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Psychological Indicators of Stress and Welfare

D M Broom

Abstract

The concepts of welfare and stress are defined and related to other key terms. Since most welfare problems involve changes in brain functioning there are psychological aspects of both good and poor welfare. Psychological processes result in changes in physiology and behaviour and even injuries and disease have psychological consequences so many indicators of welfare are psychological to some extent. In order to assess welfare effectively a wide range of measures is needed because individuals have a wide variety of coping systems and of consequences of success or failure in coping.

Introduction: Welfare and stress

The term *welfare* is applied to all animals including humans, those in the wild, those kept in farms, laboratories or zoos and those kept for working or as companions. We do not talk about the welfare of plants, micro-organisms or inanimate objects but the word stress is applied to plants. A definition of welfare which can be used in the scientific, legal and public domains is: *the welfare of an individual is its state as regards its attempts to cope with its environment* (Broom 1986). In other words, how well does the individual fare or go through life. This definition refers to a characteristic of the individual at a time, not to something which is given to the individual. Welfare will vary over a range from very good to very poor.

When facing problems in life, the individual may fail to cope, in that it dies or is unable to grow or reproduce, or it may cope but only with difficulty. In either case, welfare is poor. Many aspects of attempting to cope involve brain mechanisms. Failure to cope and difficulty in coping are therefore associated with psychological consequences, often together with bad feelings. There may also be behavioural, physiological, immunological and disease incidence changes when welfare is poor. When there are no problems, welfare will be good. Positive feelings occur on many occasions when welfare is good and are associated with certain physiological consequences.

Stress is one aspect of poor welfare. To most people, stress means something bad but the use of the term stress to mean 'something which causes adrenal cortex activity' or 'any perturbation of homeostasis' have led to considerable confusion in its use. Adrenal cortex activity can occur in normal or good situations as well

as in those which have potentially adverse effects on the individual so it is not biologically useful to equate all of such activity with stress. Similarly, the word stress is of little or no value if it is merely equated with stimulation which affects basic body functioning. It is better to reserve the word stress for situations where there is some real adversity resulting from a failure of the control systems which exist in the brain and other parts of the body. The ultimate measure of adversity is impairment of biological fitness so a definition is: '*stress is an environmental effect on an individual which overtaxes its control systems and reduces its fitness or appears likely to do so*' (Broom and Johnson 1993).

Hence stress is that part of poor welfare where the individual cannot cope with its environment. Not coping will ultimately mean severe adversity to the point where there is reduced fitness. However, in many circumstances where stress is being assessed there is an indication of failure to cope rather than a direct measure of fitness reduction. Welfare may be poor in situations where there is no stress because the individual is coping with its environment even though it is with difficulty. Whilst welfare can be good, however, stress cannot be good. This has been one of the confusing aspects of the other definitions of stress mentioned above. Varied early experience and some exposure to a variety of events in the world is good for an individual because it helps in the development of effective coping systems but the experiences are not stress and stress is never 'good for you'.

Another term which is related to welfare is *health*. Health refers to coping with the pathological impact of the environment so it is a narrower term than welfare. Health also varies from very good to very poor so health is included within welfare and concerns the presence or absence of pathology and disease. Poor health will always mean poor welfare but there could be good health combined with some other problem so that welfare is not good overall.

Wherever poor welfare involves bad feelings there is *suffering*. Feelings are biological mechanisms which have evolved like any other mechanism. (Dawkins 1977; Broom 1998). Feelings such as pain, malaise, fear or anxiety are often adaptive but still indicate poor welfare because they occur when the individual is having difficulty in coping with the environment. However, poor welfare can be indicated by other coping difficulties such as immunosuppression or injury whilst asleep, in which cases there is no suffering. Similarly, a variety of positive feelings can occur when welfare is good but will not always do so. The topics discussed in this section are explained further by Broom and Johnson (1993) and Broom (1996).

