Breed differences in oral behaviors in feed-restricted dairy heifers

Blair C. Downey1,2* and Cassandra B. Tucker1†
1Center for Animal Welfare, Department of Animal Science, University of California, Davis, Davis, CA 95616
2Animal Behavior Graduate Group, University of California, Davis, Davis, CA 95616

ABSTRACT

Holsteins and Jerseys, the 2 most prominent dairy breeds in the United States, differ in many regards. They have not been evaluated for differences in oral behavior performance, despite anecdotal evidence that Jerseys perform more abnormal behaviors than Holsteins. As abnormal behaviors can indicate compromised welfare, we evaluated whether breed differences existed in year-old heifers. Because many oral behaviors could be expressed in abnormal ways, we also sought to describe performance of a wide range of behaviors and whether these varied among individuals. We studied 42 pair-housed heifers (33 Holstein, 9 Jersey) at 12.8 ± 1.1 mo of age (mean ± SD) that were restricted to 50% of their ad libitum total mixed ration (TMR) intake for 2 d as part of a short-term feed challenge. Using continuous video recording from 0800 to 2000 h on the second day of feed restriction, we scored time spent performing tongue rolling, tongue flicking, self-grooming, allogrooming, intersucking, drinking urine, drinking water, and nonnutritive oral manipulation (NNOM) of rice hull bedding, the feed bin, or other pen fixtures. Eating TMR was recorded at 5-min intervals. We found that Jerseys spent more time tongue rolling (3.3% vs. 0.2% proportion of 12-h observations) and performing all types of NNOM than Holsteins (feed bin: 3.8% vs. 2.4%; bedding: 7.7% vs. 5.4%; other: 7.5% vs. 4.2%; total: 19.0% vs. 12.0%), and tended to spend more time tongue flicking (1.4% vs. 1.1%). Jerseys spent less time allogrooming than Holsteins (1.3% vs. 3.4%). There was no evidence of an effect of breed on self-grooming (2.0%), water drinking (1.0%), eating TMR (16.0%), or intersucking (0.06%). Urine drinking was performed by 9 total heifers and was not compared between breeds. All behaviors were highly variable across individuals, particularly tongue rolling and intersucking. Allogrooming was more variable than

self-grooming, and each subcategory of NNOM was more variable than total NNOM. Outliers, or extreme performance of oral behaviors relative to the rest of our population, were present in most behaviors. Heifers who were outliers in one behavior were not consistently outliers in all. Overall, there are breed differences in many oral behaviors in a feed-restricted environment. Despite no difference in proportion of time spent eating, Jerseys often performed higher levels of potentially abnormal behaviors than Holsteins, though both breeds performed many oral behaviors, sometimes at extreme levels, that may indicate a concern.

Key words: Jersey, Holstein, abnormal behavior

INTRODUCTION

Dairy breeds vary in many ways, some of which may be connected to differences in welfare outcomes. Holsteins and Jerseys, the 2 most common breeds in the United States (86% and 8%, respectively, of all dairy cows; USDA, 2016), differ in some of these metrics. Holsteins are more likely to be lame than Jerseys (Hoffman et al., 2013) and can be more prone to mastitis (Washburn et al., 2002), both of which are related to pain and culling risk. Indeed, Jerseys are more likely to survive longer on farms than Holsteins (Garcia-Peniche et al., 2006). Jerseys also appear to be more heat tolerant, withstanding higher temperatures before dropping or altering milk production (Smith et al., 2013), though are more susceptible to cold stress as calves compared with Holsteins (Scibilia et al., 1987) likely due to their smaller size. Quantifying breed differences can provide important insights into identifying and mitigating welfare risks.

