

## Research



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# Cows are highly motivated to access a grooming substrate

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In natural environments, cattle use trees and other abrasive surfaces to scratch and groom themselves. Modern indoor dairy cattle housing systems often lack appropriate grooming substrates, restricting the animals' ability to groom. We assessed the motivation of dairy cows to access an automated mechanical brush, a grooming resource that can be implemented in indoor cattle housing systems. Cows were trained to push a weighted gate to access either fresh feed (positive control), a mechanical brush or the same space without a brush (negative control). Weight on the gate was gradually increased until all cows failed to open it. The weight each cow was willing to push to access each resource was assessed using the Kaplan–Meier survival analysis. Despite differences in methodology used to obtain data on motivation to access feed and the brush, the outcomes were very similar; cows worked as hard for access to fresh feed and the brush ( $p = 0.94$ ) and less hard for access to the empty space (compared with fresh feed:  $p < 0.01$ ; brush:  $p < 0.02$ ). These results indicate that cows are highly motivated to access a mechanical brush and that it is an important resource for cows.

## 1. Introduction

Grooming helps animals remove dirt, parasites and other contaminants from skin and hair [1] and may positively influence the animals' affective state [2,3]. Cows can groom themselves (by licking) and participate in allogrooming with herd mates and when kept in naturalistic environments, cows can use tree bark and other abrasive surfaces to scratch areas of the body that are otherwise difficult to reach. When kept indoors, cows may lack access to suitable grooming substrates that allow them to reach otherwise unreachable body areas. Some dairy farms provide access to automated mechanical brushes, providing cows a way to express grooming behaviour [4]. In certain countries, such as Denmark, providing cows with access to resources that promote coat care, such as mechanical brushes, is mandatory [5]. Cattle with access to mechanical brushes are cleaner and spend about fivefold more time grooming compared with when brushes are not available [6], suggesting that these brushes are important to the cow.

Motivation testing provides a method to assess the importance of a specific resource to an animal. The harder an animal is willing to work to gain access to the resource, the more important the resource is hypothesized to be to the animal. One method of measuring motivation is to train animals to push open a weighted gate to access a resource and then increase the weight over time, thereby increasing the work that must be performed to access the resource

(e.g. [7–9]). Willingness to work for a resource of interest can then be compared with willingness to work for other resources, allowing inferences regarding their relative importance to the animal.

The aim of this study was to assess the motivation of dairy cows to access a mechanical brush by comparing this with their motivation to access fresh feed (as a positive control; food is a necessity, so cows would presumably have a maximal motivation for it, allowing this treatment to act as a motivation ‘yardstick’ (e.g. [10–12])) and the space the brush was in, without the brush (denoted empty space; a negative control). We hypothesized that motivation to access the mechanical brush would be lower than that for fresh feed, but higher than that for the empty space.

## 2. Material and methods

### (a) Habituation

Ten healthy, pregnant, lactating Holstein cows were used in this experiment (mean  $\pm$  s.d. days in milk:  $207 \pm 24$ ). Animals were given 5 days for social interactions to stabilize [13] and to habituate to the experimental pen and mechanical brush. See electronic supplementary material, S1 for more information on the subjects and housing.

### (b) Training

All animals were trained to push open a weighted gate from a closed position. To be included in the experiment, cows needed to be able to open the push gate with 7 kg of weight attached to it without a trainer present. See electronic supplementary material, S1 for more information on training and the push gate apparatus.

### (c) Testing

Motivation testing took place in four consecutive treatments: (i) mechanical brush I, (ii) fresh feed (total mixed ration (TMR)), (iii) empty space and (iv) mechanical brush II. Cows were not tested in a balanced order because of the constraints of having access to only a single push gate and working within the day-to-day operations of a dairy farm. However, we did partially test for an order effect within the framework of sequential treatments by testing for the mechanical brush treatment twice, once at the beginning of the experiment and once at the end of the experiment.

