# Behavior of Cattle During Hot-Iron and Freeze Branding and the Effects on Subsequent Handling Ease[1]

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**ABSTRACT:** Three hundred feedlot steers (320 ± 2 kg) were assigned to freeze brand, hot-iron brand, and sham branding treatments according to a randomized branding arrangement. Behaviors believed to be indicative of pain (i.e., tail-flicking, kicking, falling, and vocalizing) were recorded during branding. Escape behavior, measured as the amount and duration of force exerted on the headgate and squeeze chute by the animals during treatment, was obtained using load cells and strain gauges. Subsequent handling ease following branding was tested every 2nd d for 10 d by recording the time and effort required to move animals into the chute. Hot-iron-branded steers had greater tail-flick, kick, fall and vocalization frequencies than freeze-branded or sham-branded animals ($P < .005$). However, freeze-branded animals differed from shams only in regard to tail-flick frequencies ($P < .005$). The average and maximum exertion forces and the duration of force were greater in hot-iron- than in freeze- and sham-branded steers ($P < .001$); freeze branded steers had greater values than shams ($P < .001$). No treatment differences in handling ease were observed. However, all steers required more handling effort for up to 6 d, indicating that handling, per se, was aversive. Results indicate that hot-iron-branded steers experienced more discomfort at the time of branding than freeze-branded and sham steers, and freeze-branded steers experienced more discomfort than shams.

Key Words: Behavior, Branding, Cattle, Handling, Pain

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## Introduction

The assessment of pain associated with routine management procedures is often a difficult task. Physiological measures such as cortisol, heart rate, and respiration rate are frequently used to assess painful procedures (Morton and Griffiths, 1985). However, the interpretation of these data is often confounded by the handling and restraint of the animals, which can also evoke a stress response (Rushen, 1991).

Behaviors such as vocalization, kicking, tail-flicking, and escape are reliable indicators of pain in cattle and other species (Morton and Griffiths, 1985; Lay et al., 1992a). Escape-avoidance behavior is usually recorded as a subjective score in which the accuracy or consistency between and within observers may be questionable (Stookey et al., 1994). Quantifying the force and duration of the escape-avoidance response could eliminate the subjective component of the measurement. Handling ease and entry order may also be used as a measure of aversion to a previously negative experience (Grandin et al., 1986; Rushen, 1986).

The objective of this study was to compare the discomfort associated with hot-iron and freeze branding by documenting behaviors that could be indicative of pain during and after branding. A more thorough account of the behavioral responses to branding may provide a more complete assessment of the stress associated with the two branding techniques.

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## Experimental Procedures

Three hundred Charolais-cross steer calves averaging 320 ± 2 kg were purchased and trucked to the Beef Research Unit of the Department of Animal and Poultry Science at the University of Saskatchewan. Steers were housed at the feedlot in 25 separate pens containing 11 to 13 animals per pen. Steers had not been previously branded but were ear-tagged and vaccinated 4 d before the start of the experiment.

On the day of the experiment, approximately 5 d after their arrival at the feedlot, steers were assigned to one of four branding treatments: 1) freeze brand (**F**), n = 101; 2) hot-iron brand (**H**), n = 99; 3) sham freeze brand (**SF**), n = 50; and 4) sham hot-iron brand (**SH**) n = 50. Treatments were assigned, as each animal entered the chute, based on a predetermined, randomized branding order. Branding treatments were imposed on the same day for all steers.

### *Branding*

Animals were taken from their pens, moved through a chute, and captured in a manual, self-catching headgate and squeeze chute (W & W Manufacturing, Dodge City, KS) to minimize movement. All brands were applied on the right rib by an experienced District Livestock Brand Inspector. Cattle assigned to H treatments were branded with steel "running irons" (three separate irons "c" "u" "__"). The irons were combined to form the University of Saskatchewan's registered "US" brand (15 cm × 17 cm), which required six separate applications of the irons ("c" applied twice to make "S"; "u", plus "_" applied twice vertically to make "U"; "_" applied once). Irons were heated over a propane flame and applied until the hide turned a light tan color, usually 3 to 5 s per iron (Alberta Agriculture, 1988). The average length of time required to complete a hot-iron brand was approximately 40 s. The brand site was not clipped before branding H steers. Steers assigned to F treatments had a patch approximately 20 $cm^2$ clipped to expose the skin. The clipped area was saturated with 95% methyl hydrate (vol/vol) just before the application of the branding irons. Three separate copper irons ("U", "S", and "__") were immersed and maintained in liquid nitrogen and applied one at a time within the clipped patch for 20 s each. The average length of time required to complete a freeze brand was approximately 90 s. The completed brand occupied an area approximately the same size as described for H-branded animals.

