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Research Paper

Motivation of naïve feedlot cattle to obtain grain and individual responses to novelty

Jennifer M.C. Van Os[a], Erin M. Mintline[a], Trevor J. DeVries[b], Cassandra B. Tucker[a,*]

[a] Center for Animal Welfare, Department of Animal Science, University of California, Davis, USA
[b] Department of Animal Biosciences, University of Guelph, Guelph, Ontario, Canada

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ABSTRACT

Beef cattle may be fattened before slaughter using a high-energy, grain-based diet. Although previous research suggests cattle prefer grain, their motivation to obtain this feed has not been quantified. The objective of this study was to evaluate the motivation of naïve feedlot cattle to consume grain relative to hay. One method for quantifying motivation is to allow animals to perform work (e.g., push a weighted gate) for access. However, as previous research has suggested gate pushing may be rewarding, a second objective was to evaluate whether adding an aversive element (protruding studs) to the gate would increase the cost of pushing. Twenty-four individually-housed Angus-Hereford heifers were fed Sudan and alfalfa hay (3:1 ratio) in an open feed bunk with unrestricted access. In a second bunk, 200 g of either the primary diet (hay, final n = 9) or calf starter (grain, final n = 8) was fed behind a gate that required pushing for access. Additional weight was added to the gate at each feeding until heifers no longer pushed. We predicted heifers would show motivation to obtain grain by pushing heavier weights, showing a shorter latency to use the gate after feed delivery, and spending more time using the gate than those offered the additional portion of hay. Instead, heifers spent more time using the gate when offered hay vs. grain [back-transformed means: 0.4 vs. 1.8 min/12 h, respectively; 95% confidence intervals (CI): 0.1–1.0 vs. 0.9–3.3 min/12 h], likely because fibrous feed took longer to consume. Heifers offered hay or grain showed similar latencies to use the gate (back-transformed means: 88.6 vs. 59.8 min, respectively; CI: 53.7–157.0 vs. 37.6–101.1 min) and pushed similar maximum weights (mean ± SEM: 15.0 ± 1.8 vs. 18.2 ± 1.9% of bodyweight). The heifers offered hay demonstrated contrafreeloading by working to obtain a resource that was simultaneously and freely available. To further evaluate responses to novelty, we recorded the amount of time each heifer spent in proximity to (within a 1-m radius) and investigating (in proximity and with the head < 0.85 m from the ground) novel carrots in a 15-min test in an unfamiliar arena. Heifers that pushed heavier maximum weights spent more time in proximity to (R^2 = 0.45) and investigating (R^2 = 0.46) carrots, suggesting an underlying personality trait perhaps reflecting neophobia, exploratory tendency, or motivation to exert control over their environment.

1. Introduction

In many countries, beef cattle are commonly reared in grazing systems and finished in feedlots, where they are transitioned to high-energy diets based on grain concentrates (e.g., in the US, 48% of cattle in the finishing phase are fed > 75% concentrate on a dry-matter basis; USDA, 2013). To date, much of the research on the animal welfare implications of feeding high-energy diets has focused on health consequences (i.e., ruminal acidosis, reviewed by Owens et al., 1998; Galyean and Rivera, 2003; Nagaraja and Lechtenberg, 2007). To our knowledge, however, no previous studies have quantified the motivation of beef cattle to consume high-energy feeds. In theory, a motivation for high-energy feed is consistent with the optimal diet model, which predicts that animals should act to maximize their energy intake (reviewed by Sih and Christensen, 2001). The primary objective of our experiment was to evaluate the motivation of naïve feedlot cattle to obtain grain concentrates.

A widely used method to quantify the degree of motivation is to create tradeoffs, either between resources (Munksgaard et al., 2005; Schütz et al., 2008; Schütz et al., 2010) or by allowing cattle to pay a "price" to access resources by performing work, for example by walking various distances (Schütz et al., 2006), pressing panels (Webb et al., 2014b), or pushing a weighted gate (Greter et al., 2015). The approach of allowing animals to pay a price draws its terminology from consumer

* Corresponding author at: 1 Shields Ave., Davis, CA 95616, USA.
E-mail address: cbtucker@ucdavis.edu (C.B. Tucker).

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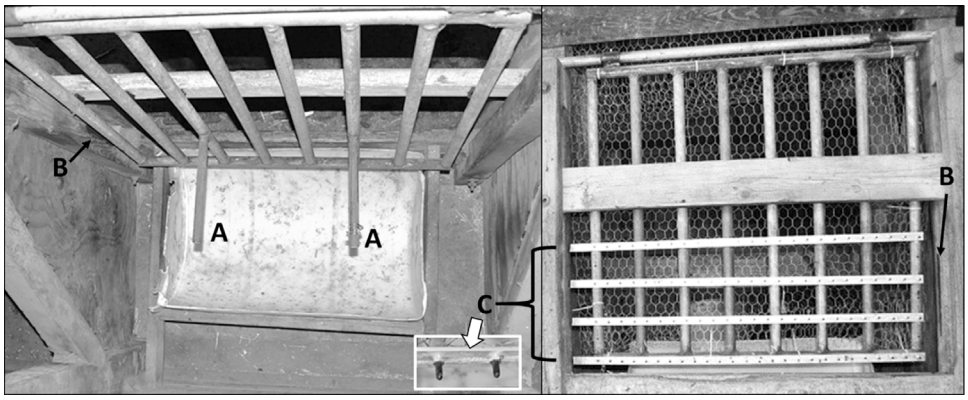