One area that has received less attention is breed differences in oral behaviors, which can provide valuable insight into how animals are interacting with their environment and each other. Feeding is the most-studied oral behavior. Jerseys spend more time grazing and eating per unit of BW compared with Holsteins (ad libitum pasture: Prendiville et al., 2010; ad libitum partial mixed ration: Munksgaard et al., 2020). This apparent motivation to spend more time eating and using their mouth could lead to differences in other oral behaviors,
particularly ones that seem abnormal, such as tongue rolling and nonnutritive oral manipulation (NNOM). These behaviors appear inappropriate and sometimes repetitive in goal or motor pattern (e.g., abnormal repetitive behaviors [ARBs]; Garner, 2005). Abnormal repetitive behaviors can indicate compromised welfare (Mason and Latham, 2004) as they are often performed in suboptimal environments. For example, when kept in environments that restrict motivated feeding behaviors, cattle increase performance of NNOM (Redbo and Nordblad, 1997; Horvath and Miller-Cushion, 2019; Downey et al., 2022). Both Jerseys and Holsteins are known to perform behaviors commonly considered ARBs, such as NNOM and tongue rolling (e.g., Pempek et al., 2016; Downey et al., 2022; Robbins et al., 2023), and while Jerseys are anecdotally considered to engage in more ARBs, breed differences have not yet been directly compared.

In addition to feeding and ARBs, other oral behaviors that cattle perform can be expressed in ways that suggest abnormality. Some oral behaviors are considered normal, such as grooming, tongue flicking, and water drinking. However, they may become abnormal when performed at high levels in restrictive environments (e.g., grooming, Downey and Tucker, 2023a; tongue flicking, Downey et al., 2022; polydipsia, or high water intake, Ishiwata et al., 2008; Faleiro et al., 2011; Downey et al., 2022). Other behaviors may be considered abnormal, and thus reflect concern, depending on the target: sucking is a normal behavior for neonates, but intersucking, or manipulating the teats or udder of conspecifics, and urine drinking are both considered abnormal (e.g., Wiepkema, 1987; Lidfors and Isberg, 2003). Similarly, although eating is normal, eating non-nutritive bedding may reflect pica (Samaha et al., 1990). Although both high level of performance and redirected targets can be concerning, extreme individual expression or wide variability within a group may also suggest abnormality. We have previously used outliers to describe excessive self-grooming performance in calves (Downey and Tucker, 2023a). Abnormal behaviors are also found to have higher coefficients of variation (CV) than more normal behaviors in broilers (Kostal et al., 1992). Breed differences may exist in these other possibly abnormal oral behaviors, but to date, none of these have been evaluated.

Our objective was to evaluate whether Jerseys and Holsteins differed in oral behavior performance. We investigated this under a feed-restricted environment, as heifers often experience limit, or precision, feeding (Zanton and Heinrichs, 2008), and abnormal behaviors in this age class are often documented under feed-limited conditions (Faleiro et al., 2011; Madruga et al., 2017; Bruno et al., 2020), suggesting the behaviors of interest were likely to occur in this setting. We expected that both breeds would spend similar amounts of time eating TMR, as this was restricted, but Jerseys would perform more abnormal (NNOM, tongue rolling) or possibly abnormal behaviors (allogrooming, self-grooming, tongue flicks, drinking water, drinking urine, intersucking) than Holsteins. We expected to see variability in all behaviors, regardless of breed, evidenced by the presence of outliers and high CV, both of which could indicate excessive performance of behaviors relative to the rest of the population.

**MATERIALS AND METHODS**

The following procedures were approved by the University of California, Davis Institutional Animal Care and Use Committee (protocol #21801). This study was conducted from July to September 2020 at the University of California, Davis Dairy Teaching and Research Facility.