The SF and SH branded steers, which served as controls, were caught in the headgate and held in the squeeze for approximately the same amount of time required to complete the brand of their respective counterparts. Steers assigned to SF treatments were clipped and saturated with methyl hydrate before the sham iron was applied. Steers assigned to SH treatments were not clipped, and the sham iron was applied for roughly the length of time require to complete a hot brand. An ambient temperature iron was used to apply the SF and SH brands. All steers were released back to their pens immediately after branding and were not grouped by treatment.

### *Behavior*

Behaviors believed to be indicative of pain were recorded during branding for all treatment and control animals. Behaviors recorded included tail-flick, kick, falling down in the chute, and vocalization. The frequencies of these behaviors were recorded from the time the first iron was applied until the last iron was taken off the hide of each animal. Individual tail-flicks were quantified by recording the number of times the base of the tail moved to the left or right of center and back again. A kick was defined as a sharp backward or sideways extension of the left or right hind legs. Falling down in the chute was defined as any downward movement of the body caused by the steer collapsing onto one or both of its front knees or rear hocks. The number of vocalizations and not the duration of the vocalization was recorded during branding.

### *Exertion Force and Duration*

Before the experiment, the headgate and squeeze chute used to restrain the animals for branding were fitted with equipment that could quantify the force exerted against the headgate and squeeze chute by steers at the time of branding. Two pairs of load cells and one pair of strain gauges capable of measuring 227 kg of force were attached to the headgate and squeeze chute. One of the load cell pairs was affixed to the top of the headgate so that any force exerted by an animal that pushed the headgate apart could be measured. A pair of strain gauges were also mounted on the headgate at approximately the height of the animals' neck, making it possible to measure the force exerted when a steer moved forward or backward in the chute. A second pair of load cells were mounted in the arm of the squeeze so that any force exerted by the animal that pushed the squeeze apart could be measured. Output signals from the load cells and strain gauges were measured in millivolts. A microphone was also mounted on the headgate to pick up all sound activities during branding.

All steers were restrained in the headgate and squeeze chute for 10 s before being branded. During this time, baseline measurements of the force exerted on the load cells and strain gauges during restraint were obtained. Measurements were also taken during branding and were made from the time the first iron was applied until the last iron was taken off the animal.

Signals from the load cells and strain gauges were amplified by a signal conditioner (Model 2310 signal amplifier, Vishay Measurement Group, Raleigh, NC) and stored on a tape drive (Teac XR-310 Cassette Data Recorder, Teac Co., Japan) using three separate channels. The audio signal from the microphone was also stored on the tape drive on its own channel. To locate on the tape when the brand was being applied, a person said, “Brand on” into the microphone to signal the start of the branding procedure. Continuous analog signals from the signal conditioner were converted to FM analog audio signals and stored on a standard VHS audio/video cassette.

A multichannel analog input board (Model AD1000, Real Time Devices, State College, PA) was used to retrieve and digitize data from the tapes. A computer program was written (GWBasic, Microsoft, Beaverton, OR., 1993) to control the input board and format the data so that they could be read onto a computer spreadsheet (Quattro Pro, Borland International, Scotts Valley, CA, 1992).

Before signal sampling began, the tape was rewound to the correct position, by listening to the audio channel, hearing the “Brand on” signal, and rewinding the tape for 11 s. This positioned the tape at the start of the 10-s baseline data so that the digitizing program could start sampling the signal. When “Brand on” was heard, a switch that was connected to the input board was turned on and a DC signal of 5 V was sent to the board. When a “Brand off” was heard, a signal of 0 V was sent to board. The change from 0 to 5 V was made with a two-position toggle switch in series with a DC power supply (Model 6215, Hewlett-Packard Co., Camas, WA) and was used to correlate the signal sample with the branding procedure.

All digitized signals were captured on a personal computer at a rate of 18.8 samples per channel per second. This sampling rate was selected because it produced an accurate representation of the analog signal without using an overwhelming number of data points. Accuracy between digitized and analog signals was checked by visually comparing the number and magnitude of the peaks obtained from graphs of the digitized values and the initial analog signal in 5% of the samples. The analog signal was recorded with a two-channel chart recorder (Model 15–6327–57, Gould, Cleveland, OH) capable of monitoring 60-Hz analog signals. Accuracy between the digitized and analog signal graphs was approximately 98%. The computer program was also checked for repeatability by comparing differences between successive output files from the same analog input signal in 5% of the samples. This was done by comparing the means and SD of three output files (digitized data) from the same analog signal. The repeatability of successive files was determined to be > 99% in the samples tested. The data for each animal were stored as a single file that included the animal identification, treatment, sample time, and the digitized output.

