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The Effects of Lameness on Social and Individual Behavior of Dairy Cows

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Lameness is one of the most important welfare problems in dairy cattle. Most studies on lameness have focused on wide ranging surveys to identify causal factors, but few have considered the welfare implications of this disorder. In this study, we compared the social and individual behavior of 10 lame cows and 10 nonlame cows. The 20 Holstein-Friesian cows calved in the summer and spent the autumn and winter together with another 36 nonlame cows in a Newton Rigg cubicle house building. The cubicle to cow ratio was 1:1, and wheat straw bedding was provided every day. The investigators fed the cows ad lib a silage-based diet and milked them twice a day, at which time they received adjusted amounts of concentrate. The investigators observed the 2 groups of cows a total of 32 hr to obtain information on social and individual behaviors through scan and behavior sampling. Although lame cows were less likely to start an aggressive interaction, there were no differences in times receiving aggression. No differences were found in the times licking other cows; however, the frequency of times being licked was higher in the lame cows. The lame cows spent more time lying out of the cubicles, had longer total lying times, and spent less time feeding. The behavioral differences seen show that lame cows do not cope as successfully with their environment as do nonlame cows. Also, these results provide useful information on how licking in dairy cows may play a role in alleviating discomfort of other herd members who are in pain or who are sick.

Lameness is one of the most important welfare problems of dairy cattle (Broom, 1987, Esslemont, 1990). To date, most of the work on lameness in cattle has fo-

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cused on causation, but fewer studies have considered the welfare implications of this condition. *Welfare* can be defined as the state of animals regarding their attempts to cope with their environment (Broom, 1986, 1988). A lame cow is less able to cope with her environment, as pain might seriously affect walking and other movements. The secondary effects of a reduced ability to walk, such as a reduced time feeding or changes in social behavior, also are important factors to consider when assessing the welfare of these animals. Some studies have considered the effects of lameness on individual time budgets of dairy cows in relation to maintenance behaviors when housed outdoors (Hassall, Ward, & Murray, 1993) or indoors (Singh, Ward, Lautenbach, & Murray, 1993). Assessing the effects of lameness on welfare, however, and other less obvious disrupted behaviors such as the involvement in agonistic and nonagonistic interactions or the social status of the affected cow have to be studied. So far, there is no information on how lameness influences the way affected cows cope in a social environment, particularly in the social strategy a lame cow will adopt to avoid aggressive encounters or seek comfort from other cows. In this study, we aimed to test the hypothesis that lameness affects social behavior as well as individual time budgets by comparing the behavior of lame and nonlame cows living in a cubicle house. This information could be used to understand better the function of social interactions directed to sick individuals as well as to modify management practices to improve the welfare of the lame cows.

METHODS

Subjects, Housing, and Management

Ten Holstein-Friesian lame cows (age range 2 to 10 years, $M = 4.6$) and 10 randomly selected nonlame cows of the same breed (age range 2 to 10 years, $M = 4.6$) were observed in a cubicle house building. The 20 cows were housed together from November to March with another 36 nonlame cows of the same milking herd. The 20 experimental cows had all calved in the summer and had a calving date range of 2 weeks. They were all pregnant and had similar body weights (mean weight for the lame cows = 578.8 ±48.5; mean weight for the nonlame cows = 582.6 ±39.3). Apart from the cases of lameness, none of the 20 cows showed any other illnesses during the study. The cows were fed ad lib on a silage-based diet (50% grass, 50% maize). A tractor delivered the food twice a day—after milking—in a feeder trough divided from the line of cubicles by a 3 m passageway. All cows were milked twice a day, at 6:30 a.m. and 3:00 p.m. While being milked, they received adjusted amounts of commercial concentrate with 18% crude protein. The cubicle to cow ratio in the building was 1:1, and all cubicles were of the Newton Rigg type (2.1 m × 1.1 m each). Every day, six bales of wheat straw weighing 20.5 kg each were used as bedding. The solid concrete flooring had passageways of 2.10 m of width that were scraped twice a day during milking times. No footbath was used, and a specialist foot trimmer trimmed the cows' hooves twice a year. All cows in this experiment had their hooves trimmed the day before the beginning of the behavioral observations. Information on behavior and lameness of the two groups of cows was collected and analyzed at a point in time, which coincided with week 16 of the housing period.

