Dairy heifers benefit from the presence of an experienced companion when learning how to graze

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ABSTRACT

Pasture remains important on many dairy farms, but the age of first contact with pasture varies depending on the month of birth, weaning age, and farm management. Regardless of age, naïve dairy heifers must learn to graze when first introduced to pasture. This study investigated whether being grouped with experienced dairy cows would affect the development of grazing behaviors. Sixty-three Holstein heifers (mean $\pm$ SD 14.2 $\pm$ 1.3 mo; 546 $\pm$ 60.7 kg) and 21 dry Holstein cows (2.6 $\pm$ 0.8 lactations; 751 $\pm$ 53.9 kg) were assigned into 7 groups of 12 animals (3 dry cows and 9 naïve heifers), and each was divided and assigned to an experienced (3 cows and 3 heifers) and nonexperienced (6 heifers) sub-group. Sub-groups were introduced to pasture in different paddocks without visual contact with any other cattle. No difference was found in the time after introduction to the paddock for heifers to first attempt to nibble grass [experienced: 0:23 (0:17–0:43) vs. nonexperienced 0:40 (0:35–0:46); median (quartile 1 – quartile 3), h:mm]. However, heifers grouped with experienced cows showed a shorter latency to begin grazing [experienced: 0:47 (0:28–0:52) vs. nonexperienced 2:13 (1:25–2:30)]. During the first hour after introduction to pasture, heifers in the experienced treatment showed fewer stomping events [experienced: 2.5 (1.25–4) vs. nonexperienced: 6.5 (4–8)] and vocalized less often [experienced: 3.5 (1.25–5.75) vs. nonexperienced: 7 (5–8.75)]. After this initial period, animals in both subgroups began to graze normally; treatments did not differ in grazing behaviors over the 3-d observation period. These results indicate that grouping heifers with pasture-experienced cows improves grazing behavior of dairy heifers in the first hours following introduction to pasture.

Key words: feeding behavior, social learning, social facilitation, dairy replacement, neophobia

INTRODUCTION

In the North American dairy industry, indoor housing systems with zero grazing have become increasingly prevalent (Fulwider et al., 2008), with less than 5% of lactating dairy cattle having access to pasture at some point during the year (NAHMS, 2010). If pasture is used by producers, it is frequently incorporated during the spring and summer months for growing heifers because pasture use results in reduced costs associated with purchased feed and reduction in labor (Hanson et al., 2013).

Beef calves are often born outside and spend much of their early life grazing with their mother and other social partners (Enríquez et al., 2011); in contrast, on intensive dairy farms calves are typically separated from the dam soon after birth (USDA, 2008; Vasseur et al., 2010), reared indoors, and provided no access to pasture until at the earliest after weaning, and sometimes much later depending on season and management on that farm. Lopes et al. (2013) found that providing grazing experience during the growing phase increased grazing time and positively affected milk production when dairy cows introduced to pasture after calving. However, most dairy replacement animals do not have the opportunity to graze when they are young, and often first-season grazing dairy heifers are placed on pasture without any companions.

These first-time grazers are thus faced with several challenges, including learning how to eat a novel feed type (Hessle, 2009; Costa et al., 2014), habituating to a novel environment (De Paula Vieira et al., 2012), and often coping with new conspecifics (De Paula Vieira et al., 2010) as heifers are frequently commingled when put out onto pasture. Numerous challenges are associated with regrouping, particularly in terms of feeding and social behavior (Hasegawa et al., 1997; see also review by von Keyserlingk and Weary, 2010). Thus, the combined effects of regrouping and the introduction to a novel environment may be disruptive to young heifers when transitioning from indoor housing to pasture.

To our knowledge, limited research has been conducted on the challenges that naïve dairy replacement

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heifers face during the introduction to pasture, and acute effects have not been investigated. One possible solution to the challenges faced by first-time grazers is to provide experienced animals that can act as social models. Thus, the aim of this study was to test if the presence of cows with previous experience on pasture would facilitate the development of grazing behavior of naïve dairy heifers when first introduced to pasture.

