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Regional Meeting

Massey University, Albany, New Zealand
27th October, 2016

The international, professional society devoted to the scientific study of applied animal behaviour

800		**Registration**
830		**Welcome**
845	*Mark Oliver*	*Maternal nutrition around conception and long term effects on the hypothalamic-pituitary-adrenal axis (HPAA), insulin secretion and behaviour in the offspring*
930	Andrew Fisher	Transported bobby calves: Do calf age, weight or colostral transfer influence lying behaviour during transit and hypoglycaemia?
945	Robert Holmes	A theoretical consideration of the welfare of animals experiencing non-chemical induction of immobility
1000	Gemma Lowe	The use of Infrared thermography and accelerometers as remote methods for monitoring dairy cow health and welfare.
1015		**Morning tea**
1045	*Kirsty Chidgey*	*Behavioural observations of sows and piglets housed in farrowing pens with temporary crating, or farrowing crates*
1115	*Mhairi Sutherland*	*Goats are not small cows!*
1145	Carolina Munoz	Assessing reliability, feasibility and seasonal variation in animal-based indicators in extensively managed ewes
1200	Melissa Hempstead	An overview of measures assessing pain associated with cautery disbudding in goat kids
1215	Clare Browne	Human Body Movements Give Unintentional Feedback During Dog Training
1220	Laura Deeming	Can a workshop alter dairy goat farmers' views on lameness?
1225	Charissa Harris	Electroencephalography for assessing pain in conscious sheep
1230	Kelsey Pool	The effect of mud on beef cattle preference for feedlot or pasture environments
1235	Dominique McCarthy	The effect of novel pain relief on the behaviour and weight gain of beef cattle following concurrent dehorning and castration
1240	Sarah Kuyken	Examining the reliability of a Horse Welfare Assessment Tool (HWAT)
1245	Rebecca Conner	Does Ambient Sound affect the behaviour and welfare of selected animals housed at Auckland Zoo: Pilot Study
1250		**Lunch**

1400	Ngaio Beausolei	Contrasting approaches to animal welfare assessment: Comparison of the Five domains model and Welfare Quality®
1420	Yu Zhang	Effect of gaseous ammonia on eating and ruminating behaviour in sheep in simulated long-distance transport by ship
1435	Kate Plush	The impact of increased dietary magnesium and month of mating on scratch scores of gestation sows
1455	Gosia Zobel	Is hoof trimming of pregnant dairy goats important?
1510	Karen Mancera	The effects of acute exposure to mining machinery noise on the behaviour of eastern blue-tongued lizards, *Tiliqua scincoides*
1525	Lorelle Barrett	Differences exist in the pre-laying behaviour of floor-laying and nest-laying Pekin ducks
1540	Jessica Monk	Assessing the relationship between immune competence and behavioural traits in sheep
1555	**Close**	

Maternal nutrition around conception and long term effects on the hypothalamic-pituitary-adrenal axis (HPAA), insulin secretion and behaviour in the offspring.

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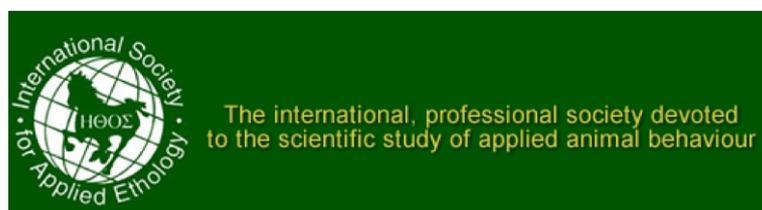[3]Formerly of AgResearch Ltd, Hamilton, NZ.
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The WW2 Dutch Famine studies suggest maternal nutrition around conception has lasting effects on endocrine regulation and obesity in the adult offspring. Periconceptional undernutrition (PCUN) of ewes resulted in premature activation of fetal HPAA and accelerated fetal pancreatic maturation. Long term effects of PCUN were examined in sheep offspring. Multiparous Romney ewes were undernourished from 60d before mating ('PCUN'). Feed restriction (~80% of controls, 'N') was maintained until 30d after mating and then ewes were *ad lib.* fed until term (147d). Offspring of were studied for cortisol and insulin secretion at 4, 10, 18 months and 3-4 years of age (at least 10 per group, per sex). At 18 months of age offspring were subjected to isolation and spontaneous locomotion tests. Sheep were DXA scanned for composition 3-4 years of age and euthanised for study of central HPAA components. Data were analysed by ANOVA and multiple regression. All stated effects represent $p < 0.05$. Plasma cortisol responses to i.v. arginine vasopressin and corticotrophin releasing hormone co-challenge (AVP+CRH) and insulin responses to glucose were reduced in PCUN offspring of both sexes at 10 and 18 months of age. Cortisol responses to isolation mirrored the AVP+CRH tests while PCUN offspring travelled 10 % less distance over 24 hours than N. By 3-4 years of age cortisol responses were not different but insulin response to glucose remained suppressed. PCUN males had 20% more fat mass than N males at 3-4 years of age. Methylation, mRNA and protein expression of hypothalamic glucocorticoid receptor and proopiomelanocortin were altered in PCUN animals. These studies indicate that peripheral HPAA may be differently affected by PCUN at certain life stages. Persistent effects of PCUN on central HPAA may influence behaviours like spontaneous locomotion, perhaps appetite and the development of obesity; in concert with observed effects on glucose-insulin homeostasis.

Animal ethics requirements
All experimentation was approved by the University of Auckland Animal Ethics Committee.

Mark Oliver is a physiologist with interests in metabolism, endocrinology and the developmental origins of adult disease. He is a former two term Animal Ethics Committee member, 2009 winner of (NZ) 3 R's award and member of the national Animal Welfare and Behaviour Consultative Committee.

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Transported bobby calves: Do calf age, weight or colostral transfer influence lying behaviour during transit and hypoglycaemia?

Andrew Fisher[1]*, Bronwyn Stevens[1], Melanie Conley[1], Ellen Jongman[1], Sue Hides[1] and Peter Mansell[1]

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Previous research has indicated that varying transport durations up to 12 h did not influence bobby calf welfare responses. However, there was considerable variation in lying during transit and some calves completed the 30-h period of transport and feed withdrawal with low blood glucose concentrations <2.8 mmol/l (Fisher et al., J. Dairy Res. 81:297, 2014). Accordingly, the objective of this study was to reanalyse that dataset to determine whether pre-transport factors influenced calf lying behaviour during transit and final blood glucose concentrations. Male Holstein-Friesian dairy calves (n=59) that had received colostrum after birth were either 1) held in situ on farm (control; n=15); 2) transported for 6 h (n=14); 3) transported for 12 h (n=15); or 4) transported for 1 h to a holding facility where they were kept for 6 h and then transported for 5 h (n=15). The space allowance in transport was the industry standard of 0.3m^2 per calf. IceTag™ loggers recorded standing and lying behaviour of each calf, and blood data from the end of the total transport and feed withdrawal period were used in regression analyses to identify the influence of calf age (5 to 9 days), weight (25 to 50 kg) and colostral status (blood GGT concentrations from 12 to 1226 IU/L, where <200 IU/l is sub-optimal), on the proportion of time spent lying during transport, as well as on final blood glucose concentrations. Calves lay for 0 to 100% of the time in transit (mean = 32%). There was no influence of calf age, weight or GGT on the proportion of time spent lying during transport (all *P* > 0.05). However, there was a significant relationship between calf weight and final blood glucose (P = 0.03), with lower calf weight associated with a greater likelihood of low final blood glucose concentrations. It is concluded that calf weight may be a useful predictor of robustness during transport.

Animal ethics requirements
The work described in this abstract conforms to Australian law regulating the use of animals in research, and was approved by the institutional Animal Ethics Committee, operating under the *Victorian Prevention of Cruelty to Animals Act 1986*.