**Experimental Design**

We enrolled 9 Jersey and 33 Holstein heifers (12.8 ± 1.1 mo, 358 ± 48 kg, mean ± SD) representing all healthy females born between May and September 2019 (between 11 and 15 mo of age). As per farm protocol, heifers were originally housed in groups between 19 and 23 animals, which included both experimental and similarly aged nonexperimental heifers. For this experiment, heifers were paired and studied in 5 total cohorts of 4 or 5 pens of 2 heifers each. Heifers were initially classified according to rearing environment from 0 to 7 wk of age (fed hay in a bucket, hay in a PVC pipe feeder, no hay; see Downey and Tucker, 2023a, for more details; sand or rice hull bedding) and breed (Jersey or Holstein) as part of a separate experiment, leading to 5 classifications (Jersey/sand/no hay, Jersey/rice hulls/no hay, Holsteins/rice hulls/no hay, Holsteins/sand/hay, Holsteins/sand/no hay). This led to 10 possible unique pairings within a pen. In each cohort, there were thus 40 to 50 possible combinations of pairing and pen location. Heifers were sorted by age and allocated to pens and pairs randomly, starting with oldest first. We made replacements based on a priori rules to balance pair combinations across all cohorts and to ensure that each classification was represented within each one. A priori rules also were in place to replace heifers that would come into heat during the experiment, based on visual and automated heat detection before pairing. We collected information about estrus from farm management 2 d before each cohort began and applied these rules consistently throughout the experiment. Due to the sample size and early life classifications, Holsteins...
could be paired with other Holsteins or Jerseys, but Jerseys were only paired with Holsteins.

Pens were outside but partially covered by a roof for shade. Each pen had an “outside” (3.7 × 6.2 m, with 3.7 × 3.4 m covered by the roof) and “inside” (3.7 × 3.9 m; fully covered by the roof) portion, along with a gate separating them that could be locked (Supplemental Figure S1 in https://doi.org/10.5281/zenodo.7940840, Downey and Tucker, 2023b,c,d). Each pen had an automatically filled water trough outside and water cup inside, and 1 feed bin in each portion. Feed bins and waterers were under the roof in both portions of the pens. A waterline with 2 spray nozzles per pen (TF-VP 7.5, Turbo FloodJet wide angle flat spray tip; Spraying Systems Co.) was positioned at a height of 2.9 m and sprayed 3.4 m out over the outside portion of the pen from 0800 to 2000 h (automatically controlled using B-hyve Smart Hose Watering Timer, Orbit Irrigation) for heifer cooling. The outside pen was bedded with rice hulls 8 to 12 cm deep over 3.7 × 2.8 m to avoid contact for heifer cooling. The inside pen was bedded with rice hulls. Pens were spot-cleaned and new rice hulls were added daily between 0700 and 0800 h. During this time, heifer pairs were shut in the inside portion of the pen and did not have access to feed.

All heifers were given 3 to 4 d to adjust to the pens (as per von Keyserlingk et al., 2008 and Smid et al., 2019, cattle adapt their behavior within 2 d). During this time, heifers were fed ad libitum TMR daily at 0800 and 1600 h. Feed was provided in both the outside and inside bins of each pen. For more details on TMR provision, including chemical composition and particle size, see Downey and Tucker (2023b).

After adjustment to pair housing, heifers were fed the same TMR at ad libitum levels for 2 d to calculate baseline feed intake. Feed was weighed before delivery at 0800 and 1600 h, and refusals were determined the next morning at 0700 h. Across the adjustment and baseline days, heifers were fed to 110% of the previous day’s intake. Baseline intake by pen was averaged across the 2 d. Individual intake was not possible to measure during the ad libitum-fed days for ethical reasons, as this would have required 24-h individual housing. Instead, we calculated the proportion of overall BW each heifer made up in their pair. We then multiplied this proportion by the pen level average feed intake to obtain a proxy for how much TMR each heifer had consumed, as higher BW is correlated with higher intake (e.g., Frisch and Vercoe, 1977; Taylor et al., 1986).

