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Qualitative Behavioural Assessment of the Motivation for Feed in Sheep in Response to Altered Body Condition Score

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ABSTRACT

Qualitative behavioural assessment (QBA) has been used to quantify the expressive behaviour of animals, and operant tests have been used to quantify measures of behavioural need. In this study we compared measures of behavioural expression and behaviour in operant tests. We examined the behavioural expression of pregnant ewes of body condition score (BCS) 2 and 3. The ewes were exposed to a feed motivation test in which they received a food reward. Pregnant ewes (48–70 days gestation) were assessed during a food motivation test after they had been maintained at BCS 3 (n = 7) or given a decreasing plane of nutrition that resulted in slow loss of 1 BCS unit (over 10–12 weeks; n = 7) or a fast loss of 1 BCS unit (over 4–6 weeks; n = 7). The feed motivation test involved ewes having the opportunity to approach a food reward and then being moved a given distance away from the reward by an automatic gate; they could then subsequently return to the feeder. Continuous video footage of each ewe during one cycle of the gate (approaching and returning from the food reward) was shown in random order to 11 observers who used their own descriptive terms (free-choice profiling methodology; FCP) to score the animals using QBA. Data of the assessment were analysed with generalised Procrustes analysis (GPA), a multivariate statistical technique associated with FCP. The research group also quantified the feeding behaviour of sheep in the same clips. These behaviours included how sheep approached the feeder, behaviours exhibited at the feeder, and how sheep returned from the feeder. There was consensus amongst observers in terms of their assessment of behavioural expression of the sheep (P < 0.001). The GPA found three main dimensions of assessed behavioural expression in the sheep, which together explained 44% of the variation observed. GPA dimension 1 differed between the three treatment groups (P < 0.05): ewes maintained at BCS 3 scored low on GPA dimension 1 (i.e. were described as more calm/bored/comfortable) compared with ewes that had a slow declining BCS (described as more interested/anxious/excited). GPA dimension 2 scores were not significantly different between treatment groups. However, quantitative behaviours exhibited by sheep during the clips were correlated with qualitative behavioural assessments made by the observers. Animals that spent more

time 'sniffing and looking for more feed' were attributed lower GPA 2 scores (described as more hungry/searching/excited) (P < 0.05), and animals that 'did not walk directly to the food reward (but stopped along the way)' were attributed significantly higher GPA 2 scores (more curious/intimidated/uneasy) (P < 0.01). GPA dimension 3 scores also did not differ between the treatment groups; however, sheep that had a higher number of feeding events during the entire 23-h feed motivation test were attributed lower GPA dimension 3 scores (they were described as more hungry/bold/interested) (P < 0.05), and sheep that consumed a larger amount of the feed reward were attributed higher GPA dimension 3 scores (more curious/concerned/reserved) (P < 0.05). We conclude that QBA is a valuable method of assessing sheep behavioural expression under the conditions tested, in that it provided an integrative characterisation of sheep behavioural expression that was in agreement with quantitative behavioural measures of feeding.

Introduction

It is common for livestock to be exposed to variation in nutrition throughout the year, and consequently, body reserves can vary quite dramatically (Adams and Briegel 1998). Variation in body reserves may be especially significant for animals during gestation or lactation, when there are already substantial demands upon the energy systems to support young. It is possible that during periods of food restriction, animals lose body condition at a fast rate (weeks) or at a slow rate (months), depending on the severity of food restriction. However, it is not known what effect different rates of body condition loss have on ewe welfare, in particular on the welfare of pregnant ewes, which require sufficient energy to support the growth of the fetus. Body condition score (BCS) is a useful indicator of the quantity of body reserves available and is therefore a useful measure within the animal production industry (Dziuk and Bellows 1983; Smith and Knight 1998). It is particularly important from a welfare point of view as an animal health indicator or an indicator of need for supplementation, particularly in times of drought (Kingwell 2002).

Quantitative studies of behaviour have demonstrated several effects of variation in BCS in sheep. In operant conditioning (behavioural demand) tests where sheep were required to work for access to food (Verbeek *et al*. 2011), sheep that had a lower BCS (BCS 2) or short-term fasted animals were demonstrably more motivated to obtain food than higher BCS or satiated animals (Verbeek *et al*. 2011, 2012). Motivation was quantified by the speed of approach to the feeding station and numbers of rewards consumed. In observational studies, low BCS or fasted sheep have also been shown to have increased feeding motivation as indicated by increased intake rates and bite mass (Newman *et al*. 1994; Sibbald 1997). Other behaviours, such as aggression (Bouissou 1972), activity (Toscano *et al*. 2007), and stereotypies (Robert *et al*. 2002), may also be affected by nutritional state.