Andrew Fisher is Chair of Cattle and Sheep Production Medicine at The University of Melbourne. He works with colleagues at the Animal Welfare Science Centre, focusing on animal welfare issues in dairy production systems.
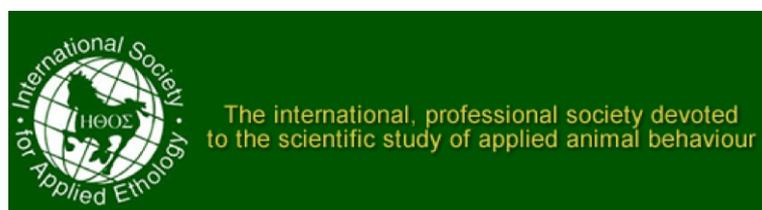
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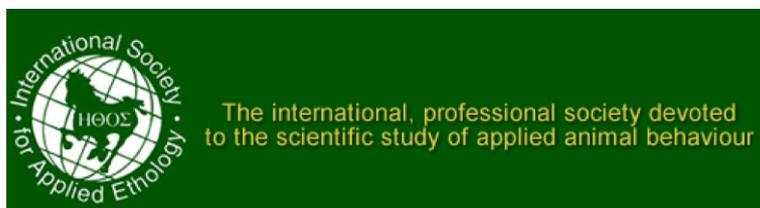# A theoretical consideration of the welfare of animals experiencing non-chemical induction of immobility

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Various immobility states of animals are induced by humans. Examples include: restraint of cats by "scruffing" for oral administration of medications; pressure on the upper lip of a horse with a twitch for minor surgical procedures such as suturing of superficial leg wounds; the use of tonic immobility as an index of fear in welfare assessment of domestic chickens; induction of tonic immobility in some shark species in anti-predator research; and the induction of immobility by dogs on stage as public entertainment. But what are the welfare implications to the animals when they are not rendered unconscious by chemical anaesthesia? Because an animal or person does not react with gross body movement to external environmental stimulation does not necessarily mean it is unconscious. For instance, pain may be perceived or negative emotional states experienced without changes readily observable to the human naked eye. Absence of proof of suffering is not proof of absence. This paper considers objective and subjective reports relevant to the affective states of animals and humans before, during and after the non-chemical induction of various immobility states. There are various mechanisms used on different species that produce immobility states that have been described with numerous terms. These immobility states may or may not have the same or similar neurophysiological characteristics. So-called "tonic immobility" can be readily induced in a number of species by restraint and inversion. But what are the feelings of an animal in which the homeostatic mechanism of balance is rapidly and severely disrupted? Anecdotal experience of the author suggests there is a widely held assumption that animals are not experiencing negative affective states associated with immobility that has not been induced by anaesthesia. Further, it is contended that there is sufficient evidence to question the validity of such an assumption. For instance, immobility states are reported by humans who have experienced severe mental trauma or violent physical assault. It is concluded that, given the use of immobility states in husbandry, research and entertainment, an assumption of absence of suffering during certain immobility states therefore deserves early, further and objective challenge.

Robert is a veterinary and animal behaviour graduate who consults and provides expert legal opinions on domestic animal behaviour matters. He is also formally associated with the Animal Welfare Science Centre.

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The use of infrared thermography and accelerometers as remote methods for monitoring dairy cow health and welfare

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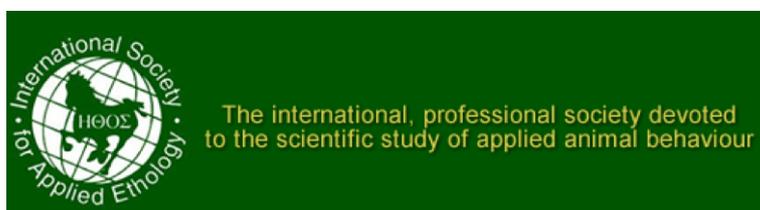[4] AgResearch Ltd, Ruakura Research Centre, New Zealand
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There is an increasing need for automated systems which can reliably monitor animal health and welfare remotely on farm. With the potential to be integrated into existing automated on-farm systems, the purpose of this study was to validate the use of infrared thermography (IRT) and accelerometers as methods to respectively measure respiration rate (RR) and the flinch step kick (FSK) response. Twenty-two Friesian and Friesian x Jersey cows (average 5 years old) were observed over a 6 minute period, which included a 2 minute baseline period, followed by 2 minutes in a crush, with a further 2 minute recovery period in the crush after being exposed to a startle. The startle consisted of someone standing near the head of the animal and shouting and repeatedly opening and closing an umbrella for 3 seconds. RR was measured by counting flank movements during live observations and video recordings and through observing nasal airflow from IRT recordings. The FSK response was measured continuously during the same period from video recordings which were analysed for leg movements, and from accelerometers which were attached to both of the animals' hind legs. There was no response to the startle, however, overall RR measured using IRT was correlated with RR as measured from both live observations (r = 0.79, P<0.001) and video recordings (r = 0.72, P<0.001). In terms of the overall FSK response, the accelerometers were found to be highly correlated with observations made from video analysis for FSK scores $\geq$ 2 (R^2 = 0.89, P<0.001) and moderately so for FSK scores $\leq$ 1 (R^2 = 0.66, P<0.001). In conclusion, IRT and accelerometers were found to be reliable methods for measuring RR and FSK respectively. Both methods have the potential to be incorporated into automated systems where they could be used to assess animal health and welfare.

Animal ethics requirements
All procedures involving animals in this study were approved by the Ruakura Animal Ethics Committee under the New Zealand Animal Welfare Act 1999.

Gemma is completing a PhD at the University of Waikato under Dr Mairi Stewart, Dr Mhairi Sutherland and Professor Joe Waas. Her Hons degree from the University of Waikato was focused on the use of infrared thermography and feeding behaviour as methods of early disease detection in New Zealand dairy calves.

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Behavioural observations of sows and piglets housed in farrowing pens with temporary crating, or farrowing crates

*Kirsty Chidgey[1]*, Patrick Morel[1], Kevin Stafford[1] and Ian Barugh[1]*

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Commercial pig farms commonly confine sows in farrowing crates to reduce pre-weaning piglet mortality. Sows are confined from 5 days prior to parturition until piglets are weaned at 28 days of age. As there are concerns for the welfare of sows confined in farrowing crates, pen-based alternatives have been developed. These farrowing pens provide sows with more space, allowing greater mobility and the potential for expressing a wider range of behaviours. This study compared sow and piglet behaviour in two farrowing systems on the same farm. In one system, sows were housed in farrowing crates from 5 days pre-farrowing until day 28 of lactation (N = 15 sows and 187 piglets born). In the other, sows were housed in crates from 3 days pre-farrowing until the fourth day of lactation, after which they were loose in a pen until day 28 of lactation (N = 16 sows and 178 piglets born). Sows and piglets in both farrowing systems were observed during days 1 – 6 post-farrowing. Behavioural observations were recorded each day from 0800 h – 1600 h using a fixed interval scan sampling method. Over four sessions each day, 100 observations lasting 30 seconds each were recorded for four sows and their piglets per farrowing system, per batch (N = 4 batches). Binomial sow data was analysed in SAS 9.2 after a Logit transformation (PROC GENMOD). Piglet behavioural data was calculated as the mean percentage of piglets in the litter displaying each behavioural parameter at a given time point. The statistical models for sow and piglet data included the fixed effects of the farrowing system, the period of observation (days 1 – 3 vs. days 4 – 6), and the interaction between these effects. Logit Lsmeans were then back transformed to calculate the % of scans during which each behavioural parameter (for sows and piglets) was observed. Sows in pens were observed whilst crated (days 1 – 3), and then when they were loose (days 4 – 6). Sows in both farrowing systems spent most of their time lying during days 1 – 6 (88 – 94% of the time in crates, and 72 – 94% of the time in pens). Sows in pens stood more ($P < 0.05$) and spent less time lying ($P < 0.05$) once they were loose compared to when they had been crated. Sows in pens also touched (($P < 0.05$), investigated ($P = 0.01$) and vocalised towards piglets more ($P = 0.01$) once loose. Piglets in pens spent less time inactive in open areas of the farrowing space (i.e. where the sow was located) compared to piglets in crates during days 1 – 6 ($P = 0.04$). Thus the farrowing system design influenced sow and piglet behaviour, with more interactions between sows and piglets in farrowing pens than in farrowing crates.

