A HEAT CHALLENGE MODEL FOR ANIMAL WELFARE ASSESSMENT

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The scientific study of livestock management issues that have a significant animal welfare component has long included the measurement of both behavioural responses and physiological effects. One of the recurring problems in this area of research is a failure to adequately link these 2 fields of measurement. In order to do this, a model is required that allows incremental increases of the intensity of the stressor so that adaptive reactions can be monitored at the different levels. Therefore, the aim of this experiment was to define the physiological effects of incremental changes in heat challenge, with the intention of developing a model whereby animal motivation to avoid certain levels of heat stress could be assessed.

Merino ewe hoggets were randomly assigned to each of 4 levels of heat challenge (n = 12 for each treatment in 2 replicates of 6 animals): 20, 25, 30 or 35°C with 70% relative humidity across all temperatures. Each animal underwent 2 weeks of habituation to pelleted feed and handling in an animal housing facility, followed by 2 weeks in climate controlled rooms (1 week baseline, 1 week heat challenge), and then 1 week of recovery back in the animal house.

The sheep were catheterised and had intravaginal temperature loggers inserted that logged body temperature every 5 minutes during the baseline and heat challenge weeks. Feed and water intake was measured daily for all animals. Respiration rates were recorded twice daily during the heat challenge period. The data were analysed by analysis of variance using a linear model, with the baseline week used as a covariate.

Although there were heat effects on feed and water intake for the hottest treatment only, body temperature was more sensitive, and respiration rate differed between all treatments (Table 1).

Table 1. Mean (sem) responses during heat challenge of 20, 25, 30 or 35°C.

Treatment	20°C	25°C	30°C	35°C
Feed intake (g)	1135^{a} (27.8)	1012^{a} (30.8)	1017^{ab} (90.4)	869^{b} (21.0)
Water intake (mL)	3201^{a} (123.1)	3110^{a} (84.0)	3620^{ab} (310.4)	4051^{b} (247.2)
Respiration rate (breaths per minute)	100^{a} (4.4)	132^{b} (3.4)	184^{c} (2.6)	216^{d} (5.4)
Body temperature (°C)	39.3^{a} (0.03)	39.4^{a} (0.01)	39.8^{b} (0.01)	39.9^{c} (0.06)

Within a row, means without a common superscript are significantly different ($P < 0.05$)

In sheep, evaporative heat loss through panting accounts for 60 to 80% of total heat loss when animals are exposed to elevated temperatures and humidity (Hales and Brown 1974). It was, therefore, expected that this would be the most sensitive indicator of adaptation of animals to a heat challenge. Increasing respiration rate enables the animals to minimise increases in body temperature, which were still seen in this study at the higher levels of heat challenge. Therefore, increased respiration rate can be seen as adaptive, enabling the animal to cope in a stressful environment, whereas an increase in body temperature is a consequence of the animal's inability to fully adapt to its environment. This suggests that the model of heat challenge used in this experiment was successful in enabling us to identify the temperature at which these sheep struggled to adapt to a hot and humid environment. Using this model, it should now be possible to link behavioural responses and physiological effects by investigating the behavioural motivation to avoid levels of heat challenge, the hypothesis being that the motivation to escape a particular level of challenge will increase at the point where the animal can no longer adapt.

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