Diagnostic significance of behaviour changes of sheep: A selected review

D.A. Gouglouli*, I. Kyriazakis, G.C. Fthenakis
Veterinary Faculty, University of Thessaly, 43100 Karditsa, Greece

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Abstract
Sheep welfare is the combination of subjective and objective (qualitative and quantitative) aspects of the conditions of life of animals, including health and disease, behaviour, husbandry and management; thus, it is a complex and abstract construct. The scientific approach to the problems of assessing suffering in sheep has to be evidence-based. Different approaches contribute to an assessment of animal suffering, such as measurements of physical damage to the animal, measurement of the animals’ preferences and considerations of the conditions to which the animal is adapted in its normal social structure. Selected literature on the behavioural alterations of sheep, which indicate internal or external distressing procedures, is reviewed in this paper. There is a need for further research to identify indicators of distress in sheep, but in the meantime it would be reasonable to make the judgement that, in some circumstances, sheep observed vocalising, panting, showing markedly increased locomotory activity and/or changes in feeding or social patterns could be experiencing distress.

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1. Introduction

Of all the affective states that animals experience, disease is of special interest. The indication and the complications of a disease are considered to be among the most considerable issues of animal welfare. Likewise, painful and distressed procedures performed on animals are among the most emotive of public concerns regarding animal welfare.

Poor physical health, caused by disease, injury or deformity, is relatively straightforward to recognise and can often be quantified, for example, by scoring how well an animal is walking or the size of lesions on its body (Dawkins, 2006). Disease reduces welfare status to the individual animal, the group of animal or the whole flock. Sheep are capable of not only feeling pain, but also of learning and displaying emotion and memory (Roger, 2008). Other, less obvious measures of decreased health, such as depressed immune function (Irwin, 1999) or reduced food intake (Dallman, 2001), have been reported in cases of reduced welfare. These can often give an indication that all are not well with the animal/group/flock, before clinical symptoms become obvious. In more advanced studies, to investigate the mental health state of an animal, one can use both physiology and behaviour.

Physiological measures of welfare that have been used so far, are the autonomic responses of the animals, such as increased heart rate, or increased levels of various hormones, e.g., corticosteroids (Korte, 2001). Behaviour has the advantage that it can be studied non-invasively and can give a direct insight into the view of the situation from the perspective of an animal. The answer to the, apparently simple, question: ‘Does the animal have what it wants?’ is the key to whether the animal is being treated in ways it dislikes (e.g., pain that it wants to avoid) and to whether the animal is deprived (i.e., it wants something it does not have) (Dawkins, 2004).

* Corresponding author.
E-mail address: dgoug@vet.uth.gr (D.A. Gougoulis).
We now have several different ways of ‘asking’ animals what they want and whether they find the situations they are in pleasurable or distressing. However, probing the emotional and behavioural life of sheep is one of the most difficult challenges that science is facing. This requires to comprehend the literature in sheep behaviour and distress (Rutherford, 2002) and to work through the key concepts for assessing behaviours during pathological conditions (Weary et al., 2006).

2. Diagnostic approach of behavioural alterations

The term ‘distress’ usually describes situations, in which sheep are likely to be suffering and show abnormal behaviours, i.e., they indicate that suffering (Ewbank, 1985). In reality, any agent that threatens an animal’s welfare can lead to distress. Infections and acute environmental changes are potential threats for health and can induce distress in sheep.

As sheep are relatively stoical creatures, they do not always display obvious signs of distress and pain; alternatively, human observers do not have the ability or the skills to identify these indicators. In the wild, as animals can be preyed upon by predators, in evolutionary terms, it is possible that lack of signs of pain can be advantageous to sheep, as they would not become predator targets. Therefore, methods to assess welfare and pain in farm animals, objectively, are required (Fitzpatrick et al., 2006).

Research on assessment of distress in sheep has used one of the three approaches: (a) measures of general body functioning (e.g., feed or water intake/preference or weight gain), (b) measures of physiological responses (e.g., plasma cortisol concentrations) and (c) measures of behavioural changes (e.g., vocalisation, mobility or socialization). All three approaches have merit and can be useful within different contexts (Weary et al., 2006). The main behavioural responses to a range of stressors that have been identified in other species include increased immobilization and increased locomotion, decreased sleeping/resting and increased alertness, decreased eating and drinking and increased vocalisation and elimination (Cockram, 2004).