Animal ethics requirements
This study was carried out with the approval of the Massey University Animal Ethics Committee (MUAEC).
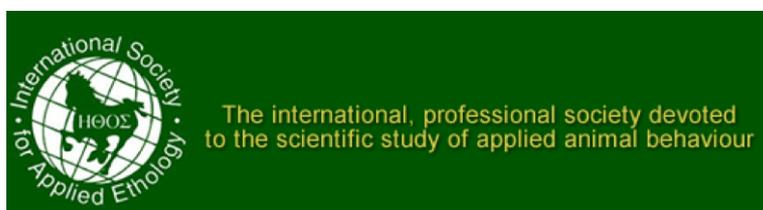
Kirsty Chidgey recently completed a PhD at Massey University. Kirsty's PhD investigated the performance and behaviour of sows and piglets housed in farrowing pens with temporary crating, or farrowing crates.
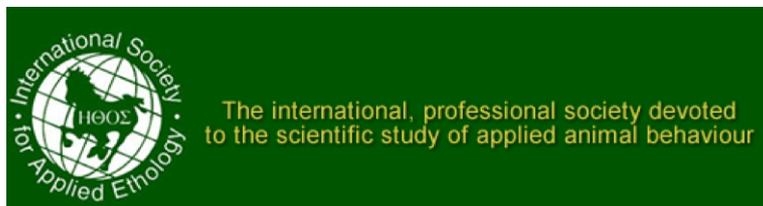
Goats are not small cows!

Mhairi Sutherland[1]* and Gosia Zobel[1]

[1]AgResearch Ltd, Ruakura Research Centre, Hamilton 3214, New Zealand
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Assessing animal welfare comes with many challenges. The animal welfare team at AgResearch has years of experience assessing welfare in cattle and developing management recommendations. Therefore, when a 6-year programme focused on developing best practice guidelines for the NZ dairy goat industry was funded, the team's minimal goat experience was not overly concerning. In fact – the general consensus was: "surely goats are similar to cattle, just smaller". Quite quickly, the inaccuracy of this statement became apparent. For example, the team has extensive experience evaluating pain mitigation strategies for disbudding in calves, and so the path seemed straightforward for designing related research for goat kids. Interestingly, toxicity to a commonly utilised nerve block and differences in the behavioural responses of kids compared to calves, meant that this approached had to be revisited. A similar contrast when designing studies to evaluate goat preference for lying surfaces was encountered. Intuitively, calves prefer to spend over 80% of their time on soft, dry bedding like sawdust, but recent findings have shown that goats prefer this bedding the least. As this research programme progresses, the thinking needs to shift, and what might seem intuitive based on previous experience needs to be challenged. Therefore, upcoming studies are aimed at designing goat-focused housing and feeding systems starting with the questions "how do goats eat?" and "how do goats rest?". Of course it is not surprising that while cows graze, goats browse, and while cows rest on soft surfaces, goats perch high on hard surfaces; ideal dairy goat management systems will need to focus on these differences. This programme will not only result in improvements to the best practice guidelines currently utilised by the dairy goat industry, it will also foster a deeper appreciation for considering goats as more than just small cows for scientist and farmer alike.

Mhairi is a senior scientist at AgResearch and has been involved in animal welfare research of dairy cattle, pigs and sheep. Her current interests are evaluation of different pain mitigation strategies and alternative methods of euthanasia for goat kids. Gosia is a scientist at AgResearch and has focused the majority of her research on end of lactation management in dairy cows and dairy goats, as well as on the housing and rearing of goat kids.
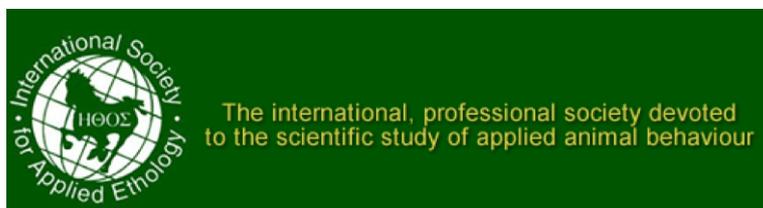
Assessing reliability, feasibility and seasonal variation in animal-based indicators in extensively managed ewes

Carolina A. Munoz[1]*, Angus J.D. Campbell[2], Paul H. Hemsworth[1] and Rebecca E. Doyle[1]

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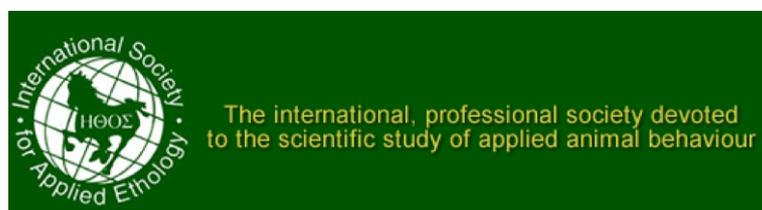* Author for correspondence: cmunoz@student.unimelb.edu.au

Welfare assessments for extensive sheep systems must incorporate indicators that are valid (meaningful to animal welfare), reliable (provide consistent outcomes when applied by different observers), feasible (practical under farm conditions), and able to detect seasonal variation in the welfare of sheep, as extensive systems have seasonal variation in both climate and food availability. This study investigated whether eight animal-based indicators of ewe welfare (body condition score (BCS), fleece cleanliness, fleece condition, skin lesions, dag score, foot-wall integrity, hoof overgrowth, and lameness) were appropriate for on-farm use in extensively managed sheep. The indicators were examined on 100 Merino ewes (aged 2-4) during late-pregnancy (LP), mid-lactation (ML) and weaning (WN) by a pool of nine trained observers. The ewes were marked within a flock of 3000 sheep, managed under commercial conditions, grazing annual/perennial pastures in a year-round outdoor system. Levels of observer agreement were determined by Kendall's coefficient (*W*) and Kappa statistics, and seasonal variation was assessed by McNemar's statistics (test for dependent dichotomous variables). Overall, good agreement (from 'moderate' (*W*=0.60) to 'almost perfect' (*W*=0.81)) were found for BCS, fleece condition, skin lesions, dag score and lameness. Seasonal variation was observed for BCS, dag score, hoof overgrowth (P<.0001 for all), skin lesions (P=0.014) and lameness (P=0.03). The occurrence of flystrike (recorded as skin lesion), hoof overgrowth and lameness increased at WN, and ewes had poorer BCS at WN than at ML. Results suggest that BCS, fleece condition, skin lesions, dag score and lameness are valid, reliable and feasible indicators for on-farm use, and they can also detect variation in the welfare of sheep in key periods of the production cycle. In general, ewes at ML and WN had poorer health than at LP, possibly due to a dry season, low pasture availability/quality and ongoing nutritional demands of the lambs.

Animal ethics requirements
The present study was approved by the University of Melbourne Animal Ethics Committee (ethical review number 1513562).

Carolina is completing a PhD at the University of Melbourne, Australia, on the relationship between farmer attitudes and sheep welfare under Dr. Rebecca Doyle, Angus Campbell and Professor Paul Hemsworth. Carolina completed her vet degree in Chile in 2010. In 2014, she completed her Master of Animal Science degree at Melbourne University where she studied the behaviour and welfare of group housed sows.

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An overview of measures assessing pain associated with cautery disbudding in goat kids

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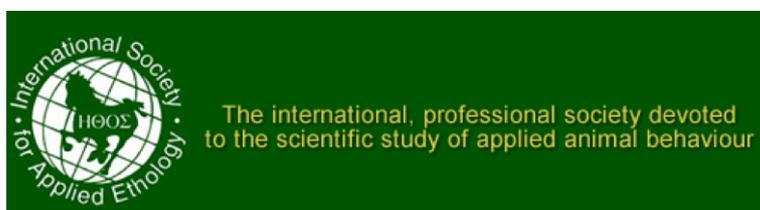* Author for correspondence: Melissa.hempstead@agresearch.co.nz

Without intervention, most goats will develop horns; however, to minimise injury to other goats and human handlers, goat kids are commonly disbudded during the first week of life. Disbudding is typically carried out with a cautery iron (to destroy horn bud cells) and without pain relief. Over 3 years, we used a range of measures to evaluate pain associated with disbudding including changes in behaviour and physiology and weight gain/loss. We aim to present an overview of useful measures of pain associated with cautery disbudding in goat kids and suggest potential measures for future studies. Assessment of behaviour during disbudding (e.g. vocalisations and struggling) and behavioural changes pre- to post-disbudding (e.g. head shaking, head scratching, lying/standing) reflect the duration of pain and changes over time; however, these measures can be affected by observer bias and are time consuming. Cortisol assessment can be useful as the hypothalamic pituitary adrenal axis is stimulated by painful experiences, although it is not without limitations: taking saliva or plasma to measure cortisol may cause stress, and cortisol is produced in response to events not necessarily associated with pain. Changes in cortisol concentrations due to disbudding, can reflect the intensity of a painful experience, providing a good measure of acute pain. Weight changes can reflect changes in feed intake associated with pain. Other measures of pain which have not been evaluated in kids include inflammation and pain sensitivity. Haptoglobin is an acute phase protein that increases in response to inflammation and can indicate inflammatory pain. Post-operative inflammation and associated skin temperature fluctuations, can be measured using infrared thermography. Pain sensitivity of the surrounding horn bud area can be measured using pressure algometry. Future research will determine whether these other potential measures of pain are useful for assessing pain associated with disbudding in goat kids.