Fig. 1. Photos show an overhead view of the outside of the gated bunk (left) and the gate as seen from inside the pen (right). The gate had two rods (A) to which weight plates were added. A black line (B) was painted on the wall to mark the position of the gate when fully closed. When heifers pushed the gate, a price was imposed by an aversive stimulus in the form of four studded aluminum bars (C) affixed to the inside. The inset shows a close up view of two of the studs.

demand theory, and a willingness to pay a higher maximum price (i.e., expend more effort) for a resource relative to others is interpreted to mean the animal values the former more. Although this technique revealed treatment differences in motivation when dairy heifers were presented with a weighted gate in brief tests (Greter et al., 2015), this was not the case in a study by our group when beef heifers had 24-h access to a gate (Van Os et al., 2017). Furthermore, the maximum price that heifers were willing to pay to access feed differed greatly between the studies (< 10% vs. 36–63% of bodyweight in Greter et al., 2015; Van Os et al., 2017). In the latter study, there was evidence that using the gate may have been inherently rewarding to cattle and also that the maximum price may not have reflected the true degree of motivation due to a ceiling on their physical ability to continue pushing heavier weights. A novel approach to address the potential drawbacks of the push-gate method is to add an aversive element to increase the cost associated with pushing. If cattle are willing to overcome aversion or discomfort to obtain a resource, this would indicate a high degree of motivation. Therefore, a secondary objective of this study was to evaluate whether adding an aversive element to the gate in the form of protruding studs would increase the tradeoff associated with pushing to obtain feed.

To evaluate our primary hypothesis that cattle would be motivated to obtain high-energy feed, we offered beef cattle an opportunity to work for either an additional portion of their primary, hay-based diet or calf starter, a high-energy feed. We included the hay treatment to establish the baseline level of effort cattle were willing to expend to obtain feed (i.e., contrafreeloading), and we predicted they would be more motivated to obtain the calf starter. This prediction was based on previous studies that demonstrated a preference for grain in both beef (Catanese et al., 2009; Moya et al., 2011) and dairy cattle (e.g., González et al., 2009; Webb et al., 2014a). Post-hoc, as we found little evidence of motivation to obtain high-energy feed in the current study, we explored the relationship between individual willingness push the gate and other responses to novelty. We evaluated this by providing another novel feed item, carrots (as in Herskin et al., 2004; Costa et al., 2014; Mainardes and DeVries, 2016), in an unfamiliar testing environment, and we predicted that cattle which spent more time investigating these would also show greater gate use.

2. Materials and methods

2.1. Animals and housing

The study was conducted at the University of California-Davis (UC Davis) from July to October 2015, with all procedures approved by the Institutional Animal Care and Use Committee. Twenty-four Angus-Hereford cross heifers were used, with mean ± SD age of 10.1 ± 0.8 mo and starting bodyweight (**BW**) of 317 ± 16 kg.

For at least 2 wk before data collection, heifers were acclimated to the UC Davis feedlot and housed in groups. The primary diet throughout both acclimation and data collection was Sudan and alfalfa hay in a 3:1 ratio (by mass as fed) with a dry matter (**DM**) content of 96.0%. Once data collection began, heifers were housed individually across six sequential cohorts of four cattle at the UC Davis beef facility. Heifers within each cohort were assigned to one of four pens, and the locations of the treatments in the barn were balanced among cohorts. The four pens were adjacent and were separated with livestock fencing (Powder River Inc., Provo, UT, USA). Heifers had visual, auditory, and limited physical contact through the fencing separating the pens, and we anecdotally observed the performance of social grooming. Each pen was 5.0 × 5.5 (width × depth) m and contained two adjacent 114 × 57 cm feed bunks and a metal 379 L trough with a float valve to provide water ad libitum. In addition, each pen had five 1.16 × 1.74 m rubber mats (Interlock; Animat Inc., Sherbrooke, QC, Canada): three were placed in the center of the pen to create a lying area and the other two were in front of the feed bunks. The feed bunks and center aisle of the barn were covered with a solid roof. Cover was provided over the remaining areas of the pens by white tarps (Intertape Polymer Group, Montreal, QC, Canada). All heifers received a physical exam by a veterinarian on the day they entered their pens and were monitored throughout the study for signs of illness or injury.

2.2. Treatments and gate design

The heifers were tested for their motivation to obtain 200 g of either calf starter (grain; n = 12), to which they were naïve, or Sudan and alfalfa hay in a 3:1 ratio (hay, identical to the primary diet; n = 12), and the treatment groups were balanced for BW. The calf starter was 89.7% DM and, on an as-fed basis, consisted of 40% rolled barley, 33.5% flaked corn, 14% soybean meal, 8% molasses, 2.5% milk replacer, 1.5% dairy mineral mix, and 0.6% oyster shell flour. The treatments were offered in small amounts to minimize the likelihood of causing cumulative changes in rumen pH or fill, which could potentially affect motivation in the subsequent 12-h period. To test motivation, a 28-kg gate was mounted inside each pen in front of the right-hand feed bunk such that a heifer had to push the gate and hold it open with her head to access the feed (gated bunk; Fig. 1). Each gate was 101 × 95 cm and was constructed with 3-cm-diameter metal pipes, spaced 11 cm apart to allow the heifers to see into the feed bunk. Attached perpendicularly to the outside of each gate were two 2.5-cm-diameter metal bars to which weight plates could be added. In addition, to increase the cost of pushing the gate, four 2.5 × 100 cm, studded aluminum bars (Everbilt, Atlanta, GA, USA) were affixed horizontally to the inside of the gate, spaced 12 cm apart. The studs were created by drilling holes in the bars every 4 cm and inserting flat-ended M3.5 × 1.9 cm machine screws covered with vinyl caps.

2.3. Feeding, training, and testing procedures

Heifers were fed twice daily at 06:00 and 18:00 h. Throughout