Assessing welfare

Animals have problems when needs are not satisfied so we should try to find out about needs. They also have problems when there is a direct adverse effect of the environment such as something which can or does cause an injury or an attack by a pathogen. The specification of the freedoms which we should give to animals provides a good general guideline for how to minimise poor welfare but in many species of animals, scientific studies have progressed to the point where we can be more precise, considering needs and assessing welfare directly.

The range of welfare indicators listed in Table 1 includes some measures of stress. Both Table 1 and Table 2 refer to psychological and non-psychological measures. In order to assess welfare effectively, a wide range of measures is needed and these must be combined if the complete range of coping mechanisms and the complete array of adverse effects of the environment on individuals is to be taken into account.

Table 1 Measures of poor welfare.

Reduced life expectancy
Reduced ability to grow or breed
Body damage
Disease
Immunosuppression
Physiological attempts to cope
Behavioural attempts to cope
Behaviour pathology
Self narcotization
Extent of behavioural aversion shown
Extent of suppression of normal behaviour
Extent to which normal physiological processes and anatomical development are prevented.

(from Broom and Johnson 1993)

Table 2 Measures of good welfare.

Variety of normal behaviours shown
Extent to which strongly preferred behaviours can be shown
Physiological indicators of pleasure
Behavioural indicators of pleasure

(From Broom and Johnson 1993)

In animals like vertebrates which have elaborate mechanisms for trying to control their interactions with their environment, there will almost always be psychological aspects of welfare problems so psychological measures must always be a part of comprehensive attempts to assess welfare. Where individuals are trying to cope, or are failing to do so, brain changes will affect: brain chemistry and electrical activity, various physiological systems, immune systems and behaviour.

When a sensory input to nociceptive systems occurs there are various changes in the peripheral nervous system and spinal cord but the sensation of pain involves changes in the brain and various brain systems will be involved in most painful experiences. Hence pain has psychological components. There will also be psychological consequences of many feelings of malaise and all feelings of fear or anxiety. Whenever there is some degree of specific frustration or more general lack of control over interactions with its environment, the individual will be functioning in a different way psychologically from an individual which does not have such welfare problems. The same is true of individuals which have such a lack of environmental variety that they feel boredom, or those subjected to specific deprivations or some degree of sensory or processing overload. In every case there will be potentially measurable psychological changes, often associated with behavioural changes. At the other extreme, absence of problems could be associated with feelings of happiness, pleasure or joy. The psychological indicators of such good welfare are lack of any behavioural coping behaviour, or a wide range of normal behaviour, or particular behaviours or physiological states which occur only when welfare is good. Good feelings must normally involve the knowledge that coping is effective and not difficult and some particular additional sensations.

Examples of the use of psychological indicators of welfare

Normal and preferred behaviour

In order to recognise abnormalities of brain functioning, body physiology or behaviour it is essential to know what is normal. Those who have watched or otherwise investigated normal animals closely are much more likely to detect the abnormal in each of these different areas. Many authors have described the normal behaviour of animals in appropriate complex environments. For example, Stolba and Wood-Gush (1989) studied pigs kept in an area of field, trees and bushes and described how sows spent the daytime period. They spent much time grazing and rooting and were considerably more active than most housed sows. More specialist studies of what constitutes normal behaviour include the work of

Ketelaar de Lauwere and Smits (1989) who described the various postures adopted by calves whilst lying and compared these with postures adopted whilst confined in a crate. Calves most commonly adopted a position partly on their sides with the legs partially extended and the head turned sideways to rest on the legs. All calves also adopted at some time a side-lying posture with the legs stretched out. In the narrow crates, neither of these postures was possible but a third lying posture, sternal lying, was used for most of the time. Since animals usually carry out behaviours and adopt postures because it is important to them to do so, welfare is likely to be less good in conditions where such behaviours are impossible.

Experimental studies can also be used to find out what are the strong preferences of animals. The strength of a positive preference for a resource or for the opportunity to carry out an activity can be quantified by making the animal work for it or forego some other important resource such as food or social contact in order to obtain it. Such studies do not indicate welfare directly but they provide information upon which to evaluate it since welfare will be better in the circumstance where strongly preferred activities can be carried out.