MATERIALS AND METHODS

This experiment was conducted between April 25 and July 4, 2013, at The University of British Columbia's (UBC) Dairy Education and Research Centre, located in Agassiz, British Columbia, Canada (49°N, 121°W). All procedures were approved by the UBC Animal Ethics Committee.

Animals

A total of 63 pregnant Holstein heifers (mean $\pm$ SD: 14.2 ± 1.3 mo; 546 ± 60.7 kg; BCS 3.2 ± 0.5 , range from 2.5 to 4; scored from 1 to 5 following Edmonson et al., 1989) with no previous experience on pasture and 21 nonlactating Holstein cows (2.6 ± 0.8 lactations; 751 ± 53.9 kg; BCS 3.5 ± 0.5 , range from 2.5 to 4) were assigned to 7 groups of 12 animals; each group had 3 nonlactating cows and 9 naïve heifers.

Each group was formed 3 wk before introduction to pasture. All cows had some experience on pasture as growing heifers and in the case of the multiparous cows during the previous summers if they were nonlactating. All experimental animals regardless of age were housed for at least 6 mo before the beginning of the experiment in a freestall barn with no access to the outdoors or to pasture during this time.

Experimental Design

The experimental period lasted 28 d per group, and groups were tested consecutively. During the first 21 d, each group was housed indoors in a pen configured with 12 freestalls. On d 22 groups were sub-divided into 2 groups of 6 animals each: 1 with 6 naïve heifers and 1 with 3 naïve heifers and 3 experienced cows. Each sub-group was placed on pasture for 72 h, starting at 0900 h. Treatment order was randomized: one sub-group was placed on pasture first on d 22, and the other sub-group stayed in the home pen until d 25 when they were granted access to pasture.

Housing and Management

Three experimental pens in a naturally ventilated freestall barn (width = 38 m, length = 156 m) with a

north-south orientation and curtained sidewalls were used for this experiment. Each pen (width = 9.5 m and length = 12.3 m) had 12 freestalls (1.2 m center to center) separated by freestall divider loops with a diameter of 0.89 m (Y2K stall dividers, Artex, Langley, British Columbia, Canada). The bed of each stall was 2.6 m long and had a brisket board that was 1.7 m from the internal side of the curb (0.2 m height), providing a lying area of approximately 2 m²/cow. The neck rail was positioned 1.2 m above the stall surface and 1.2 m from the rear curb of the stall. The stall was covered with a geotextile mattress and bedded with approximately 5 cm of river sand. Alleys were scraped 8 times per day with an automatic scraper, and crossovers were scraped by hand once per day.

The distance between the pasture and the barn varied according to the paddock used; the closest was 7 m and the farthest was 65 m from the barn. The pasture and the barn were connected via a 4.0-m-wide path covered with bark mulch. The path was cleaned and checked for obstacles daily. Pasture composition was determined using 8 haphazard 1-m² samples cut before the beginning of the experiment and the material was sorted into the species that were previously planted, the portions were weighed, and relations were determined. The pasture was approximately 45:40:10:5 festulolium [tall fescue (*Festuca arundinacea*) $\times$ ryegrass (*Lolium perenne* L.) cross]: orchard grass (*Dactylis glomerata* L.): ryegrass (*Lolium perenne* L.): white clover (*Trifolium repens*). The pasture was divided into 16 paddocks of 1,400 m² each managed using a rotational grazing system, where each group was introduced to a new paddock. A water trough located adjacent to the fence in each paddock was filled with fresh water automatically. No shade was provided on pasture.

Weather conditions (air temperature, relative humidity, rainfall, and wind speed) were recorded automatically throughout the study by an Environment Canada weather station in Agassiz, British Columbia, located adjacent to the research farm. During the course of the experiment (April to July 2013), the average $\pm$ SD daily temperature recorded was $15.7^\circ\text{C} \pm 3.6^\circ\text{C}$, minimum temperature was $10.7^\circ\text{C} \pm 3.3^\circ\text{C}$, and maximum daily temperature was $20.6^\circ\text{C} \pm 5.0^\circ\text{C}$. Precipitation averaged 3.8 ± 8.5 mm (range from 0 to 45.2 mm/d), relative humidity was $73.2 \pm 9.3\%$ (range from 34 to 99%), and wind speed was 9.6 ± 9.4 m/s (range from 0 to 24 m/s).