The push gate restricted access to the resource in each treatment and weight was added until no cow pushed open the gate. In this way, we determined the maximum price paid by each cow per treatment. For both brush treatments and the empty space treatment, animals had continuous access to the push gate, and weights were added every 3 days. In measuring motivation to access fresh TMR, these methods had to be altered; to follow the existing methods for that treatment would have required long periods of food restriction. Therefore, the fresh feed treatment consisted of daily testing where the cows were individually brought into the experimental pen and allowed 15 min to push open the push gate to access fresh feed. If a cow succeeded in pushing the push gate to get access to the feed, weights were added to the subsequent day’s testing. For this treatment, the cows were deprived of feed for approximately 1.5 h and fresh feed for approximately 15 h before testing. Between treatments, all cows were subjected to three training sessions over a 3-day period. The final (mechanical brush II) treatment was cut short by 3 days, in comparison with mechanical brush I, as the cows were approaching their expected calving dates (the experiment ended  $49 \pm 36$  days before expected calving date).

See electronic supplementary material, S1 for more information on Material and methods.

## 3. Results

No difference was found in the weight pushed between the two treatments testing motivation to access the mechanical brush ( $p = 1.00$ ; figure 1). In addition, there was no difference in weight pushed for access to the mechanical brush I and fresh feed ( $p = 0.94$ ) or in weight pushed for mechanical brush II and fresh feed ( $p = 0.85$ ). However, cows pushed less weight to access the empty space than to access the brush in treatment I ( $p < 0.02$ ), the brush in treatment II ( $p < 0.02$ ) and fresh feed ( $p < 0.01$ ).

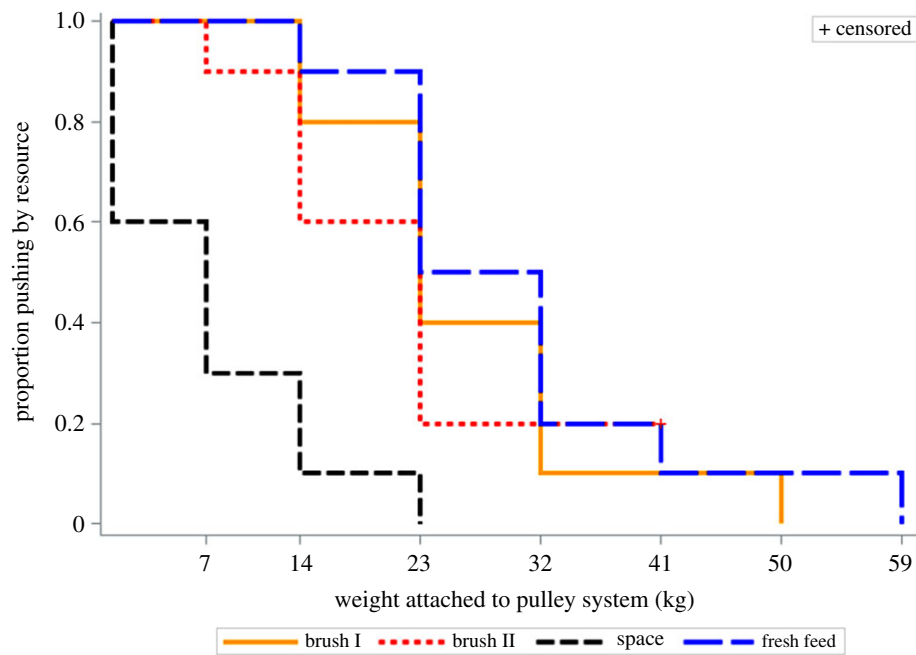
See electronic supplementary material, S1 and S2 for more information on statistical analysis, and electronic supplementary material, S3 for the datasets supporting this article.