Abnormal behaviour

If an individual is unable to carry out preferred behaviour, or if it is frustrated, frightened or depressed, its behaviour is likely to be abnormal. The abnormality may be in quality or in quantity. Examples of behaviour abnormalities associated with having to live in inadequate conditions are: inactivity, apathy and unresponsiveness, stereotypies, extra aggression and self mutilation.

An example of a situation where welfare is poor and psychological problems result in abnormalities of behaviour is the pain associated with castration in young piglets. In a study by Wemelsfelder and van Putten (1985) the behaviour of handled piglets was compared with that of piglets which were handled and surgically castrated without an anaesthetic. The castrated piglets showed an immediate vocal response in that they produced higher pitched squeals with more variation in pitch. For some time after castration the piglets showed abnormal standing, walking and lying behaviour. For two or three days, they moved in such a way that tension was not exerted on the cut scrotal region. They slid the legs rather than moving them normally and their movements during lying down and standing up were atypical. With other types of pain, different behaviour changes occur. Species vary in the extent to which they show behavioural responses to pain, for example sheep show small behavioural responses but large physiological responses to the mulesing operation in which an area of skin 50 cm² in area is cut

off their perianal region with scissors (Shutt *et al* 1987). These sheep, which showed little behavioural response at the time of the mulesing, did show abnormal posture and locomotion some time after the operation and strongly avoided the people who had restrained them during the operation (Fell and Shutt 1989).

Chronic pain may result in clear behaviour changes such as limping or lethargy. In many cases, the use of analgesics can reveal whether or not the behaviour change is a consequence of pain in that analgesia makes the abnormal behaviour disappear. For example, Duncan *et al* (1991) suspected that large male breeding turkeys suffered from leg pain. They recorded the behaviour of the turkeys in a general activity test and in a test in which the males were exposed to breeding females. The behaviour of these particularly heavy male turkeys was greatly affected by the analgesic in a way which indicates that the turkeys were normally considerably affected by leg pain. They showed 75 per cent more walking and feeding, approached females with 70 per cent less latency and at 60 per cent greater speed and attempted 55 per cent more mounts.

When animals are frightened the psychological changes affect both their physiological and behavioural responses. Whether the response is freezing or active escape, adequate assessment requires measures of behaviour, adrenal and heart rate changes. A single measure may not give sufficient information about the degree of fear and it is better to look for both active and inactive responses using a range of measurements rather than for example, just measuring the duration of tonic immobility.

Lack of control over the events which seriously affect the life of an individual results in particularly poor welfare. Domestic animals have complex systems for regulating their lives (Broom and Johnson 1993) and the psychological effects of failure of these systems can result in a variety of behavioural, physiological and brain chemistry abnormalities. Short term frustration, such as inability to reach a regularly supplied food source in hens (Duncan and Wood-Gush 1972) and inability to build a nest prior to egg-laying in hens or farrowing in sows, is indicated by stereotypies such as pacing or bar-biting. Long term confinement, with its many frustrating consequences, can also result in a high level of stereotypies. Confinement and lack of specific stimuli or general environmental variety may also lead to apathy which is indicated by reduced activity and lack of responsiveness. Specific deprivations such as absence of a teat in young calves, or absence of material to manipulate in pigs, often lead to sucking at inappropriate objects and tail-biting respectively. Some behavioural abnormalities can be linked to changes in the densities of mu and kappa opioid receptors in the brain (Zanella *et al* 1996) and many long term problems for animals are associated with

immunosuppression and constitute what Moberg (1987) has described as a pre-pathological state.

Indicators of good welfare

Good welfare, which is often associated with feelings of contentment or happiness may result in recognisable behavioural and physiological changes which allow the recognition of the state. However some apparent indicators are sometimes false. A person who smiles may be acting as if happy when actually not happy and a dog which wags its tail may be indicating subservience to a human rather than happiness. However, careful studies should allow the evaluation of such measures. As mentioned in Table 2, the breadth of normal behaviour and the proportion of strongly preferred behaviour which can be shown are also important indicators of good welfare.

