J. Dairy Sci. 100:1–8
https://doi.org/10.3168/jds.2017-12984

Technical note: Use of an automated grooming brush by heifers and potential for radiofrequency identification-based measurements of this behavior

Rachel L. Toaff-Rosenstein,* Martin Velez,† and Cassandra B. Tucker[1]*
*Center for Animal Welfare, Department of Animal Science, and
†Department of Computer Science, University of California, Davis 95616

ABSTRACT

Healthy cattle readily use grooming brushes but this behavior subsides when animals become ill. Tracking use of a brush may provide an opportunity for health monitoring, especially if the process could be automated. We assessed how healthy heifers groom themselves on a brush and hypothesized that radiofrequency identification (RFID) could be used to accurately and automatically record this behavior. Angus and Hereford heifers ($n = 16$) were fitted with 2 ultra-high-frequency RFID ear tags and monitored in groups of 8 while housed in a pen with an electronic brush, video cameras, and 4 RFID antennas. Each heifer was observed for a 6-h period using continuous video recordings, and brush contact was characterized in terms of anatomic region involved (head/neck, trunk, or posterior) and when not touching the brush but within 1 body length of it. The RFID data were collected for the same period and then processed such that intervals of up to 16 s with no detections but contained between 2 recordings were also considered positive (animal in brush proximity). Brush proximity (RFID) was regressed against brush contact duration (video) and the sensitivity and specificity for each individual heifer calculated. Across heifers, the majority of brush use involved the head/neck, although a few heifers demonstrated relatively large amounts of posterior contact, which contributed to false-negative readings when antennas failed to read the ear tags. Furthermore, for the majority of time that animals were near the brush, they were not in contact with it but rather standing or lying nearby, resulting in false-positive readings. It follows that the ability of the RFID system to accurately detect brush contact varied widely across individual heifers (sensitivity 0.54–1.0; specificity 0.59–0.98), with RFID generally overestimating the duration of brush proximity relative to actual time spent in brush contact. The implication is that RFID-based ear tag recording of brush proximity relative to continuous video observations of contact does not yield accurate results in certain heifers and therefore, as currently configured, is not a reliable representation of this type of grooming behavior.
Key words: automation, grooming, health monitoring, radiofrequency identification (RFID)

Technical Note

Grooming brushes enable self-care behaviors (e.g., hair-coat maintenance) when cattle are kept in relatively barren environments (as reviewed by Wilson et al., 2002; DeVries et al., 2007; Mandel et al., 2016). Monitoring grooming may facilitate health assessment (Weary et al., 2009), whereby sick animals, including cattle, groom less than healthy counterparts as part of a strategy in which energetic resources are redirected away from behaviors that are not essential in the short term and instead toward enhanced immune function (Hart, 1988; Borderas et al., 2008; Toaff-Rosenstein et al., 2016). Stress, including high ambient temperatures, manipulations such as AI, and calf removal in dairy cows, may also induce changes in brush use (Mandel et al., 2013; Newby et al., 2013), though whether this behavior increases or decreases appears to be situation-dependent.

Manual recording of animal behavior is laborious and generally impractical for commercial use. In contrast, automatic behavior recording may enable more timely and accurate large-scale sickness detection and welfare assessment (e.g., as reviewed in swine; Matthews et al., 2016). Specific examples include halters (Büchel and Sundrum, 2014) to monitor feeding, collars to track rumination (Ambriz-Vilchis et al., 2015), and computerized video analysis of activity levels (Ott et al., 2014). Radiofrequency identification (**RFID**) is another technology that can be used to monitor behavior automatically. In a common RFID setup, powered antennas (or readers) continuously transmit wireless interrogator radio waves. This signal powers nearby tags, which decode

Received April 4, 2017.
Accepted June 19, 2017.
[1]Corresponding author: cbtucker@ucdavis.edu

the signal and transmit back their unique serial number. The antennas then pass this information to a computer for data storage and processing. High-frequency RFID systems enable reading of multiple tags simultaneously, which is beneficial when tracking numerous animals. Radiofrequency identification has shown promise when used with electronic (gated) feed and water stations (Chapinal et al., 2007) to monitor dairy cow eating and drinking behavior. It has also successfully recorded the presence of beef cattle at an ungated feed bunk, a proxy for feeding (Mendes et al., 2011). However, RFID was less successful in recording pig feeding (Maselyne et al., 2014) and mice exploratory behaviors (Catarinucci et al., 2014).