## 4. Discussion

Dairy cows were similarly motivated to access a mechanical brush and to access fresh feed; despite differences in methodology of data collection between the brush and feed treatment, this result suggests that the brush is a valued resource for cows. The brush facilitates grooming, a highly conserved natural behaviour across species [1]. Grooming provides animals with a way to cope with stressors [2] and has been shown to increase oxytocin levels in rats [3]. By having access to the mechanical brush, cows were better able to groom, possibly increasing positive affect [14].

Motivation to access the empty space was lower than that to access either fresh feed or the brush, indicating that cows were motivated to access the mechanical brush during the brush treatments. That said, three cows did work to access the empty alley, and all cows accessed the empty alley during the interval periods between treatments, so the empty alley was not novel to them. Visiting the empty alley may be viewed as a type of exploratory behaviour; such exploration is consistent with the cows being motivated to learn about their environment [15,16].

Our results may have been impacted by a ceiling effect, meaning that cows may have been physically unable to push open the gate past a certain weight. At least some of the cows’ unsuccessful attempts to open the gate may have been due to the animal physically being unable to perform the task, rather than her being unmotivated. Indeed, we observed cows continuing to attempt to push open the gate after they had reached their experimental failure weight. Additionally, the weighted gate pressed on the side of the cow as she passed through the gate. The cows were pregnant, which may have made this passage more uncomfortable for them. Future work should examine other types of motivational tests or test cows that are not pregnant. Other types of experimental designs for motivation tests that may be less susceptible to ceiling effects may include manipulating walking distance [17] or lever pressing [18]. Increasing distance from food location has been shown to reduce brush usage in cows, suggesting that this may be a promising avenue to explore [19]. It may also be interesting to explore motivation to access a brush or other grooming substrates in other types of dairy farms, including pasture-based systems.



**Figure 1.** Survival plot of cow ( $n = 10$ ) willingness to work for access to a mechanical brush, empty space and fresh feed. Cows pushed a similar weight for access to the brush and for access to fresh feed, as indicated by the weight on the pulley system. Weight pushed was lower for empty space. Motivation for these resources was tested in sequential treatments: (i) mechanical brush I, (ii) fresh feed, (iii) empty space and (iv) mechanical brush II. Motivation for the mechanical brush was tested twice in order to partially test for an order effect. For the brush and space treatments, cows had continuous access to the push gate for 3 days. Feed access could not be constantly restricted due to animal welfare concerns and thus methods had to be altered for the feed treatment. However, motivation for food (i.e. hunger) is easier to manipulate than motivation to groom as there is more predictable, consistent behaviour evoked by food than a brush. Therefore, for this treatment, cows were deprived of feed for approximately 1.5 h and fresh feed for approximately 15 h after which they were individually subjected to a 15 min testing session, during which time cows had the opportunity to push open the push gate to access food. Data from mechanical brush II were right-censored to account for the early end of treatment. (Online version in colour.)

## 5. Conclusion

Cows were similarly motivated to access a mechanical brush and to access fresh feed and more motivated to access both of these resources than to access an empty space. These results indicate that the automated mechanical brush is an important resource for cows.

**Ethics.** The experiment and all procedures were approved by the University of British Columbia's Animal Care Committee (protocol A15-0082).

**Data accessibility.** The datasets and code supporting this article have been uploaded as part of the electronic supplementary material.

**Authors' contributions.** E.M., A.M.C.S., A.J.T., D.M.W. and M.A.G.v.K. conceived the study. M.A.G. designed, built and tested the push gate's pulley system and provided our team with the force plate, key components to experimental design. E.M., A.M.C.S. and A.J.T. executed the project and collected data. A.M.C.S., A.J.T., E.M., D.M.W. and M.A.G.v.K. analysed and interpreted data. E.M. was the primary author and drafted the initial manuscript, for which A.M.C.S., A.J.T., D.M.W. and M.A.G.v.K. provided critical revision and improvements. All authors revised the final draft, approved the final version of the manuscript and agree to be held accountable for the content therein.

**Competing interests.** We declare we have no competing interests.

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