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Motivation for cribbing by horses

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Abstract

*The motivation to crib was compared to the motivation to eat. Eight horses (*Equus caballus*) were operantly conditioned to push a switch for the opportunity to crib. When a progressive ratio was imposed, they worked as hard for a cribbing opportunity as for the opportunity to eat sweetened grain indicating a high demand. Another measure of motivation is the effort expended by the animal. The force exerted when a horse cribs was measured by attaching weights to a door and observing how heavy the weights had to be to prevent the horse from pulling a door toward itself when it cribbed. Seven horses were tested. Each neck flex of a crib-biting action was forceful enough to lift 29.4 (± 5) kg. The motivation to crib and the force involved indicates that thwarting cribbing is a welfare issue.*

Keywords: *animal welfare, crib, crib biting, horse, operant conditioning, stereotypic behaviour*

Introduction

Cribbing or crib biting is a common equine stereotypy recently reviewed by Wickens and Heleski (2010). Five to 10% of horses (*Equus caballus*) crib and there is a genetic predisposition to cribbing (Albright *et al* 2009). There are health reasons for preventing cribbing. Cribbing is associated with colic, particularly epiploic foramen entrapment (Archer *et al* 2004) as well as for simple colonic obstruction (Hillyer *et al* 2002). Recently, cribbing has been found to be a risk factor for temporohyoid osteoarthritis (Grenager *et al* 2010).

Preventing cribbing mechanically with a collar may be a welfare problem (Ödberg 2006); cribbing collars cause an increase in the horse's cortisol levels (McBride & Cuddeford 2001). Preventing cribbing by removing horizontal surfaces and feed led to a decrease in gastrointestinal motility (McGreevy & Nicol 1998a). Furthermore, horses that cannot crib because of surgery or a collar exhibited higher stress levels than horses that could crib or non-cribbing controls under experimental conditions in which feed was visible but unobtainable (Nagy *et al* 2009). McGreevy and Nicol (1998c) found that, after removing all horizontal surfaces had prevented cribbing, the horses would crib more frequently than non-deprived — an indication that cribbing is an important activity for those horses genetically predisposed to perform the behaviour. We were interested in investigating or determining how important cribbing is to the horse that performs the behaviour. Operant conditioning can measure and rank the strength of preferences; therefore, we used operant conditioning to measure the motivation of horses to crib in comparison to their motivation for food as our first objective. Food is a commodity for which animals have an inelastic demand (Dawkins 1983) because food is a necessity; thus, we compared motivation for food with motivation for the opportunity to crib. If cribbing is important to horses, then they will show an inelastic demand (Dawkins 1983) for performing cribbing behaviour. Elasticity can be quantified by measuring the slope of the function relating the reward (crib bites or grain) acquired to the price (panel presses) on log-log coordinates. Slopes with a coefficient of less than one are described as inelastic (Matthews & Ladewig 1994).

We used operant conditioning to measure the motivation of horses to crib compared with their motivation for food as our first objective. Our second objective was to measure the force exerted as a horse cribs to determine how much effort the horse is expending as it cribs as another measure of its motivation. The force exerted as a horse cribs might explain the pathophysiology of temporohyoid osteoarthritis (Grenager *et al* 2010).

This research was approved by the Institutional Animal Care and Use Committee of Cornell University.

Materials and methods

Study animals

Eight adult horses (five mares and three geldings; seven thoroughbreds and one quarter horse) aged four to 20 (mean 13.5 [± 1.8]) years were used. The horses had been donated to Cornell University. All horses were cribbers when acquired, therefore, the age at which the behaviour began was unknown. The horses were video-recorded continuously for three days prior to the start of the experiment to determine their cribbing rate. See Whisher *et al* (2011) for details. The cribbing rate for each horse is given in Table 1.

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Table 1 Cribbing rates for each horse in the study.