Behavioral Observations and Measurements

Direct observations recorded information on social interactions and individual time budgets. Plastic collars individually identified all cows selected. The timetable for observation consisted of observations at different times of each day such that, averaged across the study, each part of the day was equally represented (Martin & Bateson, 1986). Each observation day consisted of 4 hr, and observations were distributed in the following way: Day 1, 10:00 a.m. to 2:00 p.m.; Day 2, 5:00 p.m. to 9:00 p.m.; Day 3, 10:00 p.m. to 2:00 a.m.; Day 4, 2:00 a.m. to 6:00 a.m. The cycle was repeated for Days 5 to 8. At the end of the 8 days, a total 32hr of behavior observations was recorded. A combination of scan and behavior sampling techniques were used (Martin & Bateson, 1986). Behavior sampling was used to record all occurrences of agonistic and nonagonistic interactions of the 20 experimental cows. The agonistic interactions considered were butts to head, neck, and ribs, together with chases and threats. A chase was recorded when a cow actively moved toward another individual causing the latter to walk or run away. On the other hand, a threat was recorded when a cow turned toward or approached another individual with head down and then lunged without making contact. The nonagonistic interactions recorded were licks to head, neck, flank, and tail, as well as scratches head to head and head to body, used as an indicator of affiliation. The identity, the behaviors, and the outcomes of the interactions of the cows were recorded.

For the data collected on agonistic behaviors, indexes of displacements were calculated as described in Galindo and Broom (2000a, 2000b). A displacement was recorded when a cow shifted her body away from the other individual and was displaced from the place she was occupying. These indexes were used to determine the social status of each cow according to her experiences in agonistic interactions. The index of each cow could therefore range from 0 to 1:

> Index of displacements = number of times she displaces other individuals/number of times she displaces another cow + number of times she is displaced

The dependent variables considered for interactive behavior were frequency of total involvement in agonistic and nonagonistic interactions, frequency of agonistic behavior performed and received, frequency of nonagonistic interactions performed and received, and the index of displacement.

Scan sampling was carried out every 15 min as described in Galindo and Broom (2000a, 2000b) to obtain information on the proportion of time lying, lying in the cubicle, lying out of the cubicle, feeding, standing still in passageways, standing in yard, standing half in the cubicles, and total time standing for each cow. For each animal, the time spent in noninteractive behaviors during the study was expressed as proportion of time calculated as number of observations of a behavior/total number of scan samplings. The *time budget* was defined as the summed proportions (total 100%) of these behaviors.

Lameness Records

The lameness scoring system used was adapted from that described by Manson and Leaver (1988), which includes five scores according to abduction or adduction and unevenness of gait in the cow. Scores from 3 to 5 are considered clinically lame. Cows were scored by an experienced observer during 8 days before the start of the behavioral observations and throughout the study period. Every day the scoring was carried out when the cows entered and left the milking parlor. Nine of the 10 lame cows who were diagnosed with interdigital necrobacillosis had a locomotion score of 3, and one cow with a sole ulcer had a score of 4. All nonlame cows were healthy and showed no hoof lesions as well as an even and normal gait. They received a score of 1. For this reason, it was considered that there were no cows with subclinical lameness in the experimental group. Clinical diagnosis of the hoof lesions was carried out according to Greenough, MacCallum, and Weaver (1981) and Toussaint Raven (1985). Although conventional treatment was applied to all cows before the observation period, the same lameness scores persisted throughout the period of study. All necrotic tissue was pared away, and free drainage was provided. Topical antibiotics were applied.

Statistical Procedures

As distribution of data was nonnormal, a Mann–Whitney U test was used when comparing the means of the frequency of times each cow performed and received aggressive and nonagonistic interactions. The indexes of displacements also were compared between the lame and nonlame cows. This test was also used to compare the means of time lying inside the cubicles, lying out of the cubicles, total time lying, time feeding, standing still in passageways, standing half in cubicles, and total time standing by the two groups of cows.