After the baseline days, feed allowance was reduced by 50% for the following 2 d. Restriction was imposed at the individual heifer level, based on the proxy intake calculated across the baseline period, using the same TMR fed during the previous days. This is similar to the level of feed restriction used for limit feeding on farms (approximately 1.5–2% BW for heifers 4–22 mo old; Zanton and Heinrichs, 2008), but for ethical reasons, we imposed a duration of feed restriction less severe than farm and research settings (2 d vs. 26 d to 6 mo; Hoffman et al., 2007; Kruse et al., 2010; Kitts et al., 2011; Greter et al., 2015) as feed restriction is likely to cause hunger. Heifers were never restricted in water intake. The restricted TMR allowance (5.27 ± 0.8 kg/heifer per day, mean ± SD) was fed to heifers across 2 daily feedings. Heifers were separated at feeding by locking the gate in each pen so one individual would have exclusive access to the inside feed bin and the other would have exclusive access to the outside bin. Heifers were consistently fed either inside or outside during this phase, with feeding location balanced by initial heifer classification across cohorts. Heifers were separated until individuals across all pens ceased eating and did not return to the feed bin for at least 5 min, leading to a separation of approximately 1.5 h per feeding on both days. At this point, feed bins were swept out and heifers were reunited. Refusals per heifer were calculated. Any remaining feed from the 0800 h feeding was added back for the 1600 h feeding, but the 1600 h refusals were not added to the next day’s intake.

**Behavioral Observations**

Video was recorded from 0800 to 2000 h on the second day of feed restriction (GV-BL4713 Pro IR Bullet IP Cameras and GV-POE2411-V2 NVR, Geovation Inc., 24 fps, H.264 codec recording). On d 1 of feed restriction, heifers would still be adjusting to the 50% reduction in food and would likely still have had rumen content from the previous ad libitum-fed day, so only d 2 was observed. Evaluating oral behavior over daylight hours is common in this age class (e.g., Špinka, 1992; Ishiwata et al., 2008; Bourguet et al., 2011). Each pen was visible via 3 camera angles covering the inside portion, outside portion, and full pen. The cameras covering either the inside or outside portion of the pens were positioned 2 to 2.3 m above the ground, whereas the cameras covering the full pen were 3 to 4 m above the ground. Videos were scored using behavior sampling for oral behaviors (Table 1; Supplemental Videos S1–S16 in https://doi.org/10.5281/zenodo.7940840, Downey and Tucker, 2023b,c,d) with a continuous recording rule ( Bateson and Martin, 2021) for all behaviors except eating, which was quantified with a scan sampling rule and instantaneous recording at 5-min intervals (demonstrated to be accurate for eating behaviors in cattle in Chen et al., 2016). Videos were analyzed...
using BORIS (Behavioral Observation Research Interactive Software; Friard and Gamba, 2016). A total of 18 observers watched one heifer at a time and were not blind to breed as coat color could not be masked. Observers were first trained to identify tongue rolling and intersucking using 30-question video tests (15 yes, 15 no) to reliability ≥80% (Cohen’s kappa, irr package version 0.84.1; Gamer et al., 2019). Observers then scored 21 videos (5-min duration/video) continuously, and reliability values were taken from these. All observers had to reach interobserver reliability ≥80% using interclass correlation coefficients (ICC, irr package version 0.84.1, Gamer et al., 2019) against a trained observer (B.C.D., intra-observer ICC ≥ 90%) before independent video scoring. Reliability was also evaluated visually using the plot events feature in BORIS to compare observer time budgets for each video against the trained observer to identify potential mismatches and confirm all ICC values. Eating was scored by one observer trained to reliability of 0.93 (Cohen’s kappa) against a trained observer (B.C.D.) using 24 h of video for each of 4 heifers.

### Statistical Analysis

Statistical analyses were performed using R version 4.2.1 (R Core Team, 2022) on MacOS Big Sur 11.6 via RStudio version 2022.7.2.576 (RStudio Team, 2022) with heifer as the experimental unit. All model fits were checked for normality and homogeneity of variance using quantile-quantile plots and plots of residuals versus fitted values (plot, boxplot, resid functions in base R).

