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Relationships between temperament, feeding behaviour, social interactions, and stress in lambs adapting to a feedlot environment

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ABSTRACT

The production of lamb meat is a large and important industry in Australia. Variability and seasonality of the climate and the demand for a consistent product (in terms of weight and age) have led to an increase in the use of feedlot systems for finishing lambs. While most lambs acclimatise to this environment, an estimated 5–20% may suffer from inanition or shy feeding, but there is little direct information available on associated physiological stress. This exploratory study examined relationships between temperament, feeding behaviour, social interactions and cortisol concentrations in lambs in the first 2 weeks in an intensive finishing system (feedlot). Lambs in two 20-lamb feedlots (with 2 m^2 floor space/animal) were studied. Prior to entry to the feedlot, the lambs were subjected to a temperament test (Isolation Box Test) in which activity was measured. Weight gain, general activity, lying time, time at the feeder, number of feeding bouts, displacement at the feeder and plasma cortisol concentrations in weeks 1 and 2 in the feedlot were recorded. A parsimonious general linear model was developed to relate the logarithm of cortisol concentration in weeks 1 and 2 to all other measurements. In week 1 cortisol was most elevated if the lamb's activity in the feedlot (number of steps) was low ($P = 0.000025$) and also for those lambs that fed more frequently ($P = 0.0010$). Higher levels of activity in the temperament test were associated with higher cortisol concentrations in week 1 when the lamb was not displaced from the feeder. However there was an interaction with the number of displacements ($P = 0.0016$), leading to little effect when a displacement occurred. In week 2 higher cortisol concentrations were associated with higher growth ($P = 0.040$) which may be a reflection of the positive association between cortisol and feeding bouts in week 1. This study demonstrates relationships between cortisol concentrations, activity in the temperament test, feeding bouts, displacements at the feeder and activity in the first week and growth in the second week in the feedlot. A better understanding of these behaviour and stress relationships early in the feedlot may be useful in identifying strategies to protect vulnerable animals in feedlots.

1. Introduction

The production of lamb meat (meat from sheep less than 12 months old) from pastures is a large and important industry in temperate Australia (the value of total lamb exports in 2013–14 was A$1.5 billion (MLA, 2015)), but the variability and seasonality of the climate makes it difficult to consistently finish lambs to weight and age specifications throughout the year. One important approach to producing consistent lamb product is to finish lambs on prescribed grain based diets in a lot fed (feedlot) situation for several weeks before slaughter. Finishing feedlots present a range of challenges for lambs that have been reared on extensive pastures. For example, an animal introduced to a feedlot generally has to contend with a number of stressors, such as change in diet and availability of food, change in available floor space allowance, mixing of unfamiliar animals, greater exposure to disease, a novel environment, increased human contact and in many cases, transport (Arnold and Maller, 1974; Higgs et al., 1993; Burritt and Provenza, 1997; Hall et al., 1998; Waiblinger et al., 2006; Fraser, 2008; Mellor et al., 2009; Miranda-de la Lama et al., 2012; Villalba et al., 2012). Most research on sheep feedlots in Australia relates to preparing sheep for export (often using much older sheep, 2–6 years old), rather than finishing lambs for slaughter. Based on this research, an estimated 5–20% of all sheep that enter a feedlot are prone to inanition or shy feed-

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ing (Jolly and Wallace, 2007), but there is little direct information available on associated physiological stress.

In extensive systems, sheep activity has been observed to have a bimodal frequency distribution (particularly in summer) with peaks of activity around sunrise and sunset (Arnold, 1962; Squires, 1974). This circadian behaviour also occurs in feedlots (Shreffler and Hohenboken, 1980) however, unlike extensive systems where pasture is spread relatively evenly across a field or paddock, in feedlots feeding space is markedly reduced with the use of feed troughs. In fact Shreffler and Hohenboken (1980) reported that during the peaks of feeding activity, more lambs sought to feed than could be accommodated at the feed trough. While no measurements on welfare indices or production values (such as daily gain or feed intake) were reported in this study, there is evidence in the literature that such competition for feeding space can lead to an increased incidence of non-feeders. For example, Arnold and Maller (1974) reported that the percentage non-feeders increased as trough length decreased. Likewise, with limited space, competition between sheep in pens for lying space increases (Bøe et al., 2006; Jongman et al., 2008). Thus, this synchrony of behaviour can be the cause of competition not only for feeder space but also for other limited resources such as drinker space, lying space and shade.

Competition for access to a feeder can be complex with some studies showing that those animals that appear to be more dominant, based on a butting hierarchy, may not necessarily be the ones with a higher feed intake (Sherwin, 1990; Erhard et al., 2004). Dove et al. (1974) also found that dominance hierarchy, based on fights won, is not strictly linear in sheep. However, dominance rank is often correlated with animal size, suggesting that weight may be one of the important factors in establishing dominance status (Preston et al., 2003) and this may have implications for the performance and welfare of intensively-finished lambs where the practice is to group animals on weight. While dominance hierarchy assists in reducing aggression and injury (Lindberg, 2001), it is likely to influence access to resources in a feedlot, particularly if the resources are limited.