RESULTS

Social Interactions

For the frequencies of social interaction, see Table 1. The mean frequencies per hour of total involvement in aggressive interactions were not significantly different between groups ($U = 25$, $df = 19$, $p > .05$). When the means of the frequencies as an aggressive performer were compared between groups, a significant difference was found. The lame cows were significantly less likely to start an aggressive interaction compared with the nonlame cows ($U = 23.5$, $df = 19$, $p < .05$). The means of the frequencies as an aggressive receiver, however, were not different between groups ($U = 42$, $df = 19$, $p > .05$).

The means of the frequency of total involvement in nonagonistic interactions was not significantly different between groups ($U = 26.5$, $df = 19$, $p > .05$). Also, when the means of the frequencies of performing a nonagonistic interaction were compared between groups, no differences were found ($U = 39$, $df = 19$, $p > .05$). On the other hand, the lame cows received nonagonistic interactions more frequently than the nonlame cows ($U = 22$, $df = 19$, $p < .05$). Licking accounted for almost 73% of all nonagonistic interactions recorded. The lame and nonlame groups did not show differences in the times licking other cows ($U = 38.5$, $df = 19$, $p > .05$). However, the means of the frequency of times being licked by another cow was higher in the group of lame cows than in the nonlame cows ($U = 26.5$, $df = 19$, $p < .05$). There was no difference when comparing the indexes of displacements between groups ($U = 28$, $df = 19$, $p > .05$).

TABLE 1
Mean Frequencies and Standard Deviations of Social Interactions and Displacement Indexes for Lame and Nonlame Cows

	Lame Cows		*Nonlame Cows*	
Behavior	*M*	*SD*	*M*	*SD*
Agonistic interactions	2.8	± 2.9	4.1	± 3.3
Agonistic performer	1.1$_a$	± 2.9	2.1$_b$	± 2.7
Agonistic receiver	1.8	± 1.1	2.2	± 1.8
Nonagonistic interactions	4.7	± 2.4	3.9	± 1.8
Nonagonistic performer	2.2	± 1.3	1.7	± 1.2
Nonagonistic receiver	2.5	± 1.4	1.2	± 0.6
Licking performed	1.7	± 0.9	1.5	± 1.1
Licking received	1.6$_a$	± 0.6	0.7$_b$	± 0.6
Index of displacement	0.3	± 0.2	0.5	± 0.2

Note. Different subscripts in rows represent statistical differences, $p < .05$.

Time Budgets

Time budgets are shown in Table 2. When the time lying inside the cubicles was compared, no differences were found between groups ($U = 32.5$, $df = 19$, $p > .05$). The analysis revealed significant differences between the groups when the time lying out of the cubicles was compared. The group of lame cows spent significantly more time lying out of the cubicles than the nonlame cows ($U = 20.5$, $df = 19$, $p < .05$). However, the total time lying was not different between groups ($U = 16.5$, $df = 19$, $p > .05$).

The mean time spent walking was different between groups. The lame cows walked significantly less time than the nonlame cows ($U = 16$, $df = 19$, $p < .05$); however, the mean time spent feeding during a 24-hr period was not different between groups ($U = 22$, $df = 19$, $p > .05$). When the mean proportion of time spent standing still in passageway, standing half in the cubicles, standing in the yard, and total time standing were compared, no significant differences were revealed ($U = 16.5$, $df = 19$, $p > .05$; $U = 47.5$, $df = 19$, $p > .05$; $U = 49.5$, $df = 19$, $p > .05$; and $U = 33$, $df = 19$, $p > .05$, respectively).

DISCUSSION

In cubicle buildings, the level of competition for eating and lying places increases, and lame cows are less likely to be successful under these conditions (Wierenga, 1991; Wierenga & Metz, 1986). That the lame cows performed

TABLE 2
Mean Percentage and Standard Deviation of Time of Individual Time Budgets for Lame and Nonlame Cows

