 1965). So the Brambell Committee also realised that an understanding of sentience is an essential part of assessing welfare.

Through the 1980s, and triggered by the publication of Dawkins’ book “Animal Suffering” (Dawkins, 1980), behavioural scientists gradually accepted the importance of feelings in their investigations into animal welfare problems. There was a progression from a position in which feelings were seen as a necessary component of welfare (Dawkins, 1980, 1990; Duncan, 1981,

1987; Duncan and Dawkins, 1983) to one in which feelings are the only thing that matters (Duncan, 1996, 2004).

Acceptance of the fact that welfare is all to do with feelings brings with it a huge, almost insurmountable problem, which is that we can never prove conclusively that any organism is sentient. Subjective feelings are just that—subjective, and available only to the animal experiencing them. Fortunately, in the animal welfare debate we do not need to know exactly what an animal is experiencing. An indication of how positive or negative the animal is feeling would be extremely useful. For example, if we are considering a chicken that we suspect is frightened, we do not need to know if it is experiencing what a human being experiences when being threatened by a savage dog or being trapped in a burning building. In order to assess the chicken's welfare, all we need to know is whether or not it is experiencing something negative. If the chicken *is* experiencing negative feelings, it would also be helpful to know how negative these feelings are. Although it is impossible to measure feelings directly, it is possible to get some indication of what an animal is feeling by indirect means, and these methods will be discussed briefly. However, before moving on to methods, I would urge making a distinction between cognition and consciousness. Cognition usually refers to mental processes such as perception, memory, learning, computational skills, expectation, etc. In other words, these are processes that have evolved to help the animal deal with the external world in a flexible way. Consciousness, on the other hand, gives the animal information about its internal environment. Humphrey (1986, 1992) has suggested that consciousness may be similar to an “inner eye” that allows the animal awareness of certain inner states such as fear and pain. In any investigation into how animals feel, it may be necessary to involve cognitive processes (Can an animal *learn* to avoid a frightening stimulus? Can an animal *remember* a rewarding experience?). There may also be interesting interactions between emotions and cognition (e.g. Paul et al., 2005). However, it should be remembered that it is the animal's *awareness* of what is happening that is crucial for its welfare, and in investigations into welfare we should be striving for measures (albeit indirect measures) that give some indication of how positive or negative the animal feels (Dawkins, 1993).

2.1. Assessing welfare by investigating feelings

It is possible to investigate feelings by indirect methods such as preference testing, motivational testing and understanding animal communication. Preference testing was pioneered by Hughes and Dawkins, both working with domestic fowl (e.g. Hughes and Black, 1973; Hughes, 1975, 1977; Dawkins, 1976, 1977, 1978). According to this method, the animal is given a choice of aspects of its environment, and we assume that it will choose in the best interests of its welfare. There are certain pitfalls to be avoided when using preference tests. However, these have been thoroughly discussed and the precautions that need to be taken in order to avoid errors have been well elucidated (Duncan, 1978, 1992; Dawkins, 1983; Fraser and Matthews, 1997). There is no doubt that, for all their limitations, preference tests give a good first indication of what the animal feels about various aspects of its environment.

But a preference test is only the first step in investigating how an animal feels about its environment; it is also necessary to know how important a particular choice is. Even a consistent choice in one direction may not be important for the animal, if, say, neither choice results in suffering. But a choice may also represent the lesser of two evils with the animal suffering with both options. For these reasons, it is necessary to measure the strength of the preference as a follow up to preference testing.

There are various methods being used to measure strength of preference and an economic analogy is often used in the description of these methods (Mason et al., 1998). For example, we can “increase the price” of the commodity that the animal is choosing. This is done by seeing how hard the animal will “work” in order to obtain its preferred choice. Obstruction tests, in which the animal has to push past an obstruction or push open a weighted door in order to reach its preferred choice, is a common method (e.g. Duncan and Kite, 1987; Nicol and Guildford, 1991; Mason et al., 2001). Operant responding is another common method being used to measure motivation (e.g. Dawkins and Beardsley, 1986). It is ironic that the operant conditioning chamber or “Skinner box” developed by behaviourists who campaigned so strongly against giving any consideration to feelings (Skinner, 1975), is now being used to investigate these very subjective feelings in an indirect way. Rather than “increasing the price” of a commodity, it is also possible to investigate motivation by reducing an animal’s “income”, although this is rather stretching the economic argument. The time that an animal has available to perform its various activities can be regarded as “income”. The available time can be reduced until there is insufficient time for the animal for the animal to perform its full repertoire of behaviour. When this point is reached it is assumed that the animal will perform the activities that are really important to it and that other, less important activities will be omitted.