Qualitative behavioural assessment (QBA) is an integrative assessment of an animal's behavioural expression (Wemelsfelder *et al*. 2001). It examines not what the animal is doing but how. For example, assessments may determine if an animal is standing in a *relaxed* manner or in an *alert* or *focussed* manner. Previous QBA studies have shown significant agreement between observers in their assessment of pigs (Wemelsfelder *et al*. 2000, 2009; Wemelsfelder and Lawrence 2001; Rutherford *et al*. 2012), cattle (Rousing and Wemelsfelder 2006; Brscic *et al*. 2009; Stockman *et al*. 2011, 2012, 2013), buffalo (Napolitano *et al*. 2012), sheep (Wickham *et al*. 2012), horses (Napolitano *et al*. 2008; Minero *et al*. 2009; Fleming *et al*. 2013), poultry (Wemelsfelder 2007), and dogs (Walker *et al*. 2010).

The usefulness of QBA for welfare assessment is supported by significant correlations with quantitative analyses of behavior (aggressive head butting in intensively housed cattle; Rousing and Wemelsfelder 2006) and physiological stress responses (in transported cattle; Stockman et al. 2011). The usefulness of QBA for welfare assessment would be strengthened if QBA were shown to agree with other quantitative measures of behavior and husbandry parameters.

A key objective of the present study was to determine the relationship between QBA and quantitative measures of behaviour of sheep during feeding motivational assessment. In this study, it was hypothesised that observers would be able to distinguish between pregnant sheep of different BCS based on their behavioural expression during a feed motivation test. The aims of these experiments were therefore to: (1) determine whether observers could reach consensus in their assessment of the behavioural expression of the sheep; (2) determine whether observers could distinguish between experimental treatment groups based on their behavioural expression; (3) relate QBA scores to measures of quantitative behaviour that are indicative of the animals' affective state.

Methods

Animals

The animals formed part of an experimental flock used in another experiment and they had been measured for feed motivation as part of this study (Verbeek et al. 2012). Starting 60 days before mating, 21 pregnant Coopworth ewes (2–5 years of age) were fed to BCS 3. Once mated, ewes were maintained at BCS 3 until day 35 of gestation and then randomly allocated to three feeding treatments balanced for bodyweight and BCS. All ewes assessed as part of this study were twin-bearing. In one treatment, ewes were maintained at BCS 3 (maintained; $n = 7$). Ewes in the other two treatments were exposed to a decreasing plane of nutrition resulting in a decrease of 1BCS unit (corresponding to an average loss of 5 kg) over 4–6 weeks (fast; $n = 7$) or a decrease of 1 BCS unit over 10–12 weeks (slow; $n = 7$). For the 'fast' group, this corresponded to a loss of 0.8–1.3 kg/week, and for the 'slow' group to around 0.4–0.5 kg/week. Feed motivation was assessed between days 48 and 70 of gestation. At the time of the feed motivation test, ewes had a wool length of ~4 cm and the difference in BCS between treatment groups would not have been visually evident to QBA observers.

During the study, ewes were kept on pasture and supplemented with a mixture of two different pellet rations: Camtech pellet (Dunstan Horse Feeds, Camtech Nutrition Ltd, Hamilton, New Zealand), 9.8 MJ/kg dry matter content (DM), 14.3% crude protein (CP), and 47.4% neutral detergent fibre (NDF) of DM; and Seales pellet (Seales Winslow, Morrinsville, New Zealand), 12.4 MJ/kg DM, 9.7% CP, and 21.3% NDF of DM. The two pellet rations were fed in varying amounts during the study so that targeted BCS could be attained. Ewes were scored for body condition by palpation of the lumbar region by a trained assessor and weighed once a week. Stocking rate and pellet supply were adjusted to reach the desired BCS within the desired timeframe.