Pasture samples were taken 1 h before the introduction of each new group. Each sample consisted of 6 sub-samples collected from the diagonal transects, a 0.25-m² patch was identified and clipped at 8 cm height. These sub-samples were pooled to create 1 representative sample per group. To calculate pasture mass, the

sample weight was multiplied by the total area of the plot. Samples were dried at 55°C for 48 h to determine DM content. Dried samples were pooled, ground, and sent for nutritional analysis (A&L Laboratories Inc., London, ON, Canada). During the experiment, pasture mass was (average ± SD) 1,900.09 ± 203.1 g/m² of fresh matter, 22.1 ± 2.3% DM, and (expressed as % DM) 22.1 ± 2.6% CP, 57.1 ± 2.6% NDF, and 34.3 ± 2.3% ADF.

A TMR was formulated following the NRC (2001) guidelines to meet or exceed the requirements of a 550-kg Holstein not producing milk, consisting of 31.2% ryegrass straw, 25.7% corn silage, 23.1% alfalfa hay, 12.5% concentrated mix, and 7.5% grass silage, with an overall % DM of 48.7. The TMR was offered *ad libitum* in the experimental pen and delivered daily at approximately 0800 h; feed was pushed up to the feed bunk 3 times per day at 1030, 1600, and 2230 h. Water was available *ad libitum* from a self-filling water trough located in the feed alley of each pen.

Fresh TMR samples were taken on the second and last day of each replication immediately after the feed delivery. Samples were pooled to create 1 representative sample. Samples were dried at 60°C for 48 h to determine DM content and then ground and sent for nutritional analysis at A&L Laboratories Inc. The TMR contained on average 46.4 ± 2.4% DM and (expressed as % DM) 13.3 ± 1.7% CP, 49.1 ± 2.1% NDF, and 31.6 ± 1.9% ADF.

Measurements

The animals were weighed and blood was sampled. This procedure was carried out weekly during the 3 wk before introduction to pasture and again 12 h before and 72 h after introduction to pasture. Blood was analyzed for glucose following Wittrock et al. (2013), using a handheld electronic glucometer (Precision Xtra blood glucose kit; Abbott Diabetes Care, Alameda, CA) and BHB (Precision Xtra blood ketone kit; Abbott Diabetes Care) concentrations following the procedures described by Iwersen et al. (2009) for blood ketone analysis. Animals were gait scored (as described by Flower

and Weary, 2006) on a scale of 1 to 5; subjects with a gait score ≥3 were not included in the experiment.

Behavior

Behaviors were observed via continuous recording (Martin and Bateson, 2007) during the first hour immediately after animals were introduced to pasture, recording the number of stomps, agonistic interactions, vocalizations, and defecations (Table 1). During the next 3 h (i.e., 4 h in total), continuous recording was used to record latency to first graze and nibble the grass, and time spent nibbling, grazing, ruminating, walking, and alert. Within each sub-group, 3 heifers were identified as the focal animals and each animal was observed by a separate observer. Three observers collectively developed the data sheets and the descriptions of the behaviors and tested the definitions during a pilot trial. In a minute base inter-reliability test, the paired Kappa coefficient averaged 0.74.

Statistical Analyses

Number of stomps, agonistic interactions, vocalizations and defecations, latency to graze and nibble, glucose, and BHB blood concentration were considered as dependent variables and were compared between treatments. The group was considered the experimental unit; data from each individual (n = 3) within a group were averaged. Prior to all analyses, data were checked for normality using the UNIVARIATE procedure in SAS (version 9.3, SAS Institute Inc., Cary, NC) and probability distribution plots. Because data were not normally distributed, treatments were compared using the nonparametric Mann-Whitney test. Results throughout the text are presented as median and first and third quartiles (Q1 and Q3) of the median; significance was declared at *P* < 0.05.