Of all the states of suffering, pain is probably responsible in animal agriculture for a bigger reduction in welfare than any other (see, for example, Benson, 2004). Many farm animals are injured through living in ill-designed environments. For example, sows housed in dry sow stalls often have pressure sores on their hips from lying on hard surfaces, hens in battery cages often have hyperkeratosis of their feet pads from continually slipping on sloping floors, and dairy cows often have feet and hock injuries from standing and lying on hard surfaces. Injuries also arise from social interactions, such as fighting, tail-biting and feather-pecking. In addition, there are lots of surgical interventions, such as castration, tail-docking, dehorning, teeth-trimming, beak-trimming, de-snooding, de-toeing, all carried out without analgesic or anaesthetic cover. Then there are procedures, carried out for identification purposes, such as ear-tagging, ear-notching and branding, that could be painful. Finally, the poultry and swine sectors are running into fast-growth problems such as skeletal weaknesses, and the dairy sector is experiencing metabolic problems, all of which could be painful (Benson, 2004).

Asking animals if they are experiencing pain, is much more of a challenge than asking them about other feelings. We can use an animal’s tendency to avoid as a measure of its fear and we can use its tendency to approach as a measure of how motivated it is to gain access to some environmental feature. But how can we ask animals if they are in pain? Looking very carefully at the behaviour of animals with and without analgesics can give some indication (e.g. Duncan et al., 1990; Molony and Kent, 1997). In a very exciting development of this method, it has been found that broiler chickens are capable of self-administering a pain-killing drug. When given a choice between two feeds, one of which contained a pain-killer, lame broilers ate more of the drugged feed than did broilers with no lameness. Moreover the walking ability of the lame birds was improved by this self-administered treatment (Danbury et al., 2000).

Another possible route for gaining information about what animals may be feeling is through an understanding of their systems of communication. For example, Weary and co-workers have been able to assess the severity of pain experienced by piglets during castration by carefully analysing their vocalizations (Weary et al., 1998; Taylor and Weary, 2000).

3. Future research needs

In my opinion, we have already come a long way in developing methods by which we can ‘ask’ animals how aversive they find the common states of suffering such as pain, fear, frustration and deprivation. There is one state of suffering that requires further research and that is boredom. A start has been made (e.g. [Wemelsfelder, 1993](#)), but much remains to be done. However, there is an emerging view that welfare should be more than just the absence of suffering (e.g. [Mench, 1998](#)). The presence of pleasure adds much to the quality of life of human beings. Why should pleasure not also be important for animals? Pleasure may also be important to counteract the unavoidable negative states that will occur from time to time such as when animals are handled, injected or transported. Investigations into states of pleasure have lagged behind and require to be expanded, although a start has been made. For example, it has been suggested that states of suffering and states of pleasure have evolved to solve two very different types of problem ([Fraser and Duncan, 1998](#)). Negative feelings may have evolved to solve “need situations” where there is an immediate threat to fitness from not performing certain behaviour (drinking when thirsty, fleeing when a predator approaches, etc.). Positive feelings, on the other hand, may have evolved to motivate certain behaviour in “opportunity situations” in which all the animal’s essential needs are taken care of, and the cost of performing the behaviour is low (the pleasure of social grooming, the pleasure of playing, etc.). A little evidence is emerging that gives some support to this idea. For example, there is some evidence that dust-bathing in domestic fowl, previously thought to be a need-driven behaviour pattern which would result in negative feelings if prevented, actually occurs in “opportunity situations” and leads to a state of pleasure ([Widowski and Duncan, 2000](#)). There now needs to be a much wider investigation into pleasure, particularly the applied aspects of pleasure, to balance some of the recent fundamental studies (e.g. [Spruijt et al., 2001](#); [Berridge, 2003](#)).

We also need more research on the question of where on the phylogenetic scale, does sentience emerge? There seems to be some (but not universal) agreement that all the vertebrates are sentient. For example, [Rose \(2002\)](#), using neuro-anatomical evidence, denies that fish have sentience, although the physiological and behavioural evidence that they are sentient is overwhelming ([Chandroo et al., 2004](#)). However, it is when we consider the invertebrates that the debate becomes intense. There is no doubt that the cephalopods are sentient. They show emotional behaviour, exhibit surprise when their expectations are not met, and construct a fairly detailed cognitive map of their world ([Wells, 1962](#)). There has been some research showing simple learning and memory in sea snails (*Aplysia*) ([Bailey et al., 1996](#); [Abel et al., 1998](#)) and in fruit flies (*Drosophila*) ([Belvin and Yin, 1997](#)). However, whether or not this implies sentience is still open to debate. [Griffin \(1976\)](#) certainly thought that there was enough evidence to conclude that honeybees (*Apis mellifera*) were sentient.