Feed motivation test

The feed motivation test was designed using four identical testing races, each used to test one ewe at a time (Fig. 1). Sheep were trained in the feed motivation test races over 6 months (before mating) to familiarise them with the apparatus, food reward, and procedure. For a detailed description of the feed motivation procedure, see Verbeek et al. (2011, 2012). In summary, the apparatus consisted of a reward end and a home end. To minimize isolation stress during the tests, companion sheep were confined in a separate enclosure at each end of each race. The race had a transverse metal gate that was programmed to give the sheep access to a feeding station at the reward end. A sensor placed above the

feeder detected the presence of a sheep. Upon detecting a sheep, a food reward was delivered (the same pellet ration used in the animal's daily diet). After 20 s, an auditory signal was sounded for 2 s and then the gate was programmed to move the animal slowly away from the reward and towards the home end of the pen. After the transverse gate had moved 6.9 m, the gate returned to the reward end to once again allow access to pellets. The animal could choose to walk back to the feeding station at the reward end to obtain another feed reward. The reward size of 4.2 g was kept constant for all BCS treatments. Each of the sheep had the opportunity to repeat this process as many times as it chose, without restriction, during the 23-h test period. Following this period the residual feed that had not been delivered as a food reward was weighed so that individual intake could be calculated. Test and companion sheep had *ad libitum* access to water throughout the test period. Test sheep were housed in individual pens on the day before the test and were fed their daily ration.

Qualitative behavioural assessment

A video camera was positioned on the moving gate. This resulted in footage of the sheep walking (towards the camera) to the reward end, eating the reward, and then walking away from the camera. One video clip was chosen within the first 30 min of the feed motivation test for each sheep. Each video clip included one feed motivation sequence (gate moving from home end to reward end, feeding period, and gate moving from reward end back towards the home end). The clips were on average 2 min in length. The selection process was based on selecting the first available clip of the animal, or if this clip did not have the sheep clearly in view or the behaviour of the sheep was influence by outside factors (e.g. a person walking past the race), the next suitable clip was chosen.

Eleven observers were recruited from University staff and students and members of the public by advertising via email and accepting all those that responded. Each observer was required to complete a term generation session and a subsequent quantification session by correspondence. Observers were given detailed instructions on completing the sessions but were not told about the experimental treatments. It was necessary to explain the feed motivation test to observers and that sheep were habituated to the test before the study taking place. The two sessions are detailed below and they follow a procedure derived from a free-choice profiling (FCP) methodology developed by Wemelsfelder *et al.* (2001).

Session 1. Term generation

Observers were shown six clips of sheep that were also shown in session 2. Clips were chosen that included a wide range of behaviour. After watching each clip, observers were given 2 min to write down any words that they thought described that animal's behavioural expression. There was no limit imposed to the number of terms an observer could generate, but terms needed to describe not *what* the animal was doing (i.e. physical descriptions of the animal such as vocal, walking, sniffing, chewing), but *how* the animal was doing it. Subsequent editing of the observer terms was carried out to transform terms to the positive where required for ease of scoring (e.g. *unhappy* became *happy*). Terms were subsequently formatted in a list in an excel worksheet, with each term attached to a 100-mm visual analogue scale ranging from 0 = minimum to 100 = maximum for quantification during session 2. Terms with similar meaning were not listed together, and within these constraints, the order of terms in the list was random.

Session 2. Quantification

Observers were shown the 21 clips of the sheep of the three BCS treatments (one clip per sheep) in random order. Each observer used their own terms to quantitatively score (by marking on the visual

analogue scale) the behavioural expression of individual sheep. Each sheep was scored on every term generated by each observer.
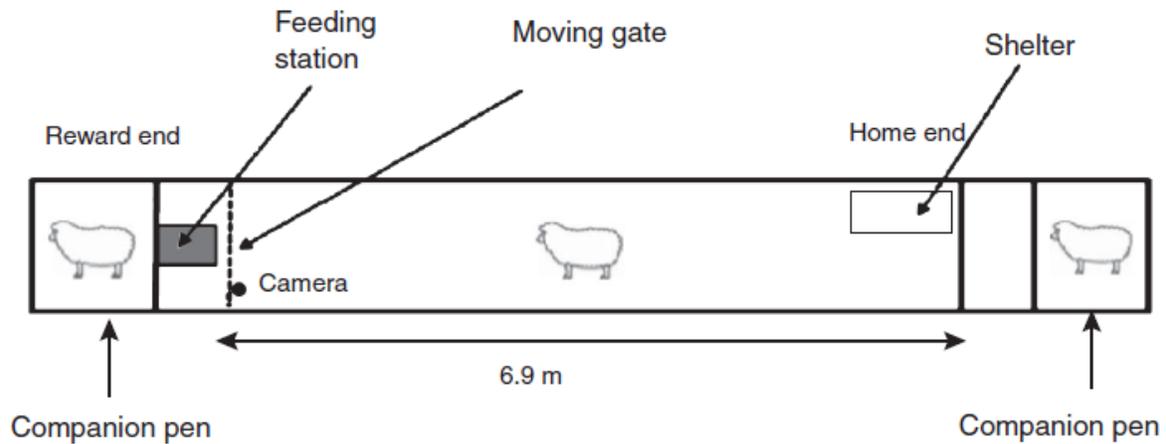