Horse	Cribs per day	Heaviest weight (kg)	Highest FR		Slope of demand	
			Cribbing	Food	Cribbing	Food
Willa	568	18.6	20	30	–0.710	–0.530
Lucy	448	42.3	250	500	0.107	–0.097
Sweetie	413	30.5	150	10	–0.195	–0.248
Country	335	18.6	50	40	–0.208	–0.075
Stoney	313	51.8	200	150	–0.069	–0.364
Purple	300	16.4	20	10	–0.456	–2.169
Lucky	212	30.5	10	50	–0.374	–0.170
Whisperer	189	–	20	10	0.375	0.413

Housing

The horses were housed in stalls of pipe rail measuring 3.3 × 3.3 × 1.4 m (length × width × height). The horses had visual, auditory and olfactory contact with at least one other horse. They were fed grass hay *ad libitum* and 1 kg of sweet feed (a corn, oat and soybean mixture containing 20% molasses) (Respond®, Agway Inc, Syracuse, NY, USA) twice daily at 0700 and 1300h, unless otherwise specified. They were released into a grassless paddock for 30–60 min each day. These conditions are similar to those under which many domestic horses in the USA are managed.

Procedures

Experiment 1 — Demand for cribbing

The training and testing of the eight horses took place in a stock constructed of pipe rail (2.3 × 1.0 m; length × width) located in a separate barn from that in which the horses were housed. The front of the stall consisted of a divided (Dutch) wooden door. The horse's task was to open the upper door in order to gain access to a horizontal surface on which it could crib or to gain access to food (see Figure 1). The progressive-ratio training and testing of food motivation preceded (three horses) or followed (five horses) the tests for motivation to crib. Three of the horses were first given the motivational test for access to food. When the responding to the task had been extinguished after one to two weeks of testing, the horses were tested for their motivation to crib. The other five horses followed the same schedule, but started with the motivation for cribbing followed by motivation for food. One to seven days elapsed between food and cribbing trials.

The operant conditioning arrangement consisted of a 10 × 10 cm (length × width) metal panel attached by a hinge to an electrical junction box that was affixed to the lower left-hand corner of the inside of the upper front door of the stock. When the horse pushed the metal panel, a small switch with a spring lever located in the box beneath the metal panel was closed, completing a 24-V circuit to an electronic counter which, in turn, released the latch holding the upper door closed. This counter could be preset to a specific number. The lower door remained latched.

The time to train each horse ranged from one to three weeks (median = ten sessions; range = five to 14 daily sessions of approximately 30 min). The horses were operantly conditioned to open the upper door of the stall. At first, the door was unlatched and the horse was encouraged to push the door. The metal panel was at the left edge of the door, and when the horse nudged the panel the switch under the press plate would be depressed. When the door opened, the horse was allowed to crib ten times or given 100 g feed. The horse was allowed to earn ten rewards each day (100 cribs or 1 kg feed).

When the horse opened the door by pressing the switch plate ten times a day for three days at FR 1 for the reward of ten crib bites testing was begun. During testing, a progressive ratio was used (one, two, five, ten, then increasing by ten each day until 100 was reached and then increasing by 50) (Matthews & Ladewig 1994). The horses wore cribbing collars to prevent cribbing except when being tested. When the door was opened, the horse was allowed to crib ten times before the door was closed, the horse then had to press the panel the preset number of times for that day in order to re-open the door. The horse was allowed to crib a total of 200 times daily (20 rewards of ten cribs each). The horse worked for the opportunity to crib each day until he or she extinguished. Then a new series of tests began with food as the reward.