Average and maximum exertion intensity measurements obtained from the headgate load cell, headgate strain gauge, and squeeze load cell outputs were calculated for the baseline (10 s before branding) and branding periods (Figure 1 A and B). To account for individual variation, the baseline averages of exertion intensity were subtracted from the averages obtained during branding. This was also done with the maximum exertion measurements.

The length of time each animal exerted force on the headgate and squeeze chute was also quantified during branding. The exertion duration values were obtained by calculating the length of time the output signals from the strain gauge and load cells remained 3 SD above or below the baseline average as shown in Figure 1 E and F. A cutoff of 3 SD above and below the baseline average was chosen because 99.7% of the baseline values would fall within that range. This would help ensure that values outside of that range were associated with the escape response due to the branding treatments and not from the normal shifting of weight and movement of the animals. The time above and below the baseline was then divided by the time required to complete the brand.

### *Handling Ease And Entry Order*

Immediately before branding, and on every 2nd d after branding, the amount of human force (handling ease) and the elapsed time required for each steer to enter the squeeze chute was recorded. Handling ease was measured to determine whether animals developed an aversion to entering the area in which they had been branded. A baseline measurement for handling ease was taken on the day of branding by recording the amount of pressure it took to move an animal through a 4-m section of chute that led to the branding area. The steers were moved individually into the 4-m section and a solid sliding door was closed behind the animal to prevent it from backing up or seeing other animals in the rear of the chute complex. Each steer had direct visual contact with the preceding animal that was being restrained in the squeeze for branding. A guillotine gate in front of the 4-m section prevented the animal from prematurely entering the squeeze area. The procedure began when the lead animal was released and the guillotine gate was opened to allow entry into the branding area. Once started, the animal in the 4-m chute was subjected to a series of procedures that applied increasing pressure on the animal, over a fixed period of time, to encourage it to move forward. The handling procedures and the time period in which they were applied were as follows: 1) no assistance (0 to 5 s), 2) vocal encouragement and touch at a rate of 1 touch/s (6 to 10 s), 3) one-handed open-palm slap at a rate of one/s (11 to 20 s), 4) vocal encouragement and two-handed open-palm slaps at a rate of one/s (21 to 25 s), 5) tail-twist (26 to 35 s), and 6) pushing the animal into the chute (> 35 s). The procedure ended when the steer had completely entered the squeeze chute and