Heifers were always in view while scoring eating at 5-min intervals. For all other behaviors, proportion of time engaged in oral behavior was calculated relative to total time in view (duration of behavior/[12 h − time spent out of view]) for each heifer. All relevant results are presented using this calculation. Heifers were in view for 93.5 ± 3.5% (mean ± SD) of the 12-h observation period. The most common way “out of view” was scored was that their muzzles were obscured by the other heifer and the camera angle.

A beta regression (betareg package version 3.1-4, Cribari-Neto and Zeileis, 2010) was fitted with breed as a fixed effect to analyze proportion of visible time.
tongue rolling, performing tongue flicks, manipulating bedding (NNOM: Bedding), performing other oral manipulation (NNOM: Other), all oral manipulation (NNOM: Total; Bedding + Feed bin + Other), drinking water, eating TMR, self-grooming (Groom: Self), and allogrooming (Groom: Allo). Models were assessed with a type II ANOVA (car package version 3.0–10, Fox and Weisberg, 2019) to obtain P-values. Time spent intersucking and manipulating the feed bin (NNOM: Feed bin) were evaluated using an unpaired Wilcoxon signed-rank test (stats package in base R), as data did not meet the assumptions of normality. All oral behaviors are reported as percentages hereafter in the text to facilitate readability. Time spent drinking urine was rare, and not evaluated with a model.

Outliers were considered those that fell more than 1.5× below or above the first and third quartiles, respectively (boxplot function in base R; interquartile range criteria). Outliers in this case were used to identify and describe extreme performances of oral behavior within the population, not as criteria for discarding data. We describe extreme performances of oral behavior within criteria (boxplot function in base R; interquartile range below or above the first and third quartiles, respectively). Outliers were considered those that fell more than 1.5× below or above the first and third quartiles, respectively (boxplot function in base R; interquartile range criteria). Outliers in this case were used to identify and describe extreme performances of oral behavior within the population, not as criteria for discarding data. We described extreme performances of oral behavior within criteria hereafter in the text to facilitate readability. Time spent drinking urine was rare, and not evaluated with a model.

Coefficients of variation and outliers and were calculated for all behaviors that were fitted with a model. Outliers were considered those that fell more than 1.5× below or above the first and third quartiles, respectively (boxplot function in base R; interquartile range criteria). Outliers in this case were used to identify and describe extreme performances of oral behavior within the population, not as criteria for discarding data. We used a similar method to describe excessive grooming bouts in Downey and Tucker (2023a).

RESULTS

All data (https://doi.org/10.25338/B81D19, Downey and Tucker, 2023e), Rmarkdown files for analyses and figures (https://doi.org/10.5281/zenodo.7308642, Downey and Tucker, 2023f), and Supplemental Table S1 (https://doi.org/10.5281/zenodo.7308644, Downey and Tucker, 2023g) containing means, standard error, confidence intervals, test statistics, degrees of freedom, and P-values for all analyses are available in the Dryad repository.

Jersey heifers spent more time performing all NNOM (bedding, feed bin, all other, and total, \( P \leq 0.013 \); Figure 1; all test statistics, df, and P-values reported in Supplemental Table S1) and tongue rolling (\( P = 0.018 \); Figure 2), and tended to spend more time performing tongue flicks (\( P = 0.071 \); Figure 2) compared with Holsteins. Holsteins spent more time allogrooming (\( P < 0.001 \); Figure 2) than Jerseys. There was no evidence of breed differences in time spent self-grooming, drinking water, or eating TMR (\( P \geq 0.264 \); Figure 2). Intersucking was performed by 30 of the 42 heifers (71%), representing 70% of Jerseys and 78% of Holsteins, but there was no evidence of an effect of breed (\( P = 0.877 \); Figure 2). Nine heifers drank urine from a penmate (18% of Holsteins, 33% of Jerseys) for a total of 1 to 15 s in 12 h.