In order to compare the horse's motivation to crib with its motivation for an essential resource (feed, a non-elastic commodity), it had to press on the same progressive ratio for 100 g of sweetened mixed grain. When working for food the horse wore a cribbing collar to prevent cribbing and the reward was 100 g of feed. The horse was allowed to earn 20 rewards (2 kg of feed) daily to avoid gastrointestinal problems. Although the durations were not timed, it took the horses less than 5 min to crib ten times or to ingest 100 g of feed. The tests of motivation for food were conducted before (three horses) or after (five horses) those for cribbing. The horses were tested only once a day; therefore each series of tests took several weeks, depending on the horse's performance. If the horse did not reach the criterion in 15 min on two consecutive days, the horse was considered to have extin-

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Figure 1

A horse performing the operant task. The horse is pushing a panel with its nose to release the upper door allowing access to a horizontal surface upon which cribbing can occur.

guished — the animal's motivation was too low to continue the test. Two methods were used to compare motivation for cribbing with that for food: the reservation method (highest amount of work performed for the reward) (Kirkden & Pajor 2006) and the slope of the demand for food and for cribbing (Matthews & Ladewig 1994).

Statistical analysis

KaleidaGraph® was used for statistical analysis. The Wilcoxon rank sign test for paired data was used to determine if there was a significant difference between the number of responses a horse would make for food and the number it would make for the opportunity to crib. In addition, as another means of comparing motivations, the slope of the demand for food and for the opportunity to crib was calculated for each horse for each reward (16 slopes) by calculating the slope of the log-log function relating the number of rewards obtained to the FR value by the method of least squares. A Wilcoxon rank sign test was used to assess differences in the slopes for cribbing and those for food.

Experiment 2 — Force of cribbing

Seven horses (five mares and two geldings) of the eight used in the motivation tests were tested in a stock with a Dutch or horizontally divided door, the same stall used for the motivation study. The upper door was open so the horse could crib at will and the lower door was unlatched. When the horse cribbed, it pulled the lower door inward. A steel cable on a pulley was attached to the lower door and the other end of the cable passed over a bar and was attached to a bucket containing lead weight. The weight was increased each day. The lowest weight was 6.8 kg (15 lb) and the weights were increased by 6.8 kg (15 lb) increments. The horses were tested in the afternoon. The horse was tested three times in one session with each weight. The next day the next weight was added until the horse could no longer lift the bucket. The horse grasped the door and cribbed, therefore, the door would move toward the horse if the force were sufficient to lift the bucket of weights. The highest weight the horse lifted three times in a session for three days in a row was used to determine motivation to crib.