RESULTS

Less than 30 min after heifers from both treatments were introduced to pasture they began to nibble the

Table 1. Behavior of naïve heifers recorded after introduction to pasture

Behavior	Description
Nibbling	Animal comes into contact with the grass, sniffs or performs small, quick bites.
Grazing	Animal grabbing and ingesting forage, may be stationary or moving forward for a period of at least 5 consecutive minutes in which the animal consumed grass.
Ruminating	Chewing with lateral jaw movements with the head at the same level or above its body, lying or standing.
Walking	Animal moving, with the head above the grass.
Alert	Animal stationary, lying, or walking with head up and ears positioned forward.
Stomp	Animal lifts and kicks one or both hind legs.
Agonistic interaction	Displacements or threats associated with a conflict between 2 individuals.

grass [Figure 1a; $W(10) = 21.0$, $Z = -1.25$, $P = 0.24$]. Soon after, heifers grouped with pasture-experienced cows began to graze, but the heifers within the naïve group took an additional hour before they began grazing [Figure 1b; $W(10) = 15.0$, $Z = -2.50$, $P = 0.01$].

During the first hour after heifers were introduced to pasture, animals in the experienced treatment showed fewer stomping events [$W(11) = 58.5$, $Z = 2.28$, $P = 0.02$] and vocalizations [$W(11) = 57.0$, $Z = 2.07$, $P = 0.03$]. Number of agonistic interactions did not differ between treatments [Figure 2; $W(11) = 45.0$, $Z = 0.36$, $P = 0.72$]. Heifers in both treatments rarely defecated during the first hour on pasture [experienced: 0.33

(0–1), median (Q1–Q3); nonexperienced 0 (0–0.33); $P = 0.21$].

Despite differences in latency to start to graze, total time spent grazing did not differ during the first 4 h on pasture [experienced: 40:58 (29:34–44:28) min:s vs. nonexperienced 27:01 (20:26–38:29) min:s; $W(12) = 64.0$, $Z = 1.40$, $P = 0.16$]. Time spent nibbling tended to be higher for nonexperienced than experienced animals during the first 4 h on pasture (experienced: 07:37 (03:10–13:07) min:s vs. nonexperienced: 19:06 (11:13–49:07) min:s; $W(12) = 37.0$, $Z = -1.92$, $P = 0.06$). All other behaviors observed (ruminating, walking, and alert) were similar in the 2 treatments (Table 2). Body weight and blood parameters (glucose and BHB) also did not vary with treatment ($P < 0.10$; Table 3).

DISCUSSION

Heifers kept in a group with experienced cows began grazing more rapidly than did naïve heifers kept with only naïve conspecifics. These results are consistent with the findings of Hessle (2009) who found that the presence of experienced animals increased grazing activity when providing calves first contact with semi-natural grassland.

Previous work has found that naïve calves are more efficient at finding preferred food locations when provided with experienced steers as social models (Ksiksi and Laca, 2000). Another study found that grazing activity increased on the first day when 10-mo-old dairy steers were turned out on semi-natural grasslands with experienced cattle. However, this study did not show increased grazing times, grazing efficiency, or live weight gains after a month on pasture compared with control calves (Hessle, 2009). Heifers that were raised on pasture with just one species of grass but grouped with animals that were habituated to tropical pastures that included the presence of shrubs and trees, showed a higher use of shrubs and trees, and consumed a higher diversity of plants in comparison with animals introduced without a social model (Velázquez-Martínez et al., 2010). In contrast, another study failed to find any improvements in foraging ability of yearling heifers grouped with experienced conspecifics (Bailey et al., 2000).

Interestingly, we observed no treatment difference in the latency to start nibbling grass; all animals had experience eating feed from the ground in the free stall pens, so accessing feed from the ground in the new pasture environment would not be novel, but the ability to collect and ingest grass was a novel behavior for the animals. We speculate that the more rapid learning of heifers with experienced animals is associated with

Figure 1. Latency (h) to (a) nibble and (b) graze for naïve heifers with and without the presence of grazing experienced cows ($n = 7$ per treatment). The lower and upper ends of the boxes indicate the first and third quartiles, respectively. The quartiles ± 1.5 the inter-quartile range are indicated by the whiskers. The line across the middle of the box identifies the median.

social learning. Social learning is defined as learning that is influenced by observation of or interaction with another individual, and has been described as an influential factor affecting the feeding behavior of many farmed species (Keeling and Hurnik, 1996; Launchbaugh and Howery, 2005). The major benefit of social learning is that the naïve animals experience increased efficiency and reduced risks associated with testing and exploring novel environments (reviewed by Bandura, 1977).