 REGARDLESS OF BREED, ALL HEIFERS VARIED IN THEIR PERFORMANCE OF ORAL BEHAVIORS. OUTLIERS WERE PRESENT IN MOST BEHAVIORS (FIGURES 1 AND 2). FOUR HEIFERS (3 HOLSTEIN, 1 JERSEY) WERE OUTLIERS FOR INTERSUCKING, SPENDING 0.2% TO 0.4% OF THE 12-H PERIOD ENGAGED IN THIS. THERE WERE ALSO 4 OUTLIERS IN TONGUE ROLLING (3 JERSEY, 1 HOLSTEIN) FOR 1.4% TO 18.9% OF TIME. DRINKING WATER HAD 1 OUTLIER (HOLSTEIN; 4.1% OF TIME), AS DID SELF-GROOMING (JERSEY; 4.4%) AND TONGUE FICKS (HOLSTEIN; 2.7%). THERE WERE NO OUTLIERS IN EATING, ALLOGROOMING, NNOM: FEED BIN, OR NNOM: BEDDING. MOST OUTLIERS REPRESENTED UNIQUE HEIFERS; NO HEIFER PERFORMED OUTLIER LEVELS OF MORE THAN ONE BEHAVIOR EXCEPT FOR A HEIFER THAT WAS AN OUTLIER FOR BOTH NNOM: OTHER (JERSEY; 15.2%) AND NNOM: TOTAL (30.1%). ACROSS ALL INDIVIDUALS, TONGUE ROLLING HAD THE HIGHEST CV, AND WAS THE MOST VARIABLE (367%), FOLLOWED BY INTERSUCKING (152%). ALLOGROOMING WAS MORE VARIABLE THAN SELF-GROOMING (61% VS. 36%). SUBCATEGORIES OF NNOM VARIED MORE THAN TOTAL NNOM (BIN: 51; BEDDING: 56; ALL OTHER: 61; TOTAL: 36%). DRINKING WATER (46%) AND TONGUE FICKS (50%) ALSO VARIED. EATING TMR WAS THE LEAST VARIABLE BEHAVIOR (13%).

DISCUSSION

Jerseys engaged in more tongue rolling and all NNOM (feed bin, bedding, other, total) than Holsteins, but all heifers performed these behaviors. To our knowledge, this is the first documented comparison of abnormal behaviors in these breeds, which together make up 94% of all US dairy cows (Holsteins outnumber Jerseys 9:1; USDA, 2016). Although Holsteins spent similar amounts of time tongue rolling (0.2%) as other steers and heifers in farm settings (0.1–1.1%, Ishiwata et al., 2008; Iraira et al., 2013; Madruga et al., 2017), Jerseys tongue rolled at higher levels (3.3%). Both breeds performed NNOM at higher levels than typically reported (e.g., 12–19% vs. 1.3–3.5%, Robles et al., 2007; Ishiwata et al., 2008; Devant et al., 2015), with Jerseys consistently doing more NNOM in each category. The differences between our work and other may be due to the approaches to sampling, as the instantaneous recording rules used by many others are noted to be inaccurate above 5-min intervals for heifers (Madruga et al., 2017).

For the breed differences, tongue rolling is reported to be twice as prevalent in Jersey cows compared with Jersey-Holstein crosses (Robbins et al., 2023), suggesting there may be a genetic component to the behavior. This is true of abnormal behaviors in other species. In mice, for example, C58/J strains show consistently high levels of ARBs such as back flipping and jumping while C57BL/6J perform almost none (Ryan et al., 2010). Species of captive primates and carnivores also...
vary in ARB severity, and this variation correlates with their natural home range and group size (e.g., Chubb and Mason, 2007; Pomerantz et al., 2013). Jerseys may similarly be more prone to ARBs in confined dairy settings because they spend more time grazing and eating in confined settings per kilogram BW than Holsteins (Prendiville et al., 2010; Munksgaard et al., 2020), and may be motivated to engage in these behaviors more. Restricting this ability by limiting feed could thus affect Jerseys more severely than Holsteins.