More investigation is also required into the ontogeny of sentience. In the past it has often been considered acceptable to carry out fairly invasive procedures, such as castration or de-horning, without anaesthetic or analgesic cover on very young animals with the assumption that they are less sentient than older animals. There can, of course, be good arguments (some of them welfare arguments) for carrying out these procedures on young animals; the animals may be easier to restrain, the healing process may be quicker, and the animals may be less likely to remember the procedure. However, the crucial question is whether the animals *are* less sentient, and to date we have little information on this topic. And, of course, we should also be considering the welfare of animals during fetal development. How sentient are they? There will obviously be huge differences between the young of a precocial species, such as sheep, and that of an altricial

species such as mink (*Mustela vison*) in the development of sentience. The matter will be further complicated by the fact that various components of sentience are likely to develop at different rates. Thus, it seems possible that a late fetal lamb may be aware of maternal vocalisations that may be comforting, or a domestic chick may be aware of changes in temperature a few days before hatching that could be disturbing, whereas some visual or olfactory awareness may only develop later.

4. Conclusions

Acceptance of the fact that the commonly farmed species are sentient, and that it is possible to gain information about what animals are feeling by indirect means, has greatly advanced animal welfare science in the past 25 years. A fairly solid body of information is being assembled about states of suffering experienced by farm animals such as pain, fear, frustration and deprivation. More research is now required on states of pleasure. There are also gaps in our knowledge about where on the phylogenetic scale and when in ontogenesis sentience emerges.

References

- Abel, T., Martin, K.C., Bartsch, D., Kandel, E.R., 1998. Memory suppressor genes: Inhibitory constraints on the storage of long-term memory. *Science* 279, 338–341.
- Bailey, C.H., Bartsch, D., Kandel, E.R., 1996. Toward a molecular definition of long-term memory storage. *Proc. Natl. Acad. Sci. U.S.A.* 93, 13445–13452.
- Bareham, J.R., 1972. Effects of cages and semi-intensive deep litter pens on the behaviour adrenal response and production in two strains of laying hens. *Br. Vet. J.* 128, 153–163.
- Belvin, M.P., Yin, J.C., 1997. *Drosophila* learning and memory: recent progress and new approaches. *Bioessays* 19, 1083–1089.
- Benson, G.J., 2004. In: Benson, G.J., Rollin, B.E. (Eds.), *Pain in Farm Animals: Nature, Recognition, and Management*. Blackwell Publishing, Ames, Iowa, pp. 61–84.
- Bentham, J., 1823. *An Introduction to the Principles of Morals and Legislation*. Clarendon Press, Oxford.
- Berridge, K.C., 2003. Pleasures of the brain. *Brain Cogn.* 52, 106–128.
- Bryant, M.J., 1972. The social environment: behaviour and stress in housed livestock. *Vet. Rec.* 90, 351–359.
- Chandross, K.P., Duncan, I.J.H., Moccia, R.D., 2004. Can fish suffer? Perspectives on sentience, pain, fear and stress. *Appl. Anim. Behav. Sci.* 86, 225–250.
- Command Paper 2836, 1965. Report of the Technical Committee to Enquire into the Welfare of Animal Kept under Intensive Livestock Husbandry Systems. Her Majesty's Stationery Office, London.
- Damasio, A., 1999. *The Feeling of What Happens: Body Emotion and the Making of Consciousness*. Vintage Random House, London.
- Danbury, T.C., Weeks, C.A., Chambers, J.P., Waterman-Pearson, A.E., Kestin, S.C., 2000. Self-selection of the analgesic drug Carprofen by lame broiler chickens. *Vet. Rec.* 146, 307–311.
- Dawkins, M.S., 1976. Towards an objective method of assessing welfare in domestic fowl. *Appl. Anim. Ethol.* 2, 245–254.
- Dawkins, M.S., 1977. Do hens suffer in battery cages? Environmental preferences and welfare. *Anim. Behav.* 25, 1034–1046.
- Dawkins, M.S., 1978. Welfare and the structure of battery cages: Size and cage floor preferences in domestic hens. *Br. Vet. J.* 134, 469–475.
- Dawkins, M.S., 1980. *Animal Suffering*. Chapman and Hall, London.
- Dawkins, M.S., 1983. The current status of preference tests in the assessment of animal welfare. In: Baxter, S.H., Baxter, M.R., MacCormack, J.A.C. (Eds.), *Farm Animal Housing and Welfare*. Martinus Nijhoff, The Hague, pp. 20–26.
- Dawkins, M.S., 1990. From an animal's point of view: motivation, fitness, and animal welfare. *Behav. Brain Sci.* 13, 1–61.
- Dawkins, M.S., 1993. *Through Our Eyes Only? The Search for Animal Consciousness*. W.H. Freeman, Oxford.
- Dawkins, M.S., Beardsley, T.M., 1986. Reinforcing properties of access to litter in hens. *Appl. Anim. Behav. Sci.* 15, 351–364.
- Duncan, I.J.H., 1978. The interpretation of preference tests in animal behaviour. *Appl. Anim. Ethol.* 4, 197–200.