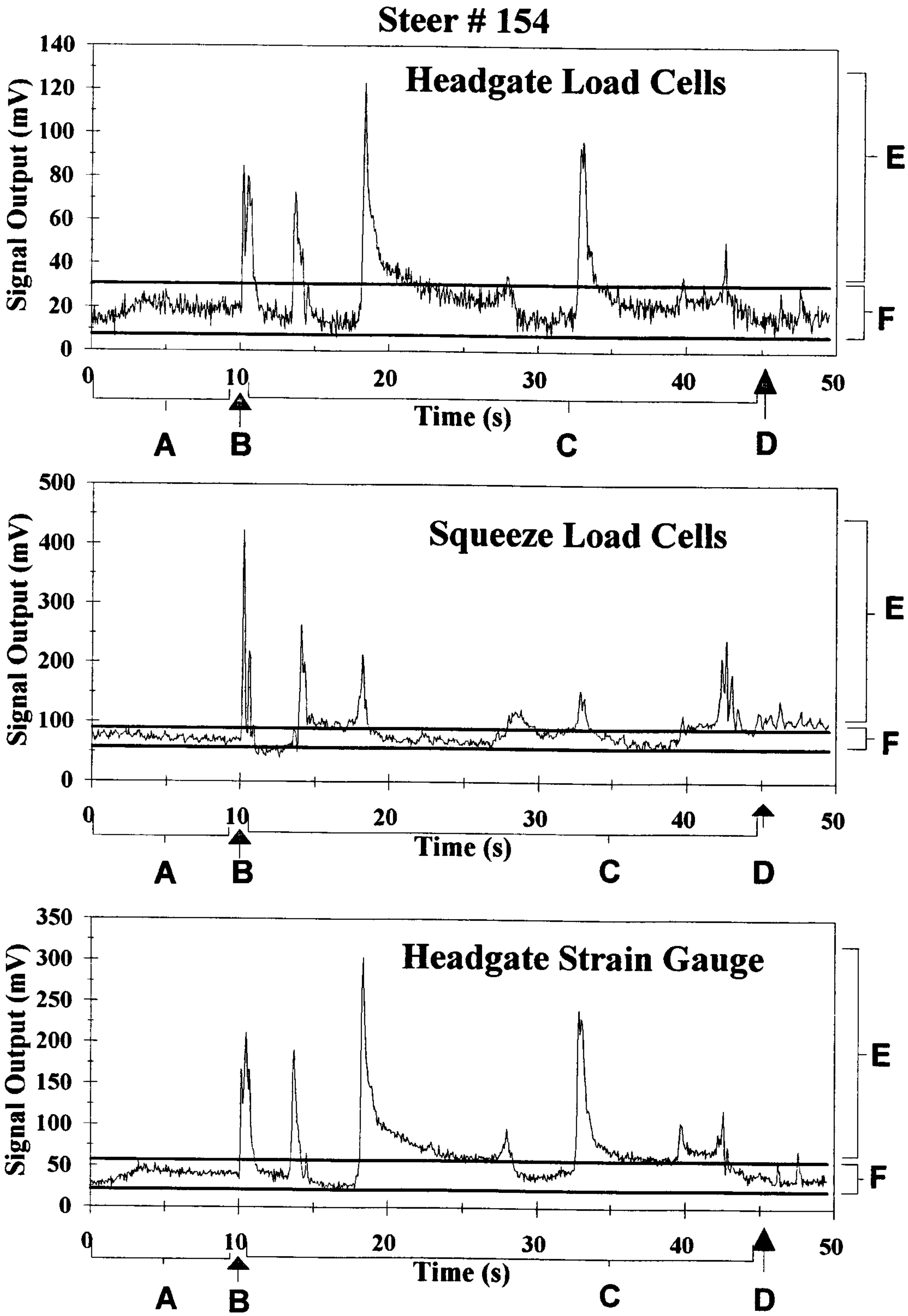


Figure 1. Signal outputs in millivolts from two load cells and one strain gauge indicating exertion forces made on the headgate and squeeze chute by a steer (#154) before and during hot-iron branding. A = baseline measurement (10 s before branding). B = first branding iron applied on the animal. C = measurement during branding. D = last branding iron taken off the animal. E = duration of exertion beyond (± 3 SD) baseline mean. F = mean baseline measurement (± 3 SD).

the guillotine gate was closed or when greater than 35 s had elapsed. The category of handling pressure required to force each steer into the squeeze was recorded on the day of branding and every 2 d for the 10-d experimental period. Animals were moved into the headgate and squeeze chute on the days following branding and held for a few seconds in the chute, without being restrained.

Entry order data were obtained by recording the sequence (between 1 and 11 to 13) in which individual steers within a pen entered the branding facility on each test day. Each group of animals was brought separately into a crowd pen (10 m × 15 m) that preceded a curved chute that led directly into the branding area. Pens were tested in the same order each day so that variation due to time of day was minimized. Animals were moved forward from the crowd pen into the curved chute by a stockperson who was standing outside of the crowd pen. Steers within each pen were free, to some degree, to choose their own order of entry. The order was recorded to examine whether individuals on a specific treatment were more or less reluctant to enter the chute that led to the branding facility.

*Statistical Analyses*

A chi-square test was used to analyze treatment differences for the behavioral responses during branding and subsequent handling ease. Tail-flick and kick frequency data were collapsed into three categories: 0, 1 to 20, and > 20 for tail-flick and 0, 1 to 2, and > 3 for

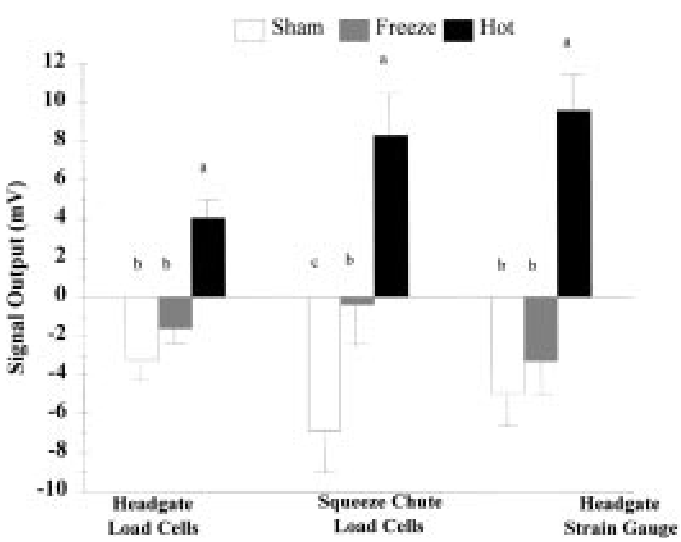