Naïve animals provided with social models are generally more efficient in ingesting forage in a new environment, suffer less from predation, and ingest fewer toxic plants compared with those not provided with a social model (Provenza and Cincotta, 1993; Launchbaugh and Howery, 2005). In the current study, we did not record the behavior of the experienced animals. We encourage future work to investigate the influence of the behaviors performed by the social model on the naïve animals. Providing access to the dam has been shown to be important in the development of neonatal grazing behavior, but other dominant individuals in the group may also be influential (Thorhallsdottir et al., 1990; Howery et al., 1998). In the current study, age and experience were confounded; future work should investigate if the age of the experienced social models affects the first experiences observed of the naïve heifers when provided access to pasture for the first time.

The benefits of providing a social model appear to be concentrated in the first hours following introduction to pasture. Despite the differences in latency to first graze, all heifers began grazing within 4 h on pasture. Over the study, heifers housed together with experienced cows had no differences in weight gains, BHB, or blood glucose compared with heifers not provided a social model. These results are consistent with earlier work. For example, Hesse (2009) found that the company of experienced animals did not increase live weight gain of 10-mo-old calves after a month on pasture. Similarly, when heifers were transferred from a grass monoculture pasture to a diverse plant species environment, with or without the presence of experienced animals, weight gain was positive for both treatments (Velázquez-Martínez et al., 2010). More recent work by Lopes et al. (2013) found that previous grazing experience as a heifer affected behavior and milk production of cows during the first days on pasture but not when averaged over a 2-mo period.

One previous study found that mixing younger cattle with older animals on pasture increases the number of aggressive social interactions, which in turn may reduce time spent grazing (Phillips and Rind, 2001). In the current study, we found that heifers put out on pasture

for the first time with or without the presence of older experienced animals engaged in the same number of agonistic interactions. These results may be explained by the use of groups that had been stable with no

Figure 2. The number of (a) stomps, (b) agonistic interactions, and (c) vocalization for naïve heifers with or without the presence of grazing experienced cows observed during the first hour immediately after introduction to pasture ($n = 7$ per treatment). The lower and upper ends of the boxes indicate the first and third quartiles, respectively. The quartiles ± 1.5 the inter-quartile range are indicated by the whiskers. The line across the middle of the box identifies the median.

Table 2. Median (quartile 1 – quartile 3) time spent ruminating, walking, and alert (min:s) for naïve heifers with or without the presence of grazing experienced cows (n = 7 per treatment) observed during the first 4 h after animals were introduced to pasture

Time (min:s)	Nonexperienced	Experienced	P-value
Rumination	00:15 (0:07–0:27)	00:08 (00:03–00:19)	0.25
Walking	47:20 (29:19–59:24)	39:47 (21:04–57:14)	0.84
Alert	37:25 (28:20–55:30)	46:27 (11:10–58:24)	0.60

Table 3. Median (quartile 1 – quartile 3) of the difference before and 3 d after the animals were introduced to pasture for BW, glucose (Wittrock et al., 2013), and BHB (Iwersen et al., 2009) of naïve heifers with or without the presence of grazing experienced cows (n = 7 per treatment)

Variable	Nonexperienced	Experienced	P-value ¹
BW (kg)	–16.66 (–23.33–6.67)	–25 (–33–6.67)	0.77
Glucose (mmol/L)	6.16 (–0.33–13.00)	6.16 (–0.67–13.00)	0.14
BHB (mmol/L)	–0.07 (–0.07–0.33)	0 (–0.10–0.16)	0.75

¹P-values are for the test of treatment.

new animals introduced for over 4 wk before testing. Regrouping is known to cause increased competitive behavior in cattle, and heifers are frequently subjected to aggressive behaviors following grouping with older cows (Neisen et al., 2009).

CONCLUSIONS

Providing heifers with pasture-experienced social companions when first introduced to pasture promotes a more rapid onset of grazing. The presence of habituated older experienced companions may improve the ability of heifers to adapt to pasture.

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