- Duncan, I.J.H., 1981. Animal rights—animal welfare: a scientist's assessment. *Poult. Sci.* 60, 489–499.
- Duncan, I.J.H., 1987. The welfare of farm animals: an ethological approach. *Sci. Prog. (Oxford)* 71, 317–326.
- Duncan, I.J.H., 1992. Measuring preferences and the strength of preference. *Poult. Sci.* 71, 658–663.
- Duncan, I.J.H., 1996. Animal welfare defined in terms of feelings. *Acta Agri. Scand., Sec. A, Anim. Sci., Suppl.* 27, 29–35.
- Duncan, I.J.H., 2004. A concept of welfare based on feelings. In: Benson, G.J., Rollin, B.E. (Eds.), *The Well-Being of Farm Animals: Challenges and Solutions*. Blackwell, Ames, Iowa, pp. 85–101.
- Duncan, I.J.H., Dawkins, M.S., 1983. The problem of assessing 'well-being' and 'suffering' in farm animals. In: Smidt, D. (Ed.), *Indicators Relevant to Farm Animal Welfare*. Martinus Nijhoff, The Hague, pp. 13–24.
- Duncan, I.J.H., Kite, V.G., 1987. Some investigations into motivation in the domestic fowl. *Appl. Anim. Behav. Sci.* 18, 387–388.
- Duncan, I.J.H., Beatty, E.R., Hocking, P.M., Duff, S.R.I., 1990. An assessment of pain associated with degenerative hip disorders in adult male turkeys. *Res. Vet. Sci.* 50, 200–203.
- Fraser, D., Duncan, I.J.H., 1998. 'Pleasures' 'pains' and animal welfare: toward a natural history of affect. *Anim. Welf.* 7, 383–396.
- Fraser, D., Matthews, L.R., 1997. Preference and motivation testing. In: Appleby, M.C., Hughes, B.O. (Eds.), *Animal Welfare*. CAB International, Wallingford, Oxon, pp. 159–173.
- Freeman, B.F., 1978. Stress in caged layers. In: Sørensen, L.Y. (Ed.), *First Danish Seminar on Poultry Welfare in Egg-Laying Cages*. Danish National Committee for Poultry and Eggs, Copenhagen, pp. 55–65.
- Griffin, D., 1976. *The Question of Animal Awareness*. Rockefeller, New York.
- Harrison, R., 1964. *Animal Machines*. Vincent Stuart, London.
- Hughes, B.O., 1975. Spatial preference in the domestic hen. *Br. Vet. J.* 131, 560–564.
- Hughes, B.O., 1977. Selection of group size by individual laying hens. *Br. Poult. Sci.* 18, 9–18.
- Hughes, B.O., Black, A.J., 1973. The preference of domestic hens for different types of battery cage floor. *Br. Poult. Sci.* 14, 615–619.
- Hume, D., 1739. In: Selby Bigge, L.A. (Ed.), *A Treatise of Human Nature*. Clarendon Press, Oxford.
- Humphrey, N., 1986. *The Inner Eye*. Faber and Faber, London.
- Humphrey, N., 1992. *A History of the Mind: Evolution and the Birth of Consciousness*. Springer-Verlag, New York.
- James, W., 1904. Does "consciousness" exist? *J. Philos. Psychol. Sci. Meth.* 1, 477–491.
- Kenny, A., 1970. *Descartes' Philosophical Letters*. Clarendon Press, Oxford.
- Mason, G., McFarland, D., Garner, J., 1998. A demanding task: using economic techniques to assess animal priorities. *Anim. Behav.* 55, 1071–1075.
- Mason, G., Cooper, J., Clarebrough, C., 2001. Frustrations of fur-farmed mink. *Nature* 410, 35–36.
- McDougall, W., 1926. *An Introduction to Social Psychology* (revised edition). John W. Luce and Co, Boston.
- McFarland, D., 1981. *The Oxford Companion to Animal Behaviour*. Oxford University Press, Oxford.
- Mench, J.A., 1998. Thirty years after Brambell: whither animal welfare science? *J. Appl. Anim. Welf. Sci.* 1, 91–102.
- Molony, V., Kent, J.E., 1997. Assessment of acute pain in farm animals using behavioural and physiological measurements. *J. Anim. Sci.* 75, 266–272.
- Nicol, C.J., Guildford, T., 1991. Exploratory activity as a measure of motivation in deprived hens. *Anim. Behav.* 41, 333–341.
- Öhman, A., Flykt, A., Lundqvist, D., 2000. Unconscious emotion: Evolutionary perspectives, psychophysiological data and neuropsychological mechanisms. In: Ekman, P., Davidson, R.J. (Eds.), *Cognitive Neuroscience of Emotion*. OUP, Oxford, pp. 296–327.
- Paul, E.S., Harding, E.J., Mendl, M., 2005. Measuring emotional processes in animals: the utility of a cognitive approach. *Neurosci. Biobehav. Rev.* 29, 469–491.
- Preece, R., 2002. *Awe for the Tiger Love for the Lamb: A Chronicle of Sensibility to Animals*. UBC Press, Vancouver.
- Radner, D., Radner, M., 1989. *Animal Consciousness*. Prometheus Books, Buffalo, New York.
- Ristau, C.A. (Ed.), 1991. *Cognitive Ethology: The Minds of Other Animals*. Lawrence Erlbaum Associates, Hillsdale, New Jersey.
- Romanes, G.J., 1884. *Mental Evolution in Animals*. AMS Press, New York (reprinted 1969).
- Rose, J.D., 2002. The neurobehavioral nature of fishes and the question of awareness and pain. *Rev. Fish. Sci.* 10, 1–38.
- Skinner, B.F., 1975. The steep and thorny path to a science of behaviour. In: Harre, R. (Ed.), *Problems of Scientific Revolution*. Oxford University Press, Oxford.
- Spencer, H., 1855. *The Principles of Psychology*. Longmen, Brown, Green and Longmans, London.
- Sprijuij, B.M., van den Bos, R., Pijlman, F.T.A., 2001. A concept of welfare based on reward evaluating mechanisms in the brain: anticipatory behaviour as an indicator for the state of reward systems. *Appl. Behav. Anim. Sci.* 72, 145–171.