Temperament is defined as an innate and relatively stable aspect of an animal's disposition of which dominance rank may be a social outcome (Gosling and John, 1999; Réale et al., 2007). It can be influenced by both genetics and early-life experiences and is often defined by an animal's response to stressors (Dodd et al., 2012). As such, in sheep it is often measured by observing the reactivity of the animal to stressors such as isolation, novelty and humans (Romeyer and Bouissou, 1992; Murphy et al., 1994). Differences in temperament, based on these responses, have been linked to animal performance such as growth (Pajor et al., 2007, 2008; Horton and Miller, 2011), wool production and lamb survival (Pajor et al., 2007; Plush et al., 2011) and meat quality (Dodd et al., 2014) and thus may be a useful predictor of coping ability within a feedlot environment.

The relationship between temperament, dominance and priority of access to finite resources is unclear, however in a feedlot where access to resources (e.g. the feeder) is restricted, temperament and dominance may become increasingly important, with implications on agonistic behaviour, feeding behaviour, lying behaviour, fear, and stress and consequently growth, health and animal welfare. There is some evidence in the literature to suggest that temperament and dominance influence the ability of a lamb to regulate both their behavioural and physiological responses in order to adapt from pasture to a feedlot environment and may, in part, explain why some animals adapt to this environment better than others. Thus, this exploratory study examined the relationships between cortisol concentrations, as a measure of physiological stress, and temperament, feeding behaviour, and displacement from the feeders in lambs in the first two weeks in an intensive finishing system (feedlot).

2. Methods

2.1. Housing

Two adjacent 20-lamb feedlot pens were built for this study at the University of Melbourne's research site at Dookie, Victoria, Australia. The study was conducted over a 2-week period across January and February 2011. The average daily maximum temperature in weeks 1 and 2 was 34.3 and 26.1 °C respectively, and total rainfall was 27.6 mm in week 1 and 98.5 mm in week 2.

Animals were provided with a space allowance of 2 m^2 per animal which is well within the recommendation of a minimum space allowance of 1.0 m^2/animal for lambs up to 41 kg in outdoor feedlots by the Australian Model Code of Practice for the Welfare of Animals (2006). The two feedlot pens (each 8 m × 5 m) were constructed on compacted gravel and had wire-mesh walls. Water was provided ad libitum via a trough that spanned both feedlot pens on the dividing fence line. Shade cloth provided shade to cover half of each feedlot pen, and the feeder was positioned outside the shaded area along the fence line in an attempt to discourage lambs from choosing to lie in front of the feeder.

Cameras, 3.6 mm infrared CCTV, were installed using the support structure for the sail cloth as attachment points (two cameras per pen, combined these 2 cameras captured the full pen in the field of view). Footage from these cameras was recorded on a PC computer using GeoVision® software.

2.2. Animals and diet

All animal procedures were conducted with prior institutional ethical approval under the requirements of the Victorian Prevention of Cruelty to Animals Act 1986 in accordance with the National Health and Medical Research Council/Commonwealth Scientific and Industrial Research Organization/Australian Animal Commission Code of Practice for the Care and Use of Animals for Scientific Purposes. Forty healthy 4 month old male Merino lambs from a single flock, with an average initial live weight of 23.8 kg (standard deviation, 2.85 kg), were allocated to two feedlot pens on an ad hoc basis and studied in this system over a 2-week period (January and February 2011). Lambs were born and reared on pasture and, at 6 weeks prior to the study, were tail docked, castrated and vaccinated with a Clostridial (5 in 1, Ultravac™) vaccination. Lambs were weaned at 3 months of age and a booster Clostridial vaccination was administered 2 weeks prior to the study. At this time the lambs were also shorn and provided with grain (lupins at approximately 200 g per lamb per day) in addition to pasture. In the feedlot, the lambs were fed a lupin-based commercial diet (EasyOne, Milne Feeds, 11.0 MJ/kg, 14.5% crude protein) specifically designed to fulfil all nutritional requirements and prevent occurrence of acidosis without the need to provide roughage such as hay. Feed was provided ad libitum, topped up daily between 09:30–10:00 h, in a modified self-feeder (Bromar sheep lick feeder, plastic inserts removed, L: 2.4 m, W: 1 m). The feeder was placed along the fence line with only one side accessible by the lambs and was modified by blocking a portion of the open trough with solid panels to provide 4 cm of trough length per animal (total accessible trough length of 80 cm). A minimum of 2 cm/lamb of trough space is recommended in the Australian Model Code of Practice for the Welfare of Animals: Sheep (2006) for ad libitum feeding (food available for up to 15 h/day).