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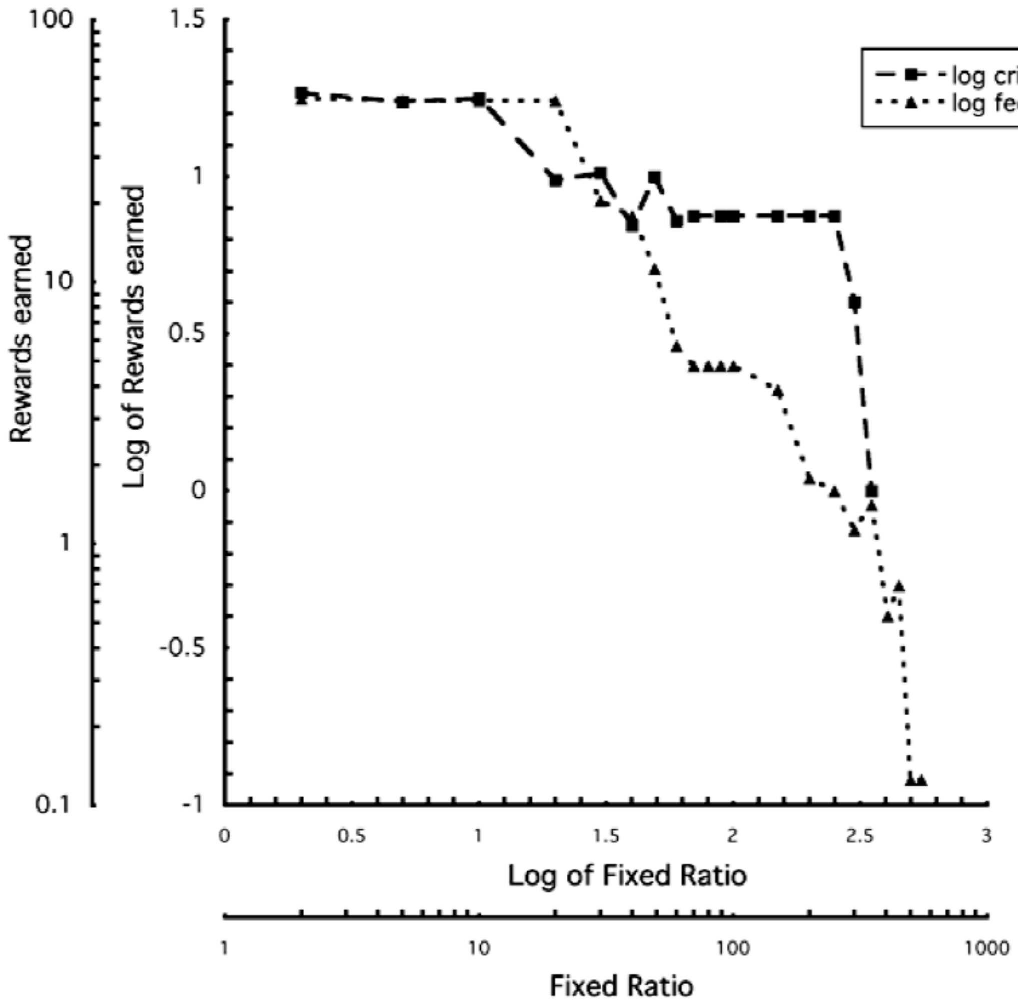
Figure 2



The demand curves for the opportunity to crib or to eat grain. The mean values for all eight horses for each commodity are plotted on a log-log scale. The outer axes indicate the back-transformed values. Each reward was the opportunity to crib ten times or to eat 100 g of sweet feed.

Results

Experiment 1 — Demand for cribbing

The horses extinguished panel pressing at a median fixed ratio of 35 (range 10–250) times for the opportunity to crib and 35 (10–500) for the opportunity to eat sweetened grain. There was no significant difference in the ratio at which the horse ceased to work for the opportunity to crib and the opportunity to eat sweetened grain (Wilcoxon rank sign test for paired data, sum of positive ranks = 20.5, sum of negative ranks = –15.5, n = 8, $P = 0.776$). The three horses that were tested first with cribbing worked for a mean FR of 83 for food and 53 for the opportunity to crib. The five horses that were tested first with food worked for a mean FR of 54 for food and 192 for the opportunity to crib. There was no significant difference between the groups (Wilcoxon Mann-Whitney rank sum test; $P > 0.3$ for all four comparisons).

The mean of the slopes of the demand for cribbing and for food are shown in Figure 2. Only one of the 16 individual slopes was greater than one and that was for food. There was no significant difference between the slopes for cribbing and those for food. (Wilcoxon rank sign test for paired data, sum of positive ranks = 16, sum of negative ranks = –20, n = 8, $P = 0.843$). Figure 3 illustrates the rewards earned at each FR or cost.

Experiment 2 — Force of cribbing

The median weight lifted was 30.5 kg (interquartile range = 39 kg) or a force of 288 newtons. The minimum weight lifted was 16.4 kg and the maximum was 51.8 kg (see Table 1).