	Lame Cows		*Nonlame Cows*	
Behavior	*M* %	*SD*	*M* %	*SD*
Lying in cubicles	20.6	± .10	25.6	± .09
Lying out of cubicles	15.0	± .10	6.4	± .07
Total time lying	35.6	± .08	32.0	± .04
Standing in passageway	18.0	± .07	16.0	± .09
Standing in yard	12.4	± .09	11.0	± .08
Standing half in cubicles	5.4	± .05	8.0	± .06
Total time standing	35.8	± .10	35.0	± .08
Walking	6.6	± .03	14.0	± .04
Feeding	22.0	± .04	19.0	± .06

Note. Different subscripts in rows represent statistical differences, $p < .05$.

fewer aggressive interactions probably relates to the condition of the lame cows, who are not strong enough to engage in attempts to displace another cow from a cubicle or feeder. On the other hand, that the means of the indexes of displacements of the two groups did not differ indicates that not all displacements are the outcome of an aggressive encounter (Galindo & Broom, 2000b). Although the lame cows are disadvantaged when it comes to a competitive situation and, possibly because of the pain, less likely to fight, the actual social status of a lame cow—at least on a short-term basis—may not necessarily change. As 9 of the 10 lame experimental cows were culled soon after this study, it was not possible to follow up the behavior and social status of those cows after treatment. In this sense, more studies are needed to measure the long-term effects of the severity and duration of lameness on the social status of cows.

The results of the nonagonistic interactions, in particular licking, are in accordance with the functional role that this behavior seems to play in maintaining social stability (Benham, 1984). Previous studies on social behavior of cattle have found stable licking patterns in groups of individuals that can be associated to matrilineal kinship, rank, and familiarity (Manteca, 1993; Reinhardt & Reinhardt, 1981). Reinhardt & Reinhardt (1981) found that cows often licked related individuals and that low-ranking cows often performed more licking than high-ranking individuals. Wood (1977) reported that high-ranking individuals received more grooming than low-ranking cows. Also, cows more often licked animals a few places higher in rank (Benham, 1982) and for longer periods (Sato, 1984). Broom and Leaver (1978) found that calves who had been reared together tended to be more likely to lick one another than those reared separately. Sato, Sako, and Maeda (1991) found that familiarity from an early age was the most important factor affecting licking. Benham (1984) mentioned that creating and moderating the effect of environmental stressors by reducing the levels of arousal and overt aggression between pairs of individuals is a functional aspect of licking. Also, being licked is thought to be comforting to animals, and it is known that those cows who solicit more licking are licked more frequently (Benham, 1984). In this sense, it is possible that in this study the lame cows received more licking than the nonlame cows because they solicited it. This could have been as a means of coping with the social environment by maintaining stable relationships with other individuals or as a way to cope with the discomfort of the injury by looking for comfort from other individuals. This result provides useful information on how licking in dairy cows may have a role in alleviating discomfort of other herd members who are in pain or sick.

Hassall et al. (1993) found that lame cows grazed for less time than nonlame cows, and Morton and Griffiths (1985) mentioned that food and water intake is reduced when there is more severe pain. Our study found no differences between lame and nonlame cows in the total time lying, feeding, and standing. However, some differences were found in the time lying out of the cubicles and

time walking. This means that lameness, although not necessarily affecting overall time budgets, qualitatively influences the way these behaviors are performed. That the lame cows lay out of the cubicles longer than the nonlame cows may be interpreted as a way of avoiding aggressive encounters in competitive areas. In this study, although the cubicle to cow ratio was 1:1, the quality of the bedding in the cubicles varied, and this could have resulted in more competition for some of the more preferred cubicles. It is likely that the cost for a lame cow to compete for a lying place is greater than lying out of the cubicle. As mentioned, a lame animal might be experiencing severe pain and to alleviate this pain might prefer lying for longer periods in less crowded areas of the building. Confirming this is the fact that the time walking during the day was lower for the lame cows than for the nonlame cows.

This study highlights the effects of lameness on the social and individual behavior of dairy cows. Lameness is a behavioral expression of pain, which is disadvantageous for cows coping with slippery floors and overcrowded feeding and/or lying areas (Potter & Broom, 1987). For this reason, the prevention of lameness should be a high priority as well as the application of management practices to improve the welfare of lame cows. Such practices include ensuring the lame cows a safe lying place, providing them with enough and adequate food, and not separating them far from the main herd, as total social isolation also could have negative effects.

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