Fig. 1. One of the four motivation testing races where sheep were filmed for qualitative behavioural assessment (adapted from Verbeek *et al.* 2011).

Quantitative behaviour assessment

Following QBA sessions, quantitative behaviours were scored in each clip by the research group. The presence of particular behaviours during the clips was assessed by a yes/no process as follows:

Approaching the feeder

– did not move initially towards the feeder

– chased the gate the whole way to the feeder

– moved halfway down the race to feeder, stopped, and then moved to feeder

At the feeder

– put its head immediately into the feeder

– pawed at the feeder

– looked about while at the feeder

– sniffed and looked for more feed

Upon return from feeder

– pushed back by gate after feeding

– moved away from the gate after feeding before being forced back by the gate

Feeding behaviour was assessed during the entire 23-h feed motivation test to assess links with QBA dimension scores. The behaviours assessed included total number of feeding events, total feed intake, and average reward size consumed by the sheep at each feeding event.

Statistical analyses

The distance (mm) from the start of the visual analogue scale to where the observer had made a mark was measured and these measurements were entered into individual observer Excel (Microsoft Excel 2003, North Ryde, NSW) files. These data were submitted to statistical analysis with generalized Procrustes analysis (GPA) as part of a specialised software package written for Françoise Wemelsfelder (GENSTAT 2008, VSN International, Hemel Hempstead, UK; Wemelsfelder *et al.* 2000). For a detailed description of its procedures, see Wemelsfelder *et al.* (2001).

Briefly summarised, GPA calculates a consensus or 'best fit' profile between observer assessments through complex pattern matching. GPA provides a statistic (called the Procrustes statistic) which indicates the level of consensus (i.e. the percentage of variation explained between observers) that was achieved. Whether this consensus is a significant feature of the dataset or, alternatively, an artefact of the Procrustean calculation procedures is determined through a randomisation test (Dijksterhuis and Heiser 1995). This procedure rearranges at random each observer's scores and produces new permutated data matrices. By applying GPA to these permutated matrices, a 'randomised' profile is calculated. This procedure is repeated 100 times, providing a distribution of the Procrustes statistic indicating how likely it is to find an observer consensus based on chance alone. Subsequently a one-way *t*-test is used to determine whether the actual observer consensus profile falls significantly outside the distribution of randomised profiles.

Through principal components analysis (PCA), the number of dimensions of the consensus profile is reduced to several main dimensions (usually 2 or 3) explaining the variation between animals. Each animal receives a quantitative score on each of these dimensions. To compare the different BCS treatments, the GPA scores for each dimension were analysed by one-way ANOVA, with BCS treatment as a factor (Statistica 9.0, 2001, StatSoft, North Melbourne, Vic.).

The GPA dimensions were interpreted by correlating the animals' scores to the observers' individual scoring patterns, producing word charts describing the consensus for individual observers that can be compared for linguistic consistency. From these word charts, a list of terms describing the consensus dimensions was produced, by selecting terms for each observer that correlated strongly with those dimensions.

The score that each animal received on each of the main consensus dimensions was used to investigate the relationship between qualitative behavioural assessments of the sheep and quantitative behavioural data recorded in this study. For each individual animal, the quantitative behaviour that was measured for each clip (categorical predictor, scored as yes or no) was compared with its scores for each GPA dimension (dependent variable) using one-way ANOVA (StatSoft Statistica 8.0). For quantitative feeding behaviours recorded over the entire 23-h test period, each feeding behaviour (e.g. total number of feeding events, total feed intake, and average reward size consumed) was compared with the animals qualitative behavioural assessment scores (for each GPA dimension) by Pearson's correlation (Microsoft Excel 2003).

Data are presented as means ± 1 standard deviation, and a statistical level of $\alpha \leq 0.05$ was used throughout.