- Taylor, A.A., Weary, D.M., 2000. Vocal responses of piglets to castration: identifying procedural sources of pain. *Appl. Anim. Behav. Sci.* 70, 17–26.
- Watson, J.B., 1928. *Behaviorism*. Routledge and Keegan Paul, London.
- Weary, D.M., Braithwaite, L.A., Fraser, D., 1998. Vocal responses to pain in piglets. *Appl. Anim. Behav. Sci.* 56, 161–172.
- Wells, M.J., 1962. *Brain and Behaviour in Cephalopods*. Heinemann, London.
- Wemelsfelder, F., 1993. The concept of animal boredom and its relationship to stereotyped behaviour. In: Lawrence, A.B., Rushen, J. (Eds.), *Stereotypic Animal Behaviour: Fundamentals and Applications to Welfare*. CAB International, Wallingford, UK, pp. 65–95.
- Widowski, T.M., Duncan, I.J.H., 2000. Working for a dustbath: are hens increasing pleasure rather than reducing suffering? *Appl. Anim. Behav. Sci.* 68, 39–53.
- Winkielman, P., Berridge, K.C., 2004. Unconscious emotion. *Curr. Direc. Psychol. Sci.* 13, 120–123.
- Wood-Gush, D.G.M., Duncan, I.J.H., Fraser, D., 1975. Social stress and welfare problems in agricultural animals. In: Hafez, E.S.E. (Ed.), *The Behaviour of Domestic Animals*. 3rd ed. Williams and Wilkins, Baltimore, pp. 182–200.
- Youatt, W.H., 1839. In: Preece, R. (Ed.), *The Obligation and Extent of Humanity to Brutes, Principally Considered with Reference to the Domesticated Animals*. Edwin Mellen Press, Lewiston, New York (republished 2003).
- Young, P.T., 1959. The role of affective processes in learning and motivation. *Psychol. Rev.* 66, 104–125.