Our objectives were to (1) describe how healthy heifers use a brush in terms of body region groomed, on a proportional basis, and (2) evaluate whether RFID-based determination of brush proximity is an accurate substitute for video observations of contact, indicating a role for this technology in automatically recording this behavior. We hypothesized that RFID-determined brush proximity could serve as a suitable substitute for video-determined brush contact and therefore enable accurate, automatic recordings of this type of grooming behavior.

The University of California, Davis Animal Care and Use Committee reviewed and approved all procedures used (Protocol 16947). Data collection was completed between May 30 and June 2, 2014, at the University of California, Davis beef research facility (Davis, CA). Heifers (8 Angus and 8 Hereford) between the ages of 7 and 9 mo with an initial average BW of 269 kg (range 198 to 364 kg), originating from the university cow-calf herd and subjected to clinical examination by a veterinarian to verify health status, were enrolled. Heifers were randomly assigned to 1 of 2 groups, balanced for breed and BW, and managed per standard herd health protocol, including treatment with a topical ectoparasiticide and use of fly-repellant ear tags. Their diet consisted of 47.5% flaked corn, 17.2% dried distillers grains, 13.7% alfalfa hay, 11.7% oat hay, 7.1% molasses, and 1.3% fat and containing 87.5% DM, 13.3% CP, 27.7% NDF, and 75.8% TDN, and providing 1.8 Mcal of NE_M/kg and 1.2 Mcal of NE_G/kg. Water was provided ad libitum from a self-filling trough.

Ten days before commencement of data collection, heifers were individually restrained in a chute for approximately 30 min and each marked with unique numerical identification (left and right withers and flank) using hair dye (Clairol Nice 'N Easy Borne Blonde; Procter and Gamble, Cincinnati, OH). Additionally, the distal portion of the tail switch was trimmed, leaving approximately 5 cm, to avoid entrapment of the tail in the mechanical brush (described below), per the manufacturer's recommendation.

Heifers were transported 3 km to the trial site and housed by group (n = 8/group), with brush exposure beginning 3 d before start of data collection. Data collection occurred in a covered, concrete-floored, L-shaped pen, which was enclosed but allowed for dim natural lighting and ventilation. The dimensions of the area containing the brush and feed bunks were 9.1 × 7.3 m. An automated grooming brush (model no. 91526202 Swinging Cow Brush, DeLaval, Kansas City, MO) was installed on the wall, 0.81 m above the floor measured from the bottom of the brush, according to manufacturer instructions (Figure 1). The brush (90 × 90 × 82 cm) hung vertically from a pivoting arm from which it could move in many directions, including over the animal's back, when manipulated. When an animal pushed the brush off center to a ≥30° angle, it began rotating at a speed of 26 rotations/min. Rotation continued until 10 s after returning to a vertical position, after the heifer was no longer pushing the brush. The lying area measured 9.1 × 4.9 m, including a 4.9- × 4.3-m bedded area with a ~25-cm-deep layer of straw.

Black and white CCTV video cameras (model no. WV-BP334, Panasonic Corporation of North America, Secaucus, NJ) and lenses (model no. 13VG2812ASII, Tamron, Commack, NY) were connected to a digital video recorder with digital surveillance software (GeoVision Surveillance System V8.5 Inc., Taipei, Taiwan). To enable video recording during low-light conditions, red holiday lights suspended from pen rafters operated on a timer between 1600 and 0800 h. Eight cameras focused on the brush (suspended 2.0 to 2.2 m above). Each camera was set to continuously record at medium quality and 30 frames/s.

An RFID reader (ALR-9900+, Alien Technology, Morgan Hill, CA) was attached to the wall of the pen above the brush. Four 25- × 25-cm panel antennas (model no. S9028PCL96RTN, Laird USA, Earth City, MO) were mounted 2 m above the ground from wood beams attached to the rafters, in each quadrant around the brush, at a distance ranging from 0.6 to 1.3 m from its center (Figure 1, marked with asterisks), and set to an attenuation level of 25 to confine the reading range to a relatively small radius around the brush. Ultra-high-frequency RFID chips (ALN-9629, Alien Technology, Morgan Hill, CA) were attached to each existing left and right plastic identification ear tag using a single layer of duct tape.

Data were collected from the 2 groups sequentially for a total of 6 h/group, between 0600 and 1200 h. All 6 h of data were collected on a single day from the first group. Following this, the second group was moved into