Table 1. Terms used by observers to describe the behavioural expression of sheep in three body condition score (BCS) treatment groups recorded during a feed motivation test.

Terms for all observers showing correlation with dimensions 1, 2, and 3 of the generalised Procrustes analysis (GPA) consensus profile (% of variation in behavioural expression accounted for by each dimension). Order of terms is determined first by number of observers to use that term (in parentheses if greater than one) and second by weighting of each term (i.e. correlation with the GPA dimension).

GPA dimension	Low values	High values
1 (26.5%)	Descriptive terms $r <-0.5$: calm (2), bored, comfortable, quiet, positively occupied, relaxed, patient	Descriptive terms $r >0.5$: interested (4), anxious (3), excited (2), frustrated (2), searching (2), skittish, pushy, curious, unsure, attentive, worried, nervous, motivated
2 (21.4%)	Descriptive terms $r <-0.4$: hungry (2), searching (2), excited (2), interested (2), relaxed (2), inquisitive (2), confident, sure, eager, motivated, purposeful, resigned	Descriptive terms $r >0.4$: curious (2), intimidated, uneasy, tense, indecisive, cautious, confused, unsure, nervous, anxious, scared, aware, watchful, distressed
3 (11.1%)	Descriptive terms $r <-0.4$: hungry (2), bold, interested, pushy, calm, frustrated, purposeful, anxious	Descriptive terms $r >0.4$: curious (2), concerned, reserved, interested, watchful, frustrated, eager, anxious, dominant, scared

Results

The 11 observers participating in this study generated a total of 58 unique terms to describe the sheep they were shown (average 11 ± 4 terms per observer, range 7–19). The level of consensus shown between observer assessment profiles (the Procrustes statistic) was 44.7%, and this differed significantly ($t_{99} = 4.69$, $P < 0.001$) from the mean randomised profile (41.0 ± 0.8%). Three main GPA dimensions were described, explaining a total of 59% of the variation between animals (Table 1).

An example of one of the 11 observer word charts is shown in Fig. 2. The axes of the chart indicate the first two main dimensions of the consensus profile and indicate which of each particular observer's terms best correlate with those dimensions. To provide an overview of highly correlated terms for all observers, Table 1 lists terms with the highest positive and negative correlations with each GPA dimension and summarises the findings of treatment effects and correlative analyses with quantitative scores of behaviour observed either during the ~2-min clips or across the entire feed motivation test period. The mean GPA scores on dimension 1, 2, and 3 for observers' assessments of ewes from each treatment group are shown in Fig. 3.

The GPA dimension 1 was characterised by terms such as *calm*/*bored*/*comfortable* on the low end of the axis, and high values for this dimension were associated with terms such as *interested*/*anxious*/*excited*. Sheep that had a slow-declining BCS had a significantly higher GPA dimension 1 score (i.e. were also described as more *interested*/*anxious*/*excited*) than ewes maintained at BCS 3 (more *calm*/*bored*/*comfortable*) ($F_{2,18} = 2.86$, $P < 0.05$). The fast-declining BCS group was not significantly different from the other two treatment groups. No quantitative behaviours were significantly correlated with GPA 1 scores.
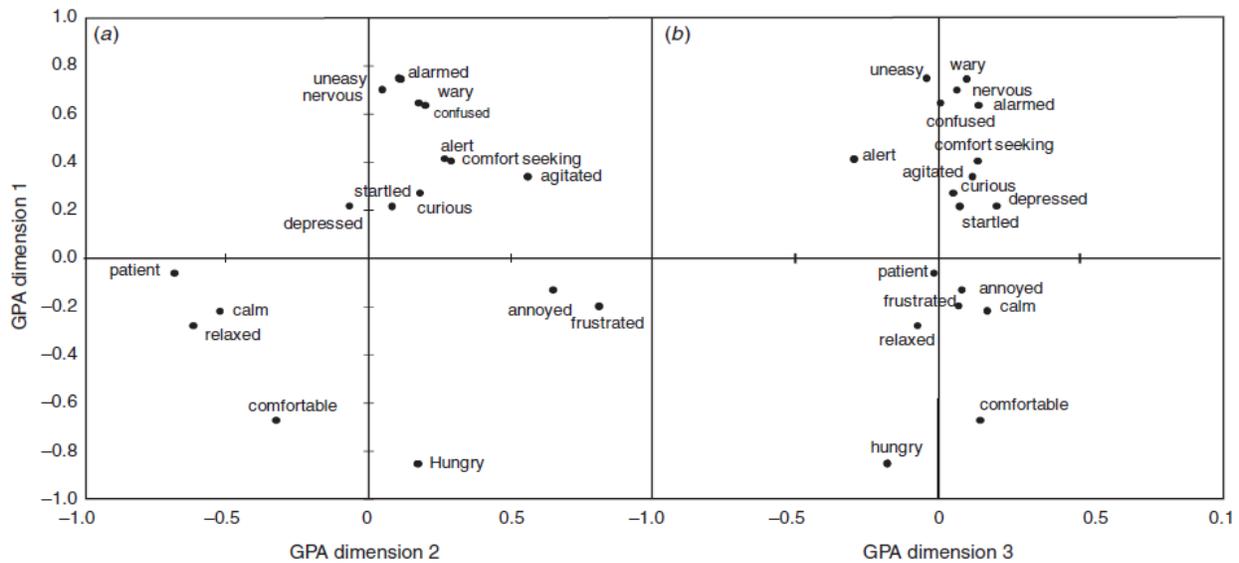
Fig. 2. Word map of consensus profile for GPA dimensions (*a*) 1 and 2, and (*b*) 1 and 3 for one observer.

The GPA dimension 2 was characterised by terms such as *hungry/searching/excited* on the low end of the axis, while high values for GPA dimension 2 were associated with terms such as *curious/intimidated/uneasy*. There was no significant BCS treatment effect on GPA dimension 2 scores ($F_{2,18}$ = 0.05, P = 0.995). This dimension was correlated with quantitative behaviour recorded during the ~2-min clips shown to observers. Animals scored as 'sniffing and looked for more feed' demonstrated significantly lower GPA dimension 2 scores (i.e. were also described as more *hungry/searching/excited*) ($F_{1,19}$ = 4.51, P < 0.05). Animals that 'did not walk directly to the food reward (but stopped along way)' demonstrated significantly higher GPA dimension 2 scores (more *curious/intimidated/uneasy*) ($F_{1,19}$ = 8.43, P < 0.01). The number of feeding events, total feed size, and average reward size were not significantly correlated with GPA 2 scores (Table 2).

Low values for GPA dimension 3 were characterised by terms such as *hungry/bold/interested*, and high values were associated with terms such as *curious/concerned/reserved*. There was no significant BCS treatment effect on GPA dimension 3 scores ($F_{2,18}$ = 0.25, P = 0.778). GPA dimension 3 was correlated with feeding behaviour that was measured over the entire 23-h feed motivation test period. Animals that had a higher number of feeding events during this period were attributed significantly lower GPA dimension 3 scores (i.e. were also described as more *hungry/bold/interested*) (r_{19} = −0.394, P < 0.05), and animals that consumed a larger amount of the feed reward were attributed higher GPA dimension 3 scores (more *curious/concerned/reserved*) (r_{19} = 0.414, P < 0.05).

Discussion

This study demonstrated consensus between observers in their assessment of behavioural expression in pregnant ewes of different BCS filmed during a 23-h feed motivation test, with the GPA consensus profile explaining around half the variation in scores between the observers. This indicates that a reasonable degree of variability in the behavioural assessments was left unaccounted for, which may be due to several underlying reasons, or combination of reasons, that cannot be easily identified without further investigation. Given significant consensus, however, an important measure of the consistency of observer

assessments is the ease and clarity with which its main dimensions can be interpreted and can be used to distinguish between experimental treatments. The observers used terms in a similar way, and it was possible to identify distinct clusters of words with similar meanings on each dimension.
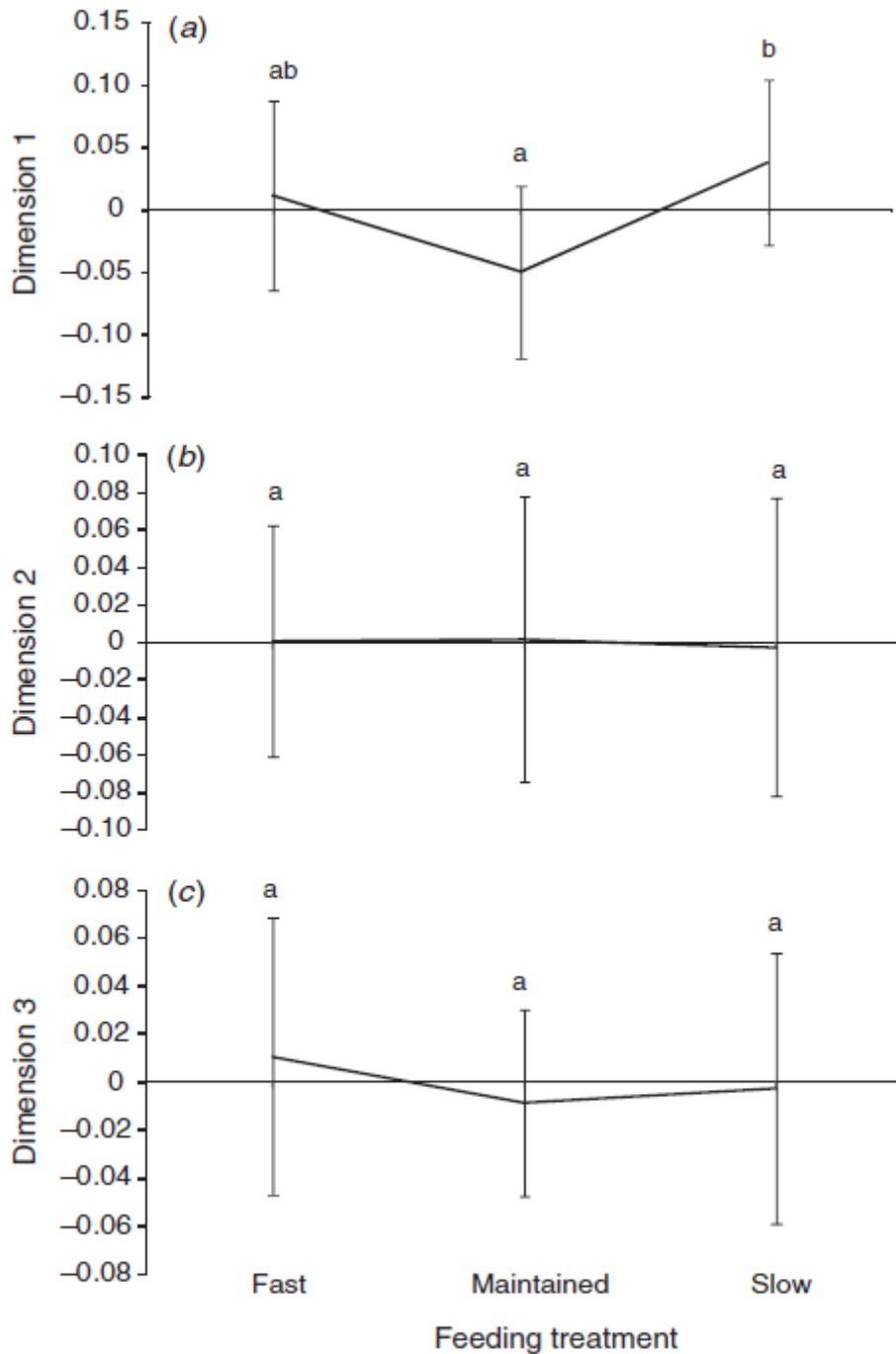

Fig. 3. Means (±s.d.) of observers GPA scores on (a) dimension 1, (b) dimension 2, and (c) dimension 3 resulting from assessments of sheep maintained at BCS 3 ('maintained') and exposed to a fast ('fast') or slow ('slow') decline in BCS. Within each dimension, the same letter links treatment groups that were not significantly different ($P > 0.05$).

Table 2. Correlation coefficients between quantitative scores of behaviour during the entire feed demand test period and behavioural expression scores (generalised Procrustes analysis, GPA dimensions 1, 2, and 3)

Significant correlations (r_{19}) are indicated by asterisk: *$P < 0.05$

	GPA 1	GPA 2	GPA 3
Number of feeding events	0.276	0.265	-0.394*
Total feed intake	0.133	0.077	0.030
Average reward size	-0.124	-0.121	0.414*

Scores for GPA dimension 1 differed significantly between the three treatment groups, and scores for GPA dimension 2 and 3 were correlated with quantitative scores of behaviour. These behavioural expression scores were therefore consistent with the experimental treatments and quantitative measures of feeding behaviour. An important finding of this study was that the observers' behavioural expression scores differed between the treatment groups. The relative position of sheep on the QBA dimension 1 varied depending on their BCS treatment, indicating that observers could differentiate between the behavioural expression of sheep that were maintained at BCS 3 and those that had a slow decrease of 1 BCS unit. The behavioural expression of sheep maintained at BCS 3 was described qualitatively as *calm*/*bored*/*comfortable* and sheep exposed to a slow decrease in BCS were described as *interested*/*anxious*/*excited* on dimension 1. QBA was carried out for ~2-min clips collected during a food motivation test. These results therefore support the ability to capture behavioural expression during even short clips, and provide context for the BCS treatments. The results of this study indicate the sensitivity of qualitative behavioural assessment to environmental contexts (in this case the feeding system), therefore making the assessment informative in an integrative sense. Other studies to demonstrate significant treatment differences in QBA scores include studies of sheep and cattle exposed to varying transport conditions (Stockman *et al.* 2011, 2013; Wickham *et al.* 2012), horses before *v.* after 1 month of intensive handling (Minero *et al.* 2009), or horses filmed at three stages of an endurance ride (Fleming *et al.* 2013). These studies also found differences in the animals' affective states between treatment groups. In particular, Fleming *et al.* (2013) found horses were more 'alert', 'curious', and 'excited' pre-ride and more 'tired', 'lazy', and 'sleepy' mid-ride and at the end of the ride. Minero *et al.* (2009) found that yearling foals responded to a month-long handling treatment and were seen to be more 'suspicious/nervous' and 'impatient/reactive' before handling, and 'explorative/sociable' and 'calm/apathetic' after handling.

This study also demonstrated that quantitative and qualitative assessments of behaviour could be meaningfully combined. Animals observed as 'sniffing and looking for more feed' were qualitatively characterised by observers as more *hungry/searching*/*excited*, whereas animals that paused when returning to the feeder were qualitatively characterised by observers as more *curious*/*intimidated*/*uneasy*. Measures of feed demand over the entire test period also correlated with qualitative assessment. Animals that had a higher number of feeding events during the entire 23-h feed motivation test period were qualitatively characterised by observers as more *hungry*/*bold*/*interested*. A previous study has shown that chronic deficits in energy intake affect feeding motivation of ewes, evident as the total number of rewards consumed (as well as maximum energy expenditure required to achieve these rewards) (Verbeek *et al.* 2012), and therefore the number of feed rewards consumed is likely to be indicative of hunger in animals. The correlation of terms used in the present study with quantitative behaviours indicative of hunger suggests that the hunger experienced by these animals could be evident in their interactions with the environment.

It is unclear why both of the BCS groups that lost weight were not assessed through QBA as both different from the maintained group. However, hunger, or the desire to eat, is a subjective feeling that is

not only influenced by internal endocrine signals, but also by external signals such as the smell and taste of food (Provenza *et al*. 1995; Ralphs *et al*. 1995), learned behavior (Kyriazakis *et al*. 1998; Villalba *et al*. 2008), and social factors (Penning *et al*. 1993). It may be that, due to many of the above factors impacting on the animals' desire to eat, the sample size was too low to achieve a significant effect, resulting in the group with fast BCS decline being similar to both the maintained and slow-decline groups. The length of time an animal is deprived of food has been found to influence feed motivation (Schütz *et al*. 2006). The results from Schütz *et al*. (2006) clearly showed that cows walk longer distances for food and were thus more motivated for food when deprived for a longer period. It may be that in the present study, sheep exposed to a long period of feed deprivation (slow group) were experiencing a higher level of hunger and motivation to feed than those sheep that had been feed deprived for a shorter period of time (fast group), resulting in the behavioural expression of sheep in the slow treatment group being different from the maintained treatment group and exhibiting an affective state indicative of hunger.

Conclusion

We conclude that QBA of pregnant ewes shows a significant difference between qualitative behaviours of ewes maintained at BCS 3 (described as more *calm/bored/comfortable*) and those that slowly lost BCS (described as more *interested/anxious/excited*). The significant association between quantitative and qualitative assessments recorded in this study illustrate how qualitative assessments add an interpretative element to quantitative analyses. This study indicates that QBA could prove useful as an objective measure to compare the desire to eat between animal groups and therefore give an indication of hunger. However, further studies are needed, possibly with larger numbers, in order to understand differences between hunger levels and how this affects an animal's qualitative behaviour.

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