Applied Animal Behaviour Science xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

What can the quantitative and qualitative behavioural assessment of videos of sheep moving through an autonomous data capture system tell us about welfare?

Emily P. Grant[a,b,*], Amy Brown[a], Sarah L. Wickham[a], Fiona Anderson[a], Anne L. Barnes[a], Patricia A. Fleming[a], David W. Miller[a,b]

[a] School of Veterinary & Life Sciences, Murdoch University, WA, 6150, Australia
[b] Cooperative Research Centre for Sheep Industry Innovation (Sheep CRC), Armidale, NSW, 2350, Australia

ARTICLE INFO

Keywords:
Sheep
Qualitative behaviour assessment
Welfare state
Footage

ABSTRACT

Sheep can be exposed to a variety of challenges and failure to adapt to these challenges can compromise their health and wellbeing. Regular monitoring of stock on large-scale or extensive systems may not always be possible, although recent technological advancements in automated data capture, such as walk-over-weighing (WoW), can make monitoring easier. The potential benefit of including behavioural assessment in such a system has yet to be tested. We investigated whether quantitative and qualitative behavioural assessment (QBA) methods could be applied to short video footage collected automatically within a WoW setup, to differentiate between sheep that were, presumably, in different (positive and negative) welfare states. Video footage was collected from 36 Merino sheep within the four treatment groups; Control (n = 12), Habituated to the WoW setup and human interaction (n = 8), Lame (n = 8) and Inappetent (n = 8). Habituated sheep were exposed to a low-stress handling regimen for six consecutive days prior to filming. At the same time, feeding behaviour was recorded by means of radio-frequency identification (RFID) technology to identify sheep suffering inappetence. Lame sheep were identified using a 6-point scoring system, and Control animals were selected ensuring that they were not Lame, Inappetent or Habituated. For QBA, the footage was presented, in a random order, to 18 observers. There was a significant ($P < 0.001$) consensus among the observers in their assessment of the behavioural expression of the sheep. Observers described the Habituated and Lame sheep as significantly more *focused/collected/assured* compared to the Control sheep ($P < 0.05$). There was no difference in observer scores between the Inappetent sheep compared to the Controls. A number of associations were found between the QBA scores and the quantitative behavioural measures recorded. Sheep that baulked more frequently at the entrance to the WoW system ($R_s = -0.70$; $P < 0.001$) or had a greater number of circling events ($R_s = -0.68$; $P < 0.001$) were described as more *reluctant/tense/wary*, while those that recorded faster walking speeds ($R_s = 0.65$; $P < 0.001$) or spent less time standing stationary ($R_s = -0.48$; $P < 0.01$) were described as more *focused/collected/assured*. We conclude that qualitative and quantitative behavioural measures can be used to identify differences in animal behaviour, presumably related to their welfare state, when applied to short video clips automatically collected in a WoW setup. These findings suggest that behavioural measures could be collected, practically, within automated biometric data capture systems to provide additional information to aid in the assessment of sheep welfare in extensive systems.

1. Introduction

The health and wellbeing of sheep can be subjected to a range of challenges within their production environments, not only from routine husbandry procedures, but also changes in management, social structure or environmental conditions (Hargreaves and Hutson, 1990; Wemelsfelder and Birke, 1997). The failure of sheep to adapt to these challenges can result in compromised health, reduced production, and economic losses (Barnes et al., 2008; Lynch et al., 1992; Rice et al., 2016). Producers are under increasing pressure from animal welfare groups to allocate more time and labour resources to monitor sheep welfare (Morris et al., 2012); however, larger-scale enterprises covering

* Corresponding author.
E-mail address: E.Grant@murdoch.edu.au (E.P. Grant).

https://doi.org/10.1016/j.applanim.2018.08.010
Received 11 January 2018; Received in revised form 8 June 2018; Accepted 6 August 2018

vast areas, and with limited labour and infrastructure inputs, have found it difficult to answer these demands (Petherick, 2006).

New technologies, such as animal radio-frequency identification (RFID) tags and automated biometric data capture, may allow for more efficient and cost-effective monitoring in both extensive and intensive sheep management systems. An automated biometric data capture technology used commercially is walk-over-weighing (WoW). In this system, livestock are trained to walk through a passageway containing weighing scales to gain a reward (e.g. access to water). As the animals walk through the passageway, an electronic ear tag reading panel records their identity along with the time and date of the event. Producers can thus identify live-weight changes, which may reflect changing states of animal health and welfare. Live-weight change alone cannot reflect the variety of welfare problems present in production environments, and collection of behavioural measures of animal welfare would therefore be beneficial if incorporated into automatic biometric data capture systems. Indeed, the success of the Pedigree MatchMaker system to match parentage in sheep with a similar success to DNA parentage testing (Kemmis et al., 2016), represents a strong example of how existing biometric data capture systems can be adapted to provide meaningful behavioural information. Much like the WoW system, this system utilises an electronic panel reader system, that records sheep movement data to identify associations between lambs and dams with the purpose of determining parentage (Richards and Atkins, 2007).