Jerseys also tended to spend more time tongue flicking than Holsteins. This behavior has normal motivations (i.e., to clear the nostrils; Meltzer and Githens, 1919), but is also increased under restrictive conditions, such as when calves are not provided hay (Downey et al., 2022), suggesting it may have abnormal underpinnings. The behavior itself appears similar to tongue rolling, though less extreme in form, further suggesting a possible abnormal connection. Tongue movements are typically involved in natural feeding motions on pasture (Sambraus, 1985), and both tongue flicks and rolls may relate to motivation to express this behavior.

We did not find evidence that breed affected intersuckling. Conspecific sucking (intersuckling and cross-suckling combined) has been found to be heritable within a breed (Austrian Fleckvieh, h² = 0.04, Fuerst-Waltl et al., 2010), and Jerseys have sometimes been reported to perform more intersuckling than other European dairy breeds (e.g., reviewed by Lidfors and Isberg, 2003). Others have found no significant breed differences (Keil et al., 2001). Intersuckling is typically reported to occur in 1% to 57% of heifers on farms (Špinka, 1992; Keil et al., 2001), though we found it was more prevalent, occurring in 70% to 78% of heifers in both breeds. This higher prevalence could be, in part, because heifers were evaluated in a limit-fed environment. Decreased solid feed has been suggested as a risk factor for intersuckling (Keil and Langhans, 2001; Goeller et al., 2023), and both breeds may have performed this behavior as a response to hunger. Intersuckling was performed for short overall durations (0.06%), which could reflect the willingness, or lack thereof, of the recipient to be sucked. Partner willingness is likely to influence the expression of this behavior, and could play a role in the

Figure 1. Mean percentage of time engaged in nonnutritive oral manipulation (NNOM) across 12 h in year-old feed-restricted Jersey (n = 9) and Holstein (n = 33) heifers. Data were collected using behavior sampling and continuous recording on the second day of feed restriction (50% of ad libitum intake). Boxplots represent the median (black line within box) and first and third quartiles (25% and 75% of data). Whiskers extend to the lowest and highest values that are not outliers (values that are 1.5× the interquartile range); outliers (o) and means (x) are also presented.
overall lack of evidence of a breed difference in these pair-housed heifers.

Jerseys and Holsteins spent similar amounts of time eating, self-grooming, and drinking water. Feed was limited for all heifers based on BW-approximated individual feed intake, and was not expected to differ. All heifers spent approximately 2% of time self-grooming, similar to findings in other confined heifers (2.5–4%; Ishiwata et al., 2008; Faleiro et al., 2011; Madruga et al., 2017), and 1.5% of time drinking water, which also mirrored findings in similar age classes (1.2–2.5%; Robles et al., 2007; González et al., 2008; Madruga et al., 2017). The lack of evidence of a difference in these 2 parameters could suggest that these behaviors are normal, as commonly thought, and thus expressed similarly across breeds. However, total time engaged in these behaviors may not exclusively indicate abnormal performance. We have previously found evidence of seemingly abnormal expression in dairy calves by tracking bout length (grooming for up to 30 min in a single bout; Downey and Tucker, 2023a) and consumption (polydipsia, Downey et al., 2022), while cattle in tiestalls have also been reported to “lap” at water (Mattielo et al., 2005; Corazzin et al., 2010). Future work should consider using more robust ways of measuring abnormal expression to evaluate whether breeds differ using more nuanced approaches.