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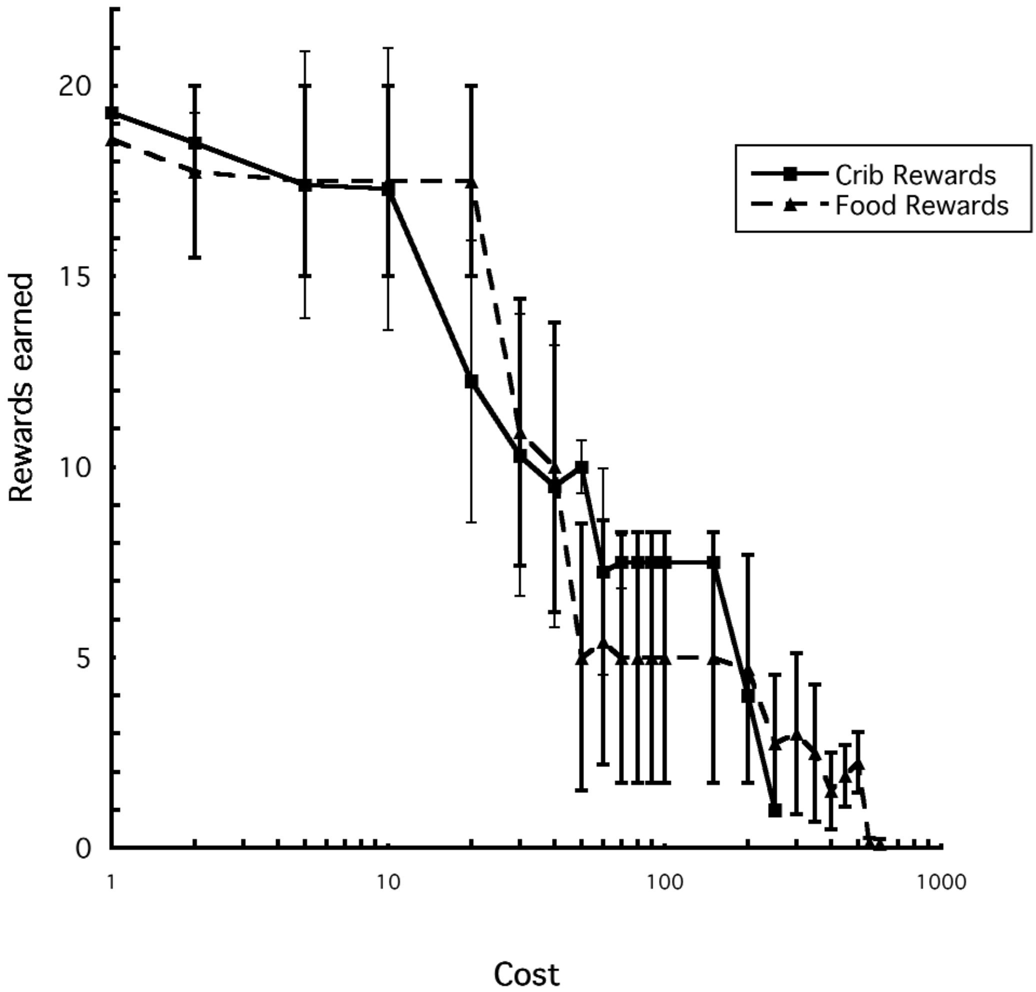
Figure 3



The mean (± SEM) values for each commodity (ten crib bites or 100 g feed) are plotted against the cost (fixed ratio of panel presses per reward).

Discussion

Horses in this study pressed a panel many times in order to access a surface upon which they could crib. As far as we are aware this is the first demonstration of motivation to perform an oral stereotypic behaviour. Their motivation was as great to crib as to eat grain. They also made a considerable muscular effort with each crib bite.

Cribbing appears to be as necessary as food to these animals. This is not true for all environmental variables. In an earlier study from our laboratory (Lee *et al* 2011) we found that horses would work significantly harder for food (FR = 258) than to be with another horse (FR = 98) or for the opportunity to exercise (FR = 38) in a paddock after 23 h in a narrow stall. Apparently exercise is an elastic demand because horses will not work for the opportunity to exercise when the price is too high.

The same apparatus was used in the Lee *et al* (2011) experiment as in the present study, but a different progressive ratio was used. In the Lee *et al* (2011) experiment, the progressive ratio rose much less rapidly (one, two, four, seven, eleven) in contrast to the ratio used in the present experiment (two, five, ten, 20, 30). In addition, the horses in the Lee *et al* (2011) experiment were tested when their afternoon meal was withheld whereas in the present experiment the horses were tested just before they would have been fed and so were not as hungry and consequently not as motivated, but horses may crib in anticipation of feeding. Using the same apparatus, Elia *et al* (2010) found that the median FR non-cribbing horses reached was 25 for the reward of pellets. Despite these differences between studies, the present findings indicate that demand for cribbing was very high in comparison to that for other resources.

We found that horses exert a force sufficient to raise 30 kg each time they crib bite, an action that takes place a thousand times a day (Clegg *et al* 2008). Recently, cribbing has been found to be a risk factor for temporohyoid osteoarthritis, presumably as a result of a thousand 25-kg pulls per day on the hyoid apparatus and stylohyoid bone as the horse cribs (Grenager *et al* 2010). The effort of neck flexing — the equivalent of lifting 30 kg — would be made hundreds of times a day which can explain why the neck muscles hypertrophy, a cosmetic consequence of cribbing. Owners also complain that cribbers do damage to their stalls. That can be explained by the force the horses exert and is the reason fence rails or stall equipment may be pulled off by the cribbing horse. The force exerted repeatedly by a cribbing horse also indicates its value to him (or her) because he (or she) devotes a considerable amount of energy to the behaviour.

Our subjects learned an operant response and worked as hard to crib as for food. They learned as quickly to push the panel as the non-cribbers we trained in the same apparatus (Elia *et al* 2010; Lee *et al* 2011) although Hausberger *et al* (2007) reported that horses exhibiting stereotypic behaviour of any kind are less likely to learn an operant task and are slower to perform the task if they do learn. Hemmings *et al* (2007) taught horses to press a button for a food reward and found that cribbers learned the task as fast as non-cribbers, but extinguished more slowly, that is they continued to respond when no reward was given. This slowness to extinguish may be reflected in the high fixed ratio the horses in the present experiment would perform in order to crib, although the response for food was similar to that of non-cribbers tested in the same apparatus, but with different progressive ratios (Lee *et al* 2011).

Economists refer to demand for commodities as elastic or inelastic. Elastic demands are those for which the consumer, in this case the horse, will not pay a high price, that is will not expend much energy to obtain. Inelastic demands are so important that the horse will pay a very high price, that is, will expend a lot of energy to obtain. Demand curves are calculated by first plotting on a log scale the number of rewards received on one axis and the cost of that reward on the other. The slope of that line is the demand elasticity. The slopes for two different rewards can then be compared statistically. The interpretation of these analyses is that slopes that are significantly different indicate a difference in demand for those two rewards. Slopes greater than one indicate elasticity and those less than one indicate inelasticity (Matthews & Ladewig (1994).

Attempts to prevent cribbing include applying cribbing collars or muzzles, removing or electrifying horizontal surfaces or surgery on the ventral neck muscles and their innervation (McGreevy & Nicol 1998b). The latest surgical technique involves removing 34 cm of the *omohyoideus* and *sternothyrohyoideus* muscles (Delacalle *et al* 2002). These procedures can be painful and ineffective and may have side-effects. The conundrum faced by equine managers and veterinarians is that inhibiting cribbing is stressful to the horse, but allowing the animal to crib may expose the horse to chronic jaw pain or the danger of painful and sometimes fatal colic. Better insight into the causes of cribbing and possible pharmacological treatment is necessary.

Animal welfare implications

Horses were as highly motivated to crib as to eat. They also expend a considerable amount of force as they flex their necks to crib. Since cribbing may have serious medical consequences, horses should be discouraged from cribbing, but that might be considered inhumane because horses are highly motivated to crib. A method should be found to decrease the motivation to crib.

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