Visual assessments of animal behaviour can provide meaningful indicators of welfare and are commonly employed in many production industries (Mench and Mason, 1997; Webster, 2005). Indeed, most livestock producers would say that they find it reasonably easy to visually identify a sick sheep by the way the sheep stands, moves or interacts with conspecifics. Scientists call this 'behavioural expression', but we could also talk about 'body language' or 'demeanour' (Wemelsfelder et al., 2012). Body language reflects not only the animal's physical or physiological state, but potentially also its psychological (emotional or affective) state (Boissy et al., 2007; Murphy et al., 2014; Rutherford et al., 2012). Qualitative Behavioural Assessment (QBA) is a methodological approach for capturing the body language of animals in numerical terms that can then be analysed statistically (Fleming et al., 2016). QBA has been supported by many studies demonstrating significant associations with standard behavioural and physiological measurements relevant to welfare assessment (reviewed by Fleming et al., 2016). QBA is suited for on-farm application, being quick, easy to implement and non-invasive, as it simply relies on observers watching live or previously-captured video camera footage of the animals (Boissy et al., 2007; Wemelsfelder, 1997; Wemelsfelder et al., 2000; Wemelsfelder and Lawrence, 2001). Thus, QBA could be used with footage collected by a video camera system incorporated into an automated biometric data capture setup, such as WoW.

To date, few comprehensive protocols that target the assessment of both positive and negative welfare conditions in animals, on-farm, have been established. One of these, the 2004–2009 European Commission's Welfare Quality ® audit (European Union, 2011), captured positive aspects of welfare in cattle employing the QBA methodology (Keeling et al., 2013). The successful identification of signs of positive welfare on farm would provide an additional assessment that would extend the value of on-farm monitoring of welfare for farm animal management guidelines (Edgar et al., 2013; Farm Animal Welfare Council, 2009; Webster, 2011).

We hypothesised that QBA and quantitative behavioural measures could be applied to short video camera footage, collected automatically within a WoW setup, to differentiate between sheep that were selected based on differing conditions of presumed welfare, both positive (+ve) and negative (−ve), i.e. (1) inanition (-ve: Barnes et al., 2008; Besier et al., 2010); (2) lameness (−ve: Goddard et al., 2006; Lynch et al., 1992); and (3) habituated to WoW setup and human interaction (+ve: Manteuffel et al., 2009).

2. Materials and methods

These experiments were approved by the Animal and Human Ethics Committees at Murdoch University (R2598/13; O2780/15; 2008/021) to ensure compliance with the guidelines of the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes, the Australian Code for the Responsible Conduct of Research 2007, and the National Statement on Ethical Conduct in Human Research, 2007. The experiment was conducted at a private sheep property, Wellard La Bergerie feedlot, located in Mundijong, Western Australia (WA) (Latitude: 32.3 °S; Longitude: 116.0 °E).

2.1. Animals and housing

All sheep used in the study were selected from a source population of 877 one-year old Merino wethers (castrated males) that had arrived at the feedlot from several farms within the South-West region of WA. All sheep used in the study were housed in three raised feedlot pens (about 270–300 sheep per pen), with dimensions of 10 × 25 m, on mesh floors that were under cover with solid sides 0.7 m high and then open to the roof. All sheep had *ad libitum* access to clean water and pelletised feed, with feed and water troughs refilling automatically.

2.2. Experimental groups

Sheep were observed over a week to identify individuals that represented each of the four treatment groups, which were then filmed on Day 7 after arrival at the feedlot.

2.2.1. Inappetent group

Inanition, or the persistent and voluntary refusal to eat, causes a significant negative welfare state in sheep (Barnes et al., 2008; Besier et al., 2010). All 877 sheep in the study were fitted with RFID ear tags upon arrival at the feedlot (Day 0). The feed troughs were fitted with antennae to detect the RFID tags when the sheep had their heads in the trough. A feeding session was allocated to a sheep when their RFID tag was within range of the antennae for more than 5 s, and the total time and number of visits to the feed troughs was recorded. The feed trough attendance data was collected over six consecutive 24-h periods, and the frequency distribution of daily feed trough attendance was used to select animals for the Inappetent group. Eight sheep were selected as being in a state of inanition, based on trough attendance data indicating that an individual's average daily attendance over the six testing days was more than two standard deviations below the mean. These animals were filmed for assessment purposes on Day 7 after arrival at the feedlot.

2.2.2. Lame group

Lameness is recognised as a major negative welfare state in sheep (Goddard et al., 2006; Lynch et al., 1992). For 6 days after arrival at the feedlot, sheep suspected of being lame were identified and filmed. The video camera footage was viewed by two independent assessors to confirm the level of lameness. The assessors were experienced in evaluating sheep lameness and scored the sheep in the present study in accordance to a 0–6 lameness scale for sheep (Kaler and Green, 2008). Eight sheep were selected for the Lame group, with an average lameness score of 2.25 ± 0.32 (range 1.25–4.00), for filming and assessment on Day 7 after arrival at the feedlot.

2.2.3. Habituation group

Research has demonstrated that the habituation process can lead to animals displaying or exhibiting positive aspects of welfare state (Manteuffel et al., 2009). After arrival at the feedlot, a group of 51 sheep were randomly allocated to a separate pen from the rest of the sheep for the duration of the study. Daily, for 6 days, these sheep were calmly taken to an adjacent WoW setup and, as a group, gently moved