Holsteins spent over twice as much time allogrooming as Jerseys. A similar pattern was reported under mixed breed pasture settings, with Holsteins grooming 1.2 times longer than Jerseys, though this included time spent self-grooming and object rubbing as well (Guimarães-Yamada et al., 2022). Despite the breed difference, both Jerseys and Holsteins spent a similar amount of time allogrooming as others have reported in this age class under restrictive settings (e.g., limited forage and individual stalls) for both dairy (e.g., 4%, Holsteins: Rotger et al., 2006) and dual-purpose breeds (e.g., 1.8–3.3%, Holsteins: González et al., 2008; Simmental: Iraira et al., 2013; Madruga et al., 2017). Familiarity with the receiver, such as through previous interactions, could be a factor in eliciting allogrooming (e.g., Sato et al., 1993; Val-Lailet et al., 2009; Pinheiro Machado et al., 2020). Similar physical appearance (e.g., coat color) may also play a role, as it can affect social preferences in environments of otherwise unfamiliar animals (e.g., Murphey and de Moura Duarte, 1990). Our pairing decisions, particularly the lack of same-breed Jersey pairs due to sample size constraints, may have influenced these results.
Across breeds, heifers showed wide variability in each behavior except eating. Variability was expressed through number of heifers performing each behavior, presence of outliers, and CV. Behaviors were performed by all or most heifers except urine drinking, which is also reported to be rare in calves (de Wilt, 1985; Lidforss, 1993), but is otherwise not often scored in cattle. Individuals performed many behaviors at outlier levels, which described extreme performance relative to the rest of our population. The most extreme outliers were found in tongue rolling, where 1 Jersey performed this behavior for 19% of the daylight period, or approximately 4.5 h, and total NNOM, where a different Jersey spent 30% of the period, or 7 h, manipulating the environment. However, heifers were not usually outliers in multiple behaviors, suggesting there may be individual variability in response to restrictive farm conditions. Variability was also seen through CV. Tongue rolling and intersucking had the highest CV, but all behaviors scored were more variable than more normal behaviors like eating (13%, this study; 16%, Dado and Allen, 1994), ruminating (18%, Dado and Allen, 1994), and sucking milk from a bottle (26%, Downey et al., 2021). This mirrors work in chickens that found ARBs such as feather pecking had much higher CV than more normal behaviors such as feeding and resting (Kostal et al., 1992). Interestingly, total NNOM was less variable than the sum of its parts (36% vs. 51–61%). This may suggest that individuals have preferred outlets for how they express abnormal behaviors, but that the behaviors may have similar underlying motivations. Taken together, these indicators of variability suggest that cattle may respond to farm environments in different ways.

All heifers faced a welfare challenge in this study and both individuals and breeds responded to this in different ways. These patterns are not straightforward. Although we have found evidence of breed differences in some behaviors, the underlying mechanism behind these, and resultant implications, are not yet known. Differences could stem from genetics or preferences in expressing abnormal behaviors. Differences may also relate to challenges in adapting to restrictive farm settings more broadly: cattle in confined settings, where feed requires minimal searching and processing, spend less time eating than those in pasture-based ones (e.g., 3–5 h/d vs. 7–13 h/d; De Vries and von Keyserlingk, 2009; Kilgour, 2012). Both breeds may have performed abnormal behaviors due to this limitation. There may also be behaviors of concern that we did not score here, such as inactivity (e.g., Hintze et al., 2020) or leaning (e.g., Krohn, 1994; Nielsen et al., 1997). Further, although abnormal behaviors indicate a concern, it is not known if Jerseys are inherently more likely to experience poor welfare in farm settings than Holsteins, as indicated by their expressed higher performance of behaviors such as NNOM and tongue rolling. Breed may be one important component of the risk profile for abnormal behaviors.

CONCLUSIONS

To the authors’ knowledge, this is the first study quantifying abnormal oral behavior differences between Holsteins and Jerseys. We found that Jerseys spend more time tongue rolling and NNOM compared with Holsteins and tended to perform more tongue flicks. Holsteins spent more time allogrooming. There was no evidence of differences in eating TMR, self-grooming, drinking water, or intersucking. Regardless of breed, behaviors were highly variable, and some, including those commonly considered “normal,” were performed at extreme levels, raising questions about what we consider to be “abnormal.”

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Downey and Tucker: JERSEYS AND HOLSTEINS DIFFER IN ORAL BEHAVIOR


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9449

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ORCIDS
Blair C. Downey © https://orcid.org/0000-0003-3747-0164
Cassandra B. Tucker © https://orcid.org/0000-0002-6014-444X