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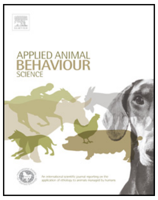

Operant conditioning of urination by calves

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ABSTRACT

The accumulation of faeces and urine in dairy barns is a cause of cattle and human health concerns and environmental problems. It is usually assumed that cattle are not capable of controlling defecation and urination. We tested whether calves could be taught to urinate in a location using either classical or operant conditioning. Twenty-four female Holstein calves were alternately assigned as treatment or control (experiment 1: $n = 12$, median age, range = 39, 31–50 days; experiment 2: $n = 12$, median age, range = 50, 29–64 days). Experiment 1 used classical conditioning, involving repeated pairing of entry into a stall and injection of a diuretic. During the training period (days 1–5) treatment calves were repeatedly placed in the stall (150 cm × 45 cm × 120 cm) and injected IV with diuretic (at 0.5 mL/kg BW) to induce urination. During the test period (days 6–15) calves were held in the stall for 10 min without diuretic injection, and urinations, defecations and vocalisations were recorded. The procedure was identical for control calves except saline was used in place of a diuretic. In the test period, the classically conditioned calves did not urinate more than controls (means ± SE: 4.3 ± 1.28 vs. 6.0 ± 1.41, for treatment and control calves, respectively). In experiment 2, calves were trained using operant conditioning. On training days, operant calves were placed in the stall, received IV of diuretic (at 0.5 mL/kg BW) and, upon urination, were released from the stall to receive approximately 250 mL of milk reward. On test days, calves were placed in the stall but did not receive the diuretic; calves that urinated received the milk reward but calves failing to urinate within 15 min were given 5 min "time out" and received diuretic the following day. Yoked controls were never given diuretic but held in the stall for the same amount of time and received the same "reward" or "punishment" as their matched operant calf the previous day. Urinations, defecations and vocalisations occurring in the stall on test days were compared between treatment calves and controls. Calves trained using operant conditioning had a higher frequency of urinations in the stall than their controls (means ± SE = 5.25 ± 0.95 vs. 2.32 ± 0.52). The results of our experiment show it may be feasible to train cattle to urinate in specific areas using operant conditioning.

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1. Introduction

The accumulation of faeces and urine in dairy barns leads to poor cow hygiene, mastitis and lameness, which reduce the welfare and productivity of the cows (Hultgren and Bergsten, 2001; Reneau et al., 2005). Cow faeces can contain infectious bacteria, posing a risk to human health, and volatile emissions released when urine and faeces mix result in environmental problems (Bittman and Mikkelsen, 2009). These risks can be reduced by minimising the spread of faeces within the barn and improving waste management. Cattle defecate between 3–29/d and urinate 2–20/d, producing approximately 30 kg faeces and 15 kg urine daily (Aland et al., 2002; Hirata et al., 2011; Villettaz Robichaud et al., 2011). Defecation and urination also occur when cattle are stressed, in conjunction with other behavioural measures such as vocalisation (Kilgour, 1975; Lauber et al., 2006).

Electric cow trainers are commonly used in tie-stall barns to prevent the stalls from becoming dirty by training cows to take a step backwards before urinating or defecating to avoid an electric shock (Bergsten and Pettersson, 1992). However, the use of electric trainers has been associated with an increased risk of silent heat, ketosis, mastitis (Oltenacu et al., 1998), hock injuries and reduced cleanliness (Zurbrigg et al., 2005). Future attempts to control where cattle urinate and defecate should explore alternative methods that avoid these negative impacts.

Cattle are often considered to have little voluntary control of urination and defecation (Whistance et al., 2009, 2011) but cows have excellent spatial memory (Bailey et al., 1989), and may be able to learn to eliminate in specific locations (Whistance et al., 2009). Simple operant conditioning techniques have been successfully employed to collect urine from mares used in the PMU (pregnant mare urine) industry (McCartney et al., personal communication, 2011) and it may be possible to adapt this method to cattle. Whistance et al. (2009) explored whether dairy heifers could be trained to control their eliminative behaviour using operant conditioning. First, they trained heifers to expect a food reward after urinating or defecating, and then they attempted to 'shape' this behaviour to a specific area of the pen, rewarding urinations and defecation only when they occurred in the desired location. While the heifers learned to approach the trainer before and immediately after urinating or defecating to claim their food reward, it was not possible to train heifers to eliminate in a specific area of the pen.

The first step towards developing a successful training protocol is to establish if it is possible for cattle to learn to urinate or defecate within specific locations. In this study, we chose to study urination as this can be easily and rapidly stimulated artificially with diuretics. The added benefit of using a diuretic is that a single dosage induces many urinations within a short space of time, allowing many opportunities to build an association and reducing the inter-trial interval (the time between trials). We used younger calves than Whistance et al. (2009) since these may be more easily trained and handled.

We examined whether classical conditioning (repeatedly pairing a particular location with urination induced by a diuretic), and operant conditioning (where urination in the stall was rewarded) could be used to increase the frequency of urination in a location.

2. Materials and methods

This study was conducted at the UBC Dairy Education and Research Centre in Agassiz, BC, Canada. All experimental conditions and procedures met the requirements of the Canadian Council for Animal Care.

2.1. Experimental animals

Twenty-four female Holstein calves were assigned as treatment or control based on birth order (experiment 1: $n = 12$, median age = 39 days, range = 31–50 days; experiment 2: $n = 12$, median age = 50 days, range 29–64 days). Calves were housed individually until 5–6 d of age at which point they were moved to a group pen (nine calves per pen). Here they were provided with a milk allowance of 12 L/d (i.e. ad libitum) via an automated milk feeder (DeLaval® CF 1000 CS Combi, Tumba, Sweden). Calves remained in group pens for the duration of the experiment and were only removed to take part in training and testing sessions. These sessions took place within the same barn in an identical pen which housed the experimental apparatus (Fig. 1b). For training and testing sessions calves were taken individually from their group pen to the experimental pen, where they were visually but not audibly isolated from other calves. None of the calves had taken part in a training experiment prior to this.

2.2. Experiment 1 – classical conditioning

Two days before beginning the experimental phase, all calves were brought individually to the experimental pen and walked through the holding stall (Fig. 1) without stopping, in order to familiarise them with the stall and the experimental set up. This process was repeated twice per d over 2 days. The experiment was divided into a training period (days 3–7) and a test period (days 8–15). During the training period, training sessions occurred once a day, Monday–Friday, beginning at approximately 08:00 h. An observer began recording all urinations occurring in the calves' home pen 30 min prior to the beginning of a training or testing session, and continued observations throughout. Only calves which had not urinated in the previous 30 min were brought for training. Classically conditioned and control calves were trained or tested on the same day, always beginning with a control calf and alternating between training and control calves thereafter. Entry order to the stall was recorded.

Calves in the classical conditioning treatment were placed in the stall, a halter was used to hold the calves' head up to expose the jugular vein and calves were injected IV with a diuretic, Furosemide (Salix, Intervet Inc., Kirkland, QC, Canada at 0.5 mL/kg BW). As soon as the diuretic was injected the handler removed the halter and moved out of sight. Calves remained in the stall for a set time (10 min) to allow time for the diuretic to act. Upon release calves were returned to the stall for