Conclusions

A lot of welfare problems, including many of the most serious problems, involve brain functioning and so affect psychological variables. Information about psychological responses comes from many indicators, including measurements of body physiology, brain function and behaviour. Even indicators of poor welfare such as injuries, immunosuppression and extent of disease will have important effects on the brain. Hence a high proportion of welfare assessment necessitates the measurement of psychological effects on behaviour or physiology.

Many different measurements can be used in the assessment of welfare and the best studies will utilise a range of relevant measurements. Measures of physiology, behaviour, disease etc. should be made and their results integrated in order to decide how good or how poor the welfare of an individual is.

References

- Broom D M 1986 Indicators of poor welfare. *British Veterinary Journal* 142: 524-526
- Broom D M 1996 Animal welfare defined in terms of attempts to cope with the environment. *Acta Agricultura Scandinavica Section A Animal Science Supplement I* 27: 22-28
- Broom D M 1998 Welfare, stress and the evolution of feelings. *Advances in the Study of Behavior* 27: in press
- Broom D M and Johnson K G 1993 *Stress and Animal Welfare*. Chapman and Hall: London, UK
- Dawkins M 1977 Do hens suffer in battery cages? environmental preferences and welfare. *Animal Behaviour* 25: 1034-1046

- Duncan I J H, Beatty E R, Hocking P M and Duff R I 1991 Assessment of pain associated with degenerative hip disorders in adult male turkeys. *Research in Veterinary Science* 50: 200-203
- Duncan I J H and Wood-Gush D G M 1972 Thwarting of feeding behaviour in the domestic fowl. *Animal Behaviour* 20: 444-451
- Fell L R and Shutt D A 1989 Behavioural and hormonal responses to acute surgical stress in sheep. *Applied Animal Behaviour Science* 22: 283-294
- Ketelaar de Lauwere C C and Smits A C 1989 *Onderzoek naar de uit ethologisch oogpunt minimaal gewenste boxmaten voor vleeskalveren met een gewicht van 175 tot 300 kg. IMAG Rapport 110*. IMAG: Wageningen, Germany
- Moberg G P 1987 A model for assessing the impact of behavioral stress on domestic animals. *Journal of Animal Science* 65: 1228-1235
- Shutt D A, Fell L R, Cornell R, Bell A K, Wallace C A and Smith A I 1987 Stress induced changes in plasma concentrations of immunoreactive endorphin and cortisol in response to routine surgical procedures in lambs. *Australian Journal of Biological Science* 40: 97-103
- Stolba A and Wood-Gush D G M 1989 The behaviour of pigs in a semi-natural environment. *Animal Production* 48: 419-425
- Wemelsfelder F and Putten G van 1985 Behaviour as a possible indicator for pain in piglets. I.V.O. *Report B-260* Instituut voor Veeteelkundig Onderzoek. Zeist
- Zanella A J, Broom D M, Hunter J C and Mendl M T 1996. Brain opioid receptors in relation to stereotypies, inactivity and housing in sows. *Physiology and Behaviour* 59: 769-775

DISCUSSION

Q Alan Long

You have not used the word 'distress'. A confined sow trying to build a nest is 'stressed'. If she copes this is OK, if not then surely she is 'distressed'.

A Don Broom

For many people it is a useful word: stress is associated with physiological changes and distress describes the psychological changes.

Q Anne McBride

In the context of the companion animal this can be a grey area. For example, if a dog has a hip problem then the advice is to reduce exercise. I may then end up treating this dog for its frustration and aggression. How do we address this conflict: a longer life with improved hips or a short life but a happy one?

A Don Broom

There is a limit to such things. One needs to balance the measures and consequences certainly and there is a dilemma. Factors such as magnitude and duration of treatment need to be taken into account.