Animal ethics requirements
All procedures involving animals were approved by the AgResearch Ruakura and University of Waikato Animal Ethics Committees under the New Zealand Animal Welfare Act of 1999.

Melissa is completing a PhD at the University of Waikato and AgResearch, investigating methods to improve current disbudding protocol for dairy goat kids, and is supervised by Professor Joseph Waas, Dr Mhairi Sutherland and Dr Mairi Stewart. She received a first class honours degree from the University of Waikato on the behavioural responses of goat kids to cautery disbudding.

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Human Body Movements Give Unintentional Feedback During Dog Training

Clare M. Browne[1,2]*; Nicola J. Starkey[1]; T. Mary Foster[1]; James S. McEwan[1]

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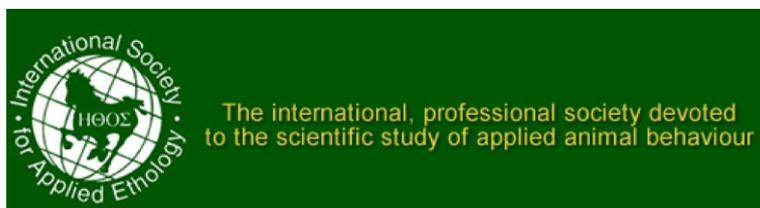* Author for correspondence: cbrowne@waikato.ac.nz

Behaviour problems are a leading reason for relinquishment of dogs, and dog training is associated with a reduced prevalence of behavioural issues. Earlier observational studies have shown that dog owners often delay the delivery of positive reinforcement during everyday dog training. Subsequent experimental research found that similar-length (1 s) delays to reinforcement have a detrimental impact on dogs' abilities to learn a novel task. Despite this, dog training is frequently successful. It was hypothesised that people provide unintentional feedback that might function as reinforcement, facilitating dogs' learning. The aim of this study was to investigate what signals owners may give to their dogs during training, in addition to intentional positive reinforcement which may be delayed. Twenty-one owners were filmed training their dogs to perform basic tasks (e.g., a nose-touch response). The footage was analysed for the order and timing of the events that followed the dogs' responses, including conditioned reinforcement (e.g., verbal praise), unconditioned reinforcement (e.g., treats), and human body movements. The most common sequence of events following a dog's correct response was for the owner to make a body movement, then to give verbal praise, followed by treat delivery. Owners made body movements as their first response in 75% of 287 trials (food was also delivered in 94% of these trials); 82% of these were hand movements. The average total trial time was 1.40 s (longer than the time that negatively impacted on dogs' learning in experimental conditions; Browne et al., 2014). However, the average delay to a body movement was just 0.32 s. Because body movements followed dogs' responses so rapidly and consistently, they probably functioned as conditioned reinforcers. Advice to people training dogs should emphasise speed and consistency when delivering feedback to dogs.

Animal ethics requirements
This research conforms with New Zealand laws and University of Waikato requirements regarding the use of animals and humans in research.

Browne, C. M., Starkey, N. J., Foster, T. M., & McEwan, J. S., 2014. Dog training: Reinforcement timing and owner body language. *Journal of Veterinary Behavior: Clinical Applications and Research, 9*(6), e17.

Clare Browne completed a PhD at the University of Waikato on the effects of delayed reinforcement on learning in dogs. Clare's MSc at Massey University examined the use of detection dogs for conservation work.

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Can a workshop alter dairy goat farmers' views on lameness?

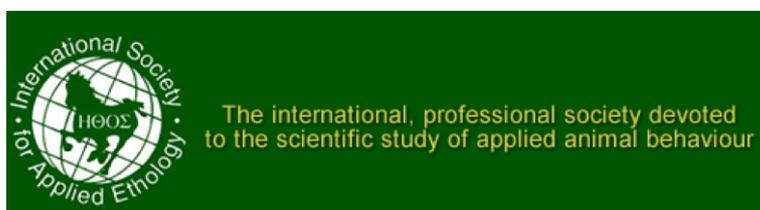*Laura Deeming[1,2], Ngaio Beausoleil[2], Kevin Stafford[2], Jim Webster[1], Gosia Zobel[1]*

[1]AgResearch Ltd., Ruakura Research Centre, 10 Bisley Road, Hamilton 3214, NZ.
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Lameness, a painful condition that impedes normal walking, is one of the most serious welfare issues faced by dairy animals. In dairy goats, knowledge about risk factors and identification of lameness is particularly limited, and therefore farmers may underestimate lameness prevalence on their farms. The aim of this study was to determine if farmer views towards lameness in dairy goats changed following a workshop. The workshop involved participants (n=26, Ontario, Canada dairy goat farmers) completing a questionnaire prior to a presentation and facilitated discussion about the impacts of lameness on welfare and production. Questions included whether they perceived lameness to be an issue on their farm, their hoof trimming regime and their opinion on the main cause of lameness. Following the facilitated discussion participants were asked to share ideas and allocate them to one of four themes: 1) not an issue (do nothing), 2) not an issue (educate the public), 3) issue (educate farmers), or 4) issue (do more research). Finally, farmers were asked to reflect upon how their opinion regarding lameness had changed. Prior to the workshop, 50% of the farmers (n=13) indicated that lameness was not an issue on their farm, while 46% (n=12) responded that there were mild or occasional lameness issues. The primary cause of lameness was thought to be infrequent hoof trimming. Following the workshop 73% (n=19) of participants stated that the information provided had altered their views on lameness, 15% (n=4) stated that their opinion had not changed, the remaining 12% (n=3) did not respond. Most farmers thought more research was needed regarding trimming regimes and hoof care, and more farmer education is required. These results suggest that workshops can be successful in educating farmers about the impacts of lameness and in turn can alter farmer views on this serious welfare issue.

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Electroencephalography for assessing pain in conscious sheep

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The use of electroencephalography (EEG) offers potential as an effective and practical way of measuring pain response and efficacy of analgesia in livestock. Two preliminary trials were conducted to: 1) Identify muscle artefacts impacting EEG signal quality in conscious sheep; and 2) Investigate EEG response to evoked potential using needle stimulation. Trial 1 was conducted using six hogget wethers sourced from the University of Sydney teaching flock, Cobbitty NSW. Lignocaine (1mL) was administered to electrode placement sites to minimise discomfort. Subdermal 12 mm, monopolar needle electrodes (29 gauge) made from surgical steel (ADInstruments, Ltd.) were placed in a three-electrode montage adapted from Murrell and Johnson (J. vet. Pharmacol. Therap. 29, 325–335, 2006). EEG was recorded using Powerlab® and LabChart® software (ADInstruments Ltd). Initial traces were bandpass filtered between 0.5-40Hz to obtain improved signals. Simultaneous video recording was used (Video Capture add on, LabChart ADInstruments) to identify artefacts caused by muscle movement, including blinking and head turns. Trial 2 was conducted to assess the EEG response to pin prick evoked potential, with removal of artefacts from Trial 1. Preliminary results for Trial 1 show distinct artefact patterns for head movement to the right, left, eye blinks, and chewing. Further analysis in Matlab (Mathworks®) is being used to characterise these artefacts for removal from recordings. Data cleaning will allow accurate detection of changes in EEG output, such as response to evoked painful stimulus in Trial 2. These results will enable more accurate recording of EEG in conscious sheep, allowing the progression of this method for use as a means of pain detection in conscious sheep during husbandry procedures. A future trial is planned to investigate EEG response to mulesing with and without analgesia following results from the above mentioned trials.