3. Alterations of feeding, grazing and sucking patterns

Alterations of feeding and grazing behaviour are usually indications of inappropriate feeding or of gastrointestinal abnormalities. Feed available to grazing animals particularly during the dry season, can often be of low quality; frequently, it is also available at low densities per unit area. Grazing sheep try to adapt to these adverse conditions, by increasing the time during which they graze each day and also by dispersing more widely. However, the time for which animals can graze, may be limited by solar radiation or fly irritation during the day and by confinement of animals in pens during the night (Manteca and Smith, 1994).

Behaviour may be altered as animals respond to the invasion of their personal field. Reducing space allowance can lead to increase in aggressive interactions and is considered to be highly important for optimum welfare and production. Little is known about the direct effects of space allowance on the grazing behaviour of herbivores, since animal density cannot easily be altered without affecting the vegetation and is almost always confounded with differences in herbage availability (Sibbald et al., 2000).

In flocks raised under intensive husbandry conditions, Meisfjord Jørgensen et al. (2009) have reported that queuing at the feeding trough is a good indicator of increase population density.

A stereotypic change in feeding behaviour can be observed during the early stages of pregnancy toxæmia, when pregnant ewes switch from concentrate feeding to hay feeding, then to straw feeding, which, at terminal stages of the disease, is followed by complete self-starvation (Kronfeld, 1972). Progressive change of behaviour is a useful diagnostic sign of the disease, which on the other hand deteriorates the already energy-lacking situation of the pregnant ewes.

Sheep have a range of behaviours, by which they can reduce the probability of ingesting infective stages of gastrointestinal parasites during grazing. They avoid grazing swards contaminated with faeces and thus parasites; freshly contaminated swards are avoided most strongly, whilst this avoidance declines with time of contamination (Hutchings et al., 1998). If they were forced to graze swards contaminated with faeces, they would reduce the grazing depths, thus the probability of ingesting infective parasitic stages, which concentrate in the lower portions of the sward (Hamilton and McAnulty, 1997).

Young lambs change their sucking behaviour and reduce the time sucking a mammary gland with subclinical mastitis compared to the healthy gland (Gougoulis et al., 2008). This behavioural modification is a clear indication and can be used to raise a suspicion of presence of subclinical mastitis in a flock, which may be then confirmed by using other diagnostic techniques.

Villalba et al. (2006) showed that sheep learned to associate three illness-inducing substances in feeds, with three compounds known to cause recovery from those illnesses; sheep also showed greater preference for the medicinal compound that specifically attenuated the effect of each illness-inducing substance. Sheep learn to ingest medicines, such as polyethylene glycol, which can attenuate the aversive effects of tannins, when they eat feeds high in tannins; they can also adapt the dose of polyethylene glycol intake, in accord with the amount of tannin in their diet (Provenza et al., 2000). Sheep can discriminate the medicinal benefits of polyethylene glycol from non-medicinal substances, by selectively ingesting polyethylene glycol after eating a meal high in tannins (Villalba and Provenza, 2000). Sheep also choose to forage in areas with polyethylene glycol when offered feeds with a high tannin content. In contrast, time spent at locations with polyethylene glycol decreased, if tannins were not included in their diets (Villalba and Provenza, 2002).

Current evidence for the use of plant secondary metabolites by sheep for self-medication purposes remains equivocal. Plant secondary metabolites have both positive (anti-parasitic) and negative (toxic) effects on sheep. There is strong evidence suggesting that sheep have developed the skills needed to forage by taking advantage of...
plant properties, in order to combat parasites, thus using behaviour as a means to potentially prevent parasitic infestation (Hutchings et al., 2003).

4. Postural and motion disorders

Altered locomotor activity can be interpreted in several ways. For example, it may be an attempt to escape, which could reflect fear; it may also be used as a search for conspecifics, reflecting social motivation or exploration and a low level of fear. The opposite response to locomotion – immobilisation – is seen in some sheep in response to stressors. Immobilisation may reflect docility and absence of fear, or it may reflect a high degree of disturbance and nervousness (Cockram, 2004).

The most common sign of illness or pain in an animal is the modification of its posture or of the way of moving and standing. Signs of in-coordination, limping, reluctance to walk, teeth gnashing, amaurosis and head tilt gait are indications of severe pain or depression due to a disease. Neurological signs, such as circling movements, wandering, chewing movements with salivation, are usually suggestive of damage of the central nervous system. General lethargy and apathy is also being regarded as a sign of pain and severe illness in animals (Morton and Griffiths, 1985), whilst behavioural studies often include measures of reduced activity, such as normal gait, or of reactivity, such as latency to withdraw from a handler (Weary et al., 2006). Once these symptoms are obvious, differential diagnosis among several diseases should be performed. Scrapie, pregnancy toxemia, cerebro-cortical necrosis, intoxication by various poisonous plant, coenurusis and *Listeria monocytogenes*-infection are some of the most common diseases, in which sheep present those symptoms (Ligios et al., 2004).

There are certain behaviours that can be useful in the assessment of distress caused by environmental condition or handling. The most obvious of these are pain-specific behaviours, like the increased number of high-frequency calls made by lambs during castration and the defensive behaviours seen occasionally when an injured site or a wound of a sheep is manipulated, such as bucking in lambs upon palpation of a limb with laminitis (Ley et al., 1995). A painful injury may sometimes increase an animal’s sensitivity to other painful stimuli; such hyperalgesia is typically assessed by exposing the animals to a painful stimulus (e.g., heat or pressure) and measuring the withdrawal response. The site and intensity of distress and its duration usually affect the severity of these responses and the sorts of behaviours observed (Dolan et al., 2000; Fitzpatrick et al., 2006; Weary et al., 2006).

Sheep affected by *Psoroptes ovis* show a variety of abnormal behaviours: rubbing, scratching or biting at the lesion site; these resulted in interruption of the normal behaviours: grazing, cudding and idling, but did not result in reduced levels of these behaviours. In some cases, infested sheep showed stereotypic mouthing behaviour, initiated by rubbing or scratching, or in other cases even with no external stimulus (Corke and Broom, 1999).

Physical injuries and diseases can cause a loss in normal functioning, regardless of whether pain is present. Joint injuries may prevent normal movements of the limbs, leading to stiffness in gait that may not be associated with pain (Weary et al., 2006). Hood disorders can lead to shortened strides and slower walking speeds, but these are findings also seen in sheep walking on wet, slippery surfaces found in many barns (Winter, 2008, 2009); therefore, if animals were observed on slippery surfaces, changes in gait might be due rather to the testing environment rather than to a painful condition. In order to identify gait characteristics associated with painful injuries, animals must be observed under conditions that do not confound the behaviour of interest.

An increase in respiration rate to over 40 breaths/min together with open-mouthed breathing is considered as ‘panting’ in sheep, the main reason for panting is to increase body cooling by losing heat through evaporation. However, it is also possible that sheep also pant in response to psychological stimuli. Under severe heat stress, the respiration rate of sheep can reach 300 breaths/min (Hales and Brown, 1974). Silanikove (2000) suggested that measurement of respiration rate and evaluating panting in sheep could help to quantify the severity of heat stress according to panting rate: low heat stress: 40–60 breaths/min, medium heat stress: 60–80 breaths/min, high heat stress: 80–200 breaths/min, severe heat stress: over 200 breaths/min. This was considered to be an easily accessible method for evaluating the impact of heat on farm animals under extensive conditions. It would not be unreasonable to propose that the increased respiration rate shown by sheep when exposed to high environmental temperatures could be associated with an aversive emotional response (Cockram, 2004).

5. Social and sexual abnormal behaviours

Social behaviour of sheep reflects the group size. Sheep in large groups had a larger variation in resting time, rested and fed with reduced synchrony than sheep in small groups. Behaviour may be altered as animals respond to the invasion of their personal field. The most prevalent aggressive interaction ‘pushing’ (butting) is used to displace another ewe from the feed barrier or a resting place. In general, the level of aggression in ewes is relatively low compared to other female ungulates; however, the level of aggression in ewes is sensitive to changes in space allowance, especially in the resting area. It is possible that decrease in the length of perimeter per ewe in the largest group size contributed to increased competition for attractive resting places, thus decreasing the predicted group size effect on aggression. This is in accordance with the findings of Førævik et al. (2005) and Bée et al. (2006), who showed that ewes preferred to lying next to a wall. Hence, wall space in the resting area might be regarded as an important source of competition in ewes. Aggression in sheep is more sensitive to changes in space allowance, and especially wall space in the resting area, than to changes in group size (Meisfjord Jàrgensen et al., 2009).

Even though social rank may be less obvious in sheep than in some other species (Lynch et al., 1992), it still affects many aspects of sheep behaviour, mainly, but not only, when competing for resources. In multi-sire matings, for

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**References**

instance, the dominant ram will sire more offspring than other rams (Fowler and Jenkins, 1976). Furthermore, presence of a dominant ram in an adjacent pen can reduce the mounting frequency of subordinate rams, even without any direct competition occurring (Lindsay et al., 1976). This can have catastrophic effects in the reproductive performance of a flock, if the dominant ram is sub-fertile and thus, underlines the importance of breeding evaluation of rams (Gouletsou and Fthenakis, 2006). ‘Pushing’ (butting) is also used to displace another ram from an area commanded by a ram, is usually associated with sexual dominance of rams over a group of female animals.

More dominant lambs displayed more intensive sexual behaviour towards subordinate males and ewes in oestrus, whereas more subordinate males received more mounts from other males and were less active toward ewes. Libido development and intensity in these lambs may play significant role, because libido and social hierarchy are not necessarily related. Another factor, possibly influencing male–male sexual activity, is the individual differences in male-oriented sexual behaviour. It has been suggested that male–male sexual mounts may negatively affect normal behavioural patterns toward ewes during pubertal development (Ungerfeld et al., 2007). These male–male (‘homosexual’) behaviours can be confirmed by finding the penis coated with faecal material (Boundy, 1992).

Most of the literature cited on social isolation and exposure to a novel environment reported increased vocalisations. However, when lambs are separated from the ewe at weaning, increased vocalisations could indicate distress or simply that the animals are attempting to communicate and identify each other to assist in reuniting (Shillito-Walser and Alexander, 1980; Lynch et al., 1992). Orgeur et al. (1998) recorded a greater frequency of vocalisations towards the end of a separation period than at the beginning, suggesting that in this case vocalisation might be part of an emotional response. Also, increased high-pitched vocalisations reported in response to separation have been interpreted primarily as a stress response to separation, and low-pitched bleating has been interpreted as a recognition signal. The reduction in the frequency of vocalisations in the presence of a human or a dog is likely to be an antipredator, possibly a ‘fearful’, response, which overrides the increased vocalisation reported in many other aversive situations (Romeyer and Bouissou, 1992).

6. Concluding remarks

This review has highlighted a number of abnormal findings in behaviour that may be used as signals for further investigation and possible action, as well as stimulus to validate or refute their usefulness in recognising pathological conditions in sheep. The development of an objective animal welfare index, to be applied at farm level by individual assessment, would seem to be an area for priority; this should help integration of the behavioural observations in the diagnostic process, alongside various contributors to animal welfare measurement, i.e., physiological, biochemical, pathological, emotional and legal indicators. Attention is needed in cases where sheep do not show an obvious behavioural response to a situation. This is a particular problem when attempting to identify behavioural responses of sheep during distress, because some sheep may respond to stressors with immobility rather than with an active response.

It is important to be able to recognise and deal with suffering; the use of behavioural signs for the identification of distress in sheep is an obvious practical welfare issue. Until firmer evidence is available it would be reasonable to make the judgement that, in some circumstances, sheep that are found to be vocalising, panting and/or showing markedly increased locomotor activity could be experiencing distress.

References