Animal ethics requirements
The experimental protocol was approved by the animal ethics committee of the University of Sydney (Approval No. 5382).

Charissa Harris is completing a Masters by research at the University of Sydney, under Dr Sabrina Lomax and Dr Peter White in the use of EEG as an on-farm tool for pain detection in sheep. Charissa is following on from undergraduate research in livestock pain detection and alleviation undertaken during the completion of a bachelor of animal and veterinary bioscience.
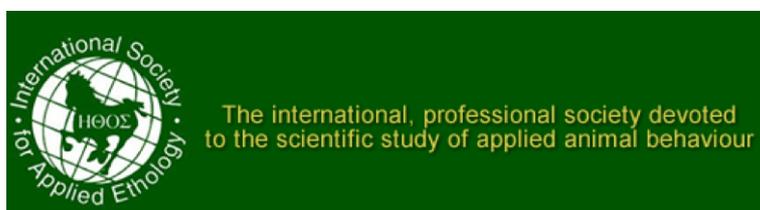
The effect of mud on beef cattle preference for feedlot or pasture environments

Kelsey Pool1,2, Jim Lea1, Ian Colditz1, Peter Thomson2, Caroline Lee1*

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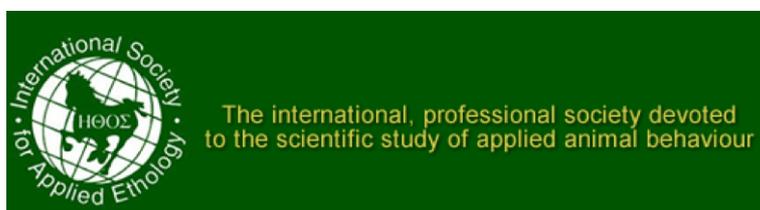2 University of Sydney, Werombi Rd, Camden, NSW, 2570
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The accumulation of mud and faeces in beef cattle feedlots promotes a negative public perception of animal welfare, though there is little evidence available demonstrating how mud affects the welfare and behaviour of beef cattle. The objective of this study was to determine the effect of increasing feedlot mud level upon cattle preference for a feedlot or pasture environment. A total of 60 12 month old Angus steers were tested to determine their preference for a pasture or feedlot environment across 3 feedlot pad scores (2 cohorts per pad score, 10 animals per cohort). Cattle were habituated to each environment for 10 days prior to testing and then were trained over 3 days to navigate the Y maze. Testing occurred twice daily (morning and afternoon) from alternating sides of a 'double Y maze' for 10 consecutive days, steers remaining in their chosen environment. Steers were fitted with IceTags^{TM} to record behaviours (time standing, lying and number of steps). Data were analysed using a logistic generalised linear mixed model in ASReml. Day of testing (P<0.0001), side tested (P=0.022) and time of day (P=0.043) were found to affect cattle preference, with cattle more frequently choosing pasture during the afternoon testing and preferring to lie at pasture. Level of mud did not affect the environmental preference of cattle. No behaviours were related to mud level. Overall this indicates that increasing mud level in a feedlot environment does not significantly influence the environmental preference of cattle. However, it should be noted that this study did not extend to include colder conditions which may increase the challenges of mud. Whilst a definite relationship between afternoon pasture preference and lying behaviour was observed, further studies to determine the welfare impacts of mud on cattle environmental preference and behaviour are needed during winter conditions.

Animal ethics requirements
The protocol and conduct of the study were approved by the McMaster Laboratory Animal Ethics Committee, under the New South Wales Animal Research Act 1985.

Kelsey is currently completing a bachelor of Animal & Veterinary Bioscience at the University of Sydney. Her Honours project aims to demonstrate the influence of feedlot mud level on cattle preference for feedlot or pasture environments

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The effect of novel pain relief on average daily gain of beef cattle following concurrent dehorning and castration

Dominique McCarthy[1]*, Peter White[1] and Sabrina Lomax[1]

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The aim of this study was to evaluate the effect of a topical anaesthetic (TA) and an oral-trans-mucosal (OTM) non-steroidal anti-inflammatory drug (NSAID) on average daily gain (ADG) of beef cattle following amputation dehorning and surgical castration. Two hundred and fifty beef bull weaner cattle were randomly allocated to one of five treatment groups: (1) sham castration and dehorning / positive control (CONP, n = 50); (2) castration and dehorning / negative control (CONN, n = 50); (3) castration and dehorning with a pre-operative OTM NSAID (N, n = 50); (4) castration and dehorning with a post-operative TA (TA, n = 50); and (5) castration and dehorning with the pre-operative OTM NSAID and the post-operative TA (NTA, n = 50). Body weights of all cattle were collected immediately prior to and 6 days post treatment. A subset of these cattle (20 per treatment group) were fitted with GPS units immediately post treatment. A further subset of these cattle (10 per treatment group) were also fitted with accelerometers immediately post treatment. The GPS and accelerometer units were removed 6 days post treatment, immediately prior to weighing. Data on ADG was subjected to restricted maximum likelihood (REML) for repeated measures using the mixed models procedure of Genstat® 17th Edition statistical software. GPS and accelerometer data is yet to be analysed. There was a significant effect of treatment on ADG (P < 0.001). CONP and NTA cattle had significantly higher ADG values than CONN cattle (-0.62 kg, -0.9 kg and -1.38 kg, respectively). N and TA cattle had ADG values intermediate of CONN and NTA cattle (-1.1 kg and -1.1 kg, respectively). Results yet to be obtained through analysis of the GPS and accelerometer data may add to the conclusions of this study by providing information on cattle spatial usage and locomotory behaviour.

Animal ethics requirements
The experimental protocol was approved by the animal ethics committee of the University of Sydney (Approval No. 5832).

Dominique is completing a PhD at the University of Sydney, on practical pain management for extensively raised beef cattle undergoing aversive husbandry procedures, under the supervision of Dr Peter White and Dr Sabrina Lomax.
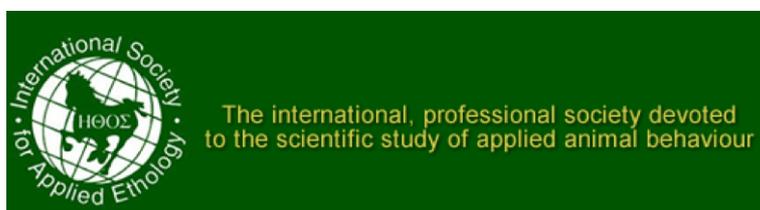
Examining the reliability of a Horse Welfare Assessment Tool (HWAT)

Sarah Kuyken[1]* and Dr Lauren Hemsworth [1]

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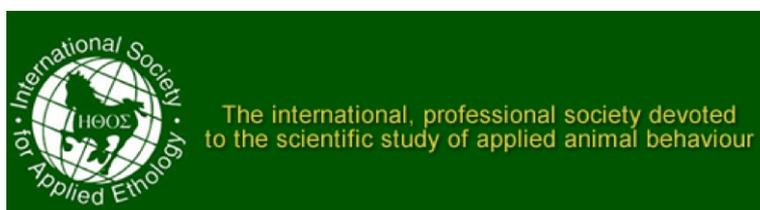* Author for correspondence: skuyken@student.unimelb.edu.au

The RSPCA reports that a significant proportion of the horse welfare cases investigated in Victoria, Australia are the result of neglect or mismanagement by the horse owner, due to ignorance rather than intentional abuse. The Horse Welfare Assessment Tool (HWAT) enables horse owners to measure and benchmark their horses' welfare over time, in order to improve their knowledge on effective horse management practices and awareness of their horses' welfare state. The HWAT consists of five animal-based horse welfare indices that were identified via an extensive literature review; body condition score (BCS), lameness score (LS), injury score (IS), hoof condition score (HCS) and dental condition score (DCS). BCS, IS and LS were heavily referenced in the literature, however HCS and DCS were developed for this study. In order to ensure that the HWAT is a valid measure of horse welfare, when applied by owners for self-assessment purposes, the inter- and intra-observer reliability of the welfare indices was examined in the field using a test-retest assessment. Participants were recruited via Victorian Horse Riding Clubs and data was collected using the HWAT during two on-site visits with horse owners and their horses. The HWAT assessments were performed by both the horse owner and the researcher at each visit in a blind manner. Data was analysed using Spearmans's rho (ρ) and Kappa statistics (κ). The results suggest that BCS and LS had acceptable levels of inter- and intra-observer reliability ($\rho > 0.50$ and $\kappa > 0.60$), however IS, HCS and DCS need further refinement and testing before they can be included in the final HWAT.

Animal ethics requirements
The work described in this abstract conforms with regional laws regulating the use of animals in research, and the ISAE Ethical Guidelines (see ISAE website www.applied-ethology.org). Animal Ethics and Human Ethics approval was obtained through The University of Melbourne, ID Numbers 1513549.1 and 1545373.1 respectively.

Sarah is a current PhD candidate at The University of Melbourne, studying the effect over time of equine welfare assessments conducted by horse owners using an electronic application that delivers feedback. This project is being conducted under the supervision of Dr Lauren Hemsworth and Dr Ellen Jongman. Sarah also holds a Diploma of Equine Podiotherapy and is a Polyurethane Horseshoeing specialist.

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Does Ambient Sound affect the behaviour and welfare of selected animals housed at Auckland Zoo: Pilot Study

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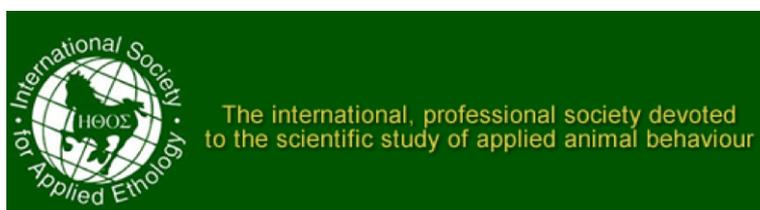[3] Faculty of Engineering, The University of Auckland, Private Bag 92019, Auckland 1142
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Animals in zoos are exposed to a diverse range of sounds, however little is known about whether this has a negative effect on the animal's welfare. This pilot study assessed the impact of the auditory environment on the behaviour of the solitary male emu (*Dromaius novaehollandiae)* and the two male blue and gold macaw (*Ara ararauna*) at Auckland Zoo. Behaviour observations were collected three days a week for 12 weeks between February and April. The 20 minute observational periods were undertaken four times a day during both opening and closing hours, and the observation day was rotated. Behavioural responses were measured using focal sampling with continuous recording and the ambient sound level (dB) and frequency (kHz) around the enclosure were recorded simultaneously. Noise level was considered independent of visitor numbers as recordings indicated most noise was generated by people in the direct vicinity of the microphone (e.g. vehicle noise). Each observation period was given categorical classifications for the average sound level and for sound level within low, medium and high frequency bands. The loudest and quietest 25% were classified as 'Loud' and 'Quiet' respectively, and behaviour was compared between them using a Wilcoxon signed rank test. The average volume of the observation periods affected behaviour of all individuals, but loud sounds at certain frequencies had a greater effect. The emu responded to loud low frequency sounds by decreasing vocalisations ($P < 0.01$) and the time spent eating ($P < 0.01$), while the two macaw responded to loud high frequency sounds by increasing flying (Blake: $P = 0.02$, Chico: $P < 0.01$). Results will also be used for the development of a larger study. The results are specific to individuals at Auckland Zoo, but findings from the long term study could be of value to the wider zoo industry.

Animal ethics requirements
The study involved no manipulations of animals or their environments and did not require animal ethics approval.

Rebecca is completing a Bachelor of Applied Science (Animal Welfare and Management) at Unitec Institute of Technology. This research is being undertaken as part of a final year research project.

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Contrasting approaches to animal welfare assessment: Comparison of the Five domains model and Welfare Quality®

Ngaio Beausoleil[1] and David Mellor[1]

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Animal welfare is often described and evaluated according to one of three 'orientations': biological functioning, affective state or naturalness. We compare two approaches to welfare assessment which emphasize different orientations and are currently used in different fields. The Five Domains model, used in the zoo context, is based on the affective state orientation, according to which, welfare is a state within the animal that reflects its mental experiences or 'affects'. It uses behavioural and physiological evidence, organized into four physical/functional domains, to infer likely mental experiences most relevant to welfare (domain 5). The Welfare Quality® (WQ) system, used to assess farm animal welfare, incorporates elements of all three orientations but does not consistently interpret observed/measured indicators in terms of animals' mental experiences; assessment criteria are a mixture of mental experiences and descriptions of behaviour or physical state. These approaches cover the same major areas of interest or concern (nutrition/hydration, environment, health/function and social/environmental interaction) and rely mainly on observations of behaviour. However, they have different foci and thus different advantages and limitations. The Five Domains lends itself to comprehensive evaluation of mental experiences that influence welfare. The links between observable indicators and associated affects are specific, providing clear understanding of the implications, for the animal, of observing a particular indicator and providing information about how specific unpleasant experiences can be prevented or alleviated to improve welfare. The benefits of WQ® are its practical utility on-farm, that it covers main welfare issues identified by experts/stakeholders for a specific animal system and allows comparison to reference populations facilitating development of assessment standards. The Five Domains is most useful for theoretical analyses of welfare impacts in individual animals at specific time points and to validate proposed welfare indicators. WQ® is more useful for routine on-farm assessment of welfare over time at group level.

Ngaio is Deputy Director of the Animal Welfare Science and Bioethics Centre at Massey University, New Zealand.
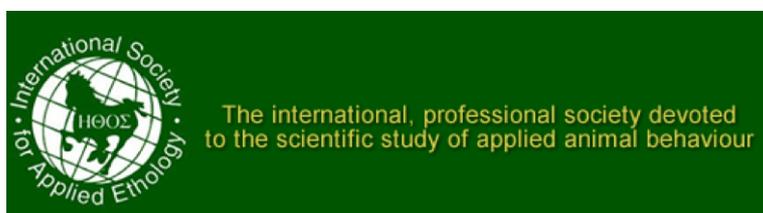
Effect of gaseous ammonia on eating and ruminating behaviour in sheep in simulated long-distance transport by ship

Yu Zhang1*, Laureline Guinnefollau2, Clive. J. C. Phillips1

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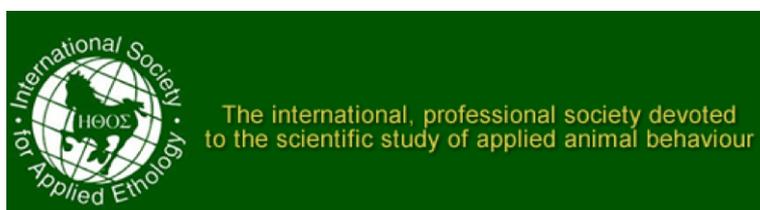* Author for correspondence: yu.zhang2014@gmail.com

Abstract

Ammonia accumulates in sheep accommodation during live export, irritating the sheep's mucosal surfaces and suppressing feed intake. This study investigated the mechanisms involved in this effect by exploring eating and ruminating behaviour in sheep under simulated live export conditions. Twelve 6 months old lambs with an average body weight of 24.5 ± 2 kg were randomly assigned to control or 30 ppm ammonia treatment for three periods (14 days each) with a change-over design. The duration of each period was comparable with the voyage duration of live sheep export from Australia to the Middle East. In each period, ruminating behaviour was recorded by the same observer for ten periods of 60 seconds from 14:00 pm to 19:00 pm on day 7 and day 8. Rumination was categorized as the number of chews/min and the time interval between swallowing and regurgitation. Sheep were fed TMR pellet (400 g) and long-chopped lucerne hay ad libitum daily. Eating behaviour was recorded during 6 min palatability test with lucerne pellet and sorghum chaff on day 10 and day 11. Ammonia decreased lucerne hay intake (1.10 vs 1.03 kg/d, SEM = 0.014, P = 0.002) and ruminating chewing rate (88.10 chewing bouts/min vs 85.68 chewing bouts/min, SEM = 0.60, P = 0.014). The time between swallowing and regurgitation during rumination increased (5.83 seconds vs 6.75 seconds, SEM = 0.18, P = 0.002). During the palatability test, ammonia reduced mastication rate for lucerne pellet (2.28 chews per second vs 2.20 chews per second, SEM = 0.012, P < 0.001) but not sorghum chaff (2.28 chews per second vs 2.26 chews per second, SEM = 0.018, P = 0.47). Our results confirm adverse effects of ammonia on sheep feed intake, and one potential reason may be that ammonia irritated the buccal cavity, making chewing and/or swallowing painful.

Animal ethics requirements
This study was approved by the University of Queensland Production and Companion Animal (PCA) Ethics Committee (CAWE/242/14) and was fully ethically reviewed to the standards required of ISAE.

Yu is a 3rd year PhD student in the University of Queensland which investigates the ammonia effects on sheep welfare and develops effective sampling strategy for environmental measurement on ships, aims to improve animal welfare during long-distance sea live export.

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The impact of increased dietary magnesium and month of mating on scratch scores of gestation sows

Kate Plush[1]*, David Lines[2], Julia Sophia Huser[2], William van Wettere[3] and Paul Hughes[1]

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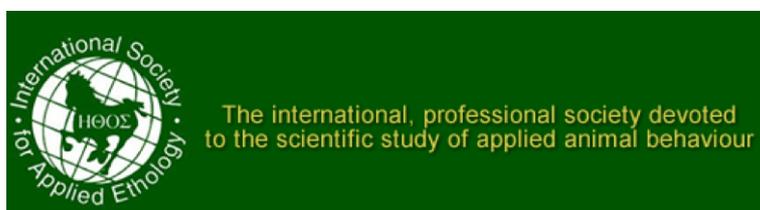* Author for correspondence: kate.plush@sa.gov.au

Fighting when sows are grouped is inevitable whilst a dominance order is established. Fights generally subside quickly, but high levels of aggression may continue when resources are not well managed. Increased dietary magnesium has been shown to reduce aggression and stress in grower pigs. The aim of this experiment was to determine if increased dietary magnesium concentrations reduced injuries throughout gestation under competitive, commercial conditions. Immediately following insemination, multiparous sows were grouped (six per pen at $1.9m^2$/sow) and randomly allocated to treatment; 180 sows fed a standard gestation diet, 180 sows fed a gestation diet mixed with 5.0kg/tonne of a commercially available marine algae extract high in magnesium, and 180 sows fed a gestation diet mixed with 2.84kg/tonne magnesium sulphate. Sows were floor fed 2.4kg once daily. A scratch score (zero; 0 scratches, one; 1-5 scratches, two; 6-10 scratches, and three; >11 scratches) for the head, body and rump was allocated to each sow and summed to give a total scratch score on d2, 31 and 102 of gestation. No impact of the magnesium treatments were observed on scratch score throughout the experiment. On d2, total scratch score was higher in sows mated in December (6.6 ± 0.5), January (6.0 ± 0.4) and March (6.3 ± 0.4) when compared to those in May (4.8 ± 0.5), with April sows being intermediate (5.5 ± 0.4; P<0.001). There was no difference on d30 of gestation, but on d102, sows mated in April recorded the highest scratch score (4.9 ± 0.4), those in January the lowest (3.1 ± 0.4), with all other months intermediate (December 3.4 ± 0.4, March 3.7 ± 0.4, May 4.1 ± 0.4; P<0.001). Increased dietary magnesium doesn't appear to be a suitable method to reduce aggression and so scratches in gestation, but seasonality of injuries requires further investigation.

Animal ethics requirements
This work was conducted with approval from the Primary Industries and Resources South Australia Animal Ethics Committee (approval number 18-14).

Kate Plush is a research scientist who works closely with South Australian farmers to improve the reproductive performance as well as welfare standards of pigs housed in breeder units

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Is hoof trimming of pregnant dairy goats important?

Gosia Zobel[1,2], *Ken Leslie*[3] *, and Marina. von Keyserlingk*[1]

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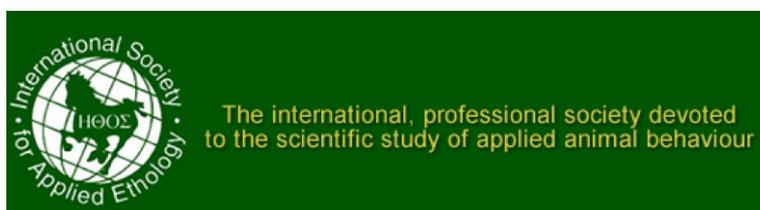[3]Population Medicine, University of Guelph, Ontario, Canada
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Little is known about the effect of hoof overgrowth on daily activities of does. We evaluated the impact of hoof overgrowth on the lying behaviour of commercially housed dairy does in the days around kidding. The lying behaviour of does on 8 commercial farms (Ontario, Canada) was monitored using leg-based data loggers. Lying time, bout frequency and duration for each doe were calculated for the day before (d-1), the day of (d0) and the day after (d+1) kidding. During a metabolic health check post-kidding (9±4 d), each doe's front left and rear right hoof was scored (0 = no/minimal toe overgrowth with no curling, n=78; 1 = presence of toe overgrowth and curling, n=55). Mixed models were used (PROC GLIMMIX, SAS) to assess effect of hoof overgrowth on lying behaviour. Results presented as mean ± SED. Kidding (d0) resulted in a dramatic decrease (3.0±0.3 h/d; P=0.001) in lying time compared to d-1, but the decrease was dependent on hoof score. Does with hoof overgrowth lay longer on d0 (10.3 vs. 8.9 ± 0.5 h/d; P=0.001) and on d1 (11.9 vs. 10.7 ± 0.5 h/d; P=0.01) compared to does with no or minimal overgrowth. The number of lying bouts did not differ over the 3-day period; however, goats with hoof overgrowth lay down longer during each bout compared to goats with no or minimal hoof overgrowth (53 vs. 44 ± 2.0 min/bout; P=0.001). In summary, goats lay down less on kidding day and hoof overgrowth reduced the magnitude of this behavioural change. Hoof overgrowth restricted movement; this reduced activity is a concern during a period when freedom to move, both to isolate from penmates and to have adequate access to feed and water, is crucial to maintain good health. This work demonstrates the importance of hoof care for late gestation does.

Animal ethics requirements
The study was conducted in accordance to the University of British Columbia's Animal Care Certificate A12-0249 and the University of Guelph's Animal Use Protocol 1636.

Gosia is a scientist at AgResearch. Her current research focuses on housing and management improvements in the NZ dairy goat industry. When she gets the opportunity, she dabbles in dairy cow studies as well.

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The effects of acute exposure to mining machinery noise on the behaviour of eastern blue-tongued lizards, *Tiliqua scincoides*

Karen Mancera[1]*, Peter Murray[1, 2], Allan Lisle[3], Coline Dupont [1, 4], Floriane Facheux [1, 4], Clive Phillips[1]

[1]Centre for Animal Welfare and Ethics, School of Veterinary Science, The University of Queensland, Australia
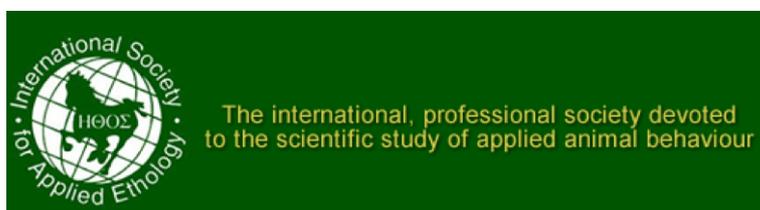[2]Wildlife Science Unit, School of Agriculture and Food Sciences, The University of Queensland, Australia
[3]Statistical Advisory Services, Faculty of Science, The University of Queensland, Gatton Campus, Queensland 4343, Australia
[4]Université de Picardie Jules Verne, IUT d'Amiens, Avenué des Facultiés, Le Bailly, 80025, Salouël, France.
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The mining industry is major source of noise which may negatively impact nearby wildlife, such as the eastern blue- tongued (EBT) lizard (*Tiliqua scincoides*). We analyzed the behavioural reactions of nine EBT lizards exposed to acute mining machinery noise in an acute manner. For this purpose, a modified open field test was used to evaluate reptile behaviour during and after exposure for 5 sec to one of five combinations of mining machinery noise frequency and amplitude (low and high frequencies, < or > 2 kHz; and low (60-65 dB (A)) and high (70-75 dB (A)) amplitudes; or a Control treatment (no exposure to mining noise, speakers turned on without broadcasting sound)). Five seconds exposure was chosen due to its effectiveness to provide behavioural reactions without generating additional unnecessary stress and was an exposure regime previously used with the same species. Following exposure, lizards' could leave the test chamber and enter an escape chamber, which led to a small hiding chamber. All chambers were monitored for 15 mins post initial exposure. Results were analyzed using a General Linear Model for parametric data, Kruskal-Wallis for non-parametric and binary logistic regression for low frequency behaviours. In the test chamber lizards exposed to high frequency treatments spent more time freezing, a typical stress response in reptiles, when compared with all the other treatments (P = 0.004; 120.1 vs 49.73 sec / 900sec). In the hiding chamber, high frequency noise at high amplitudes decreased durations of head positioning to the right and downwards compared to all other treatments (P = 0.01; 2.7 vs 4.4 sec/ 900 sec) as well as the duration of standing (P = 0.02; 40.9 vs 86.02 sec/ 900 sec) and bouts of freezing (P = 0.05; 0.24 vs 0.61 bouts / 900 sec), suggesting a decreased lateralized fear reaction. We hypothesize that lizards have lateralized behaviour reactions to mining noise, with high frequency, high amplitude noise being the most detrimental. Our results demonstrate that acute exposure to mining noise had negative effects on EBT lizards' behavior. This may suggest a threat for lizards experiencing mining noise in the wild, making the study of mining machinery noise *in situ* a research priority.

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Animal ethics requirements

This research was approved by The University of Queensland's Animal Ethics Committee (UQAEC Approval Number SAFS/104/14) and by Queensland Parks and Wildlife Service (Scientific Purposes Permit WISP05075208). These guidelines conform to the regional laws regulating the use of animals in research as well as the ISAE Ethical Guidelines.

Karen Mancera has completed a PhD in Veterinary Science, focused on Animal Behaviour and Welfare at the University of Queensland, Australia, under the supervision of Prof. Clive Phillips. Her work studied the effects of different frequencies and amplitudes of mining machinery noise in two animal models: wild mice and blue tongued lizards. Her MSc. in the National Autonomous University of Mexico was on the effects of different percentages of tree coverage on welfare indicators of dairy cattle in the tropics

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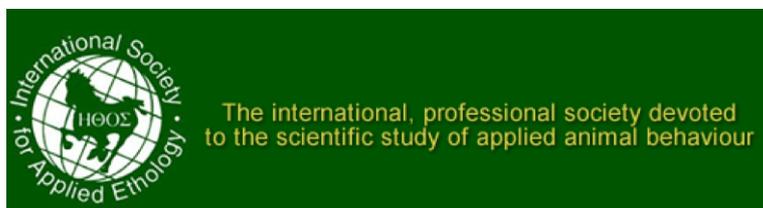
Differences exist in the pre-laying behaviour of floor-laying and nest-laying Pekin ducks

Lorelle Barrett[1,2]*, Irek Malecki[1]and Dominique Blache[1]

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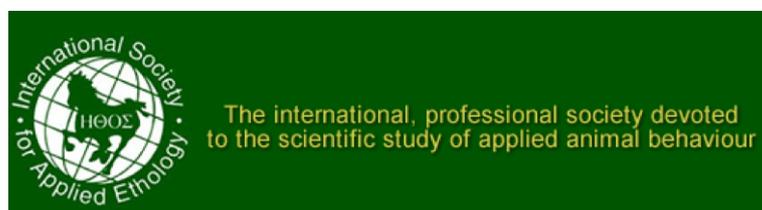[2] Poultry CRC, University of New England, Armidale, NSW, Australia
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Factors contributing to floor-laying in farmed Pekin ducks are not well understood. This study aimed to determine if behavioural differences exist between floor-laying and nest-laying ducks. Social, exploratory and nesting behaviours of floor-layers (FL; n=24) and nest-layers (NL; n=24) were continuously analysed during the hour prior to the selection of the oviposition site using video footage from a small commercial breeding flock (n=51 birds, 2 females:1 nest box). The frequency, percentage of time spent, and mean bout duration of behaviours were compared between the laying groups and between locations (in or out of nest boxes). Thirteen floor-layers never entered or investigated the nest boxes (FL-Out), whilst 11 visited the nest boxes (FL-In). Nest-building behaviour differed only in location, with FL-Out performing it on the shed floor and the other groups performing it primarily in boxes. Behaviours observed outside of the nest boxes were compared using Kruskal-Wallis tests and post-hoc pairwise Mann-Whitney U tests with a Bonferroni correction. FL-Out roosted more, stood less and walked less (P <0.05) than FL-In and NL. FL-Out experienced less aggression than both other groups (P<0.05). Behaviours between FL-In and NL in the nest were compared using Mann-Whitney U tests. FL-In and NL spent similar amounts of time in nest boxes (46.5% vs 47.3%) and experienced similar amounts of both total aggression and box-associated aggression. Aggression-associated box exits and total number of box exits were strongly correlated (r = 0.93). Occurrences of multiple birds in a nest box and the number of aggressive interactions in the box were strongly correlated (r = 0.81). Competition could be a contributing factor to floor-laying in Pekin ducks. FL-Out birds may roost more and not engage with nest boxes as a coping strategy to avoid agonistic interactions. Other factors, such as nest design, may also reduce the motivation of FL-Out birds to use nest boxes.

Animal ethics requirements

This study was approved by the Animal Ethics Committee of The University of Western Australia (protocol RA/3/600/34).

Lorelle Barrett is a veterinarian who is currently undertaking her PhD at UWA. Her research addresses floor-laying and the nesting needs of commercially kept Pekin ducks, under the supervision of Drs Blache & Malecki, and Assoc. Prof Shane Maloney. She previously completed a Masters of Veterinary Science at Massey University, which investigated tools for pain assessment in dairy cattle, with specific reference to post-liver biopsy pain.

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Assessing the relationship between immune competence and behavioural traits in sheep

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Resilience is the ability of an animal to cope with short-term challenges and return to its pre-challenge state. Strategies aiming to identify and select resilient animals that can better cope with our production systems are expected to improve livestock productivity and welfare. Livestock cope with environmental and disease challenges through immunological, physiological and behavioural defence responses which are highly integrated. For example, links between immunological responses and behavioural coping styles have been observed in pigs. The current experiment aimed to investigate whether such relationships also exist in sheep. Animals used in the study were selected from a pool of 340 ewes (3.5 years of age) from the Sheep CRC follower flock, which were previously immune competence phenotyped. Animals were ranked for immune competence and 50 high and 49 low sheep representing the extremes of the phenotype underwent a suite of behavioural tests; threat perception, arena, isolation box, flight speed, maze and food competition. Changes in serum cortisol levels and eye and body temperature in response to the tests were also assessed. Behavioural and physiological responses were analysed using a generalised linear model, fitting appropriate fixed effects. Key measures in the threat perception test such as attention to threat and vigilance did not differ between immune competence groups. There were also no significant differences observed between eye temperature (P=0.36), agitation score in the isolation box test (P=0.25), flight speed (P=0.44) or change in serum cortisol concentration (P=0.97) between groups. While the results of other tests and behaviours are yet to be analysed, results to date suggest that the behavioural and immune competence traits investigated in the current study were not correlated. However, further testing on a larger population of animals will be necessary to establish the strength and nature of the relationship that exists between immune competence and behaviour in sheep.

Animal ethics requirements
The protocol and conduct of the study were approved by the University of New England Animal Ethics Committee, under the New South Wales Animal Research Act 1985.

Jessica is completing a PhD with the CSIRO, University of New England and Sheep CRC, developing methods for the assessment of resilience in livestock. During her BAnVetBioSc (Hons) at the University of Sydney, she refined the threat perception test in sheep as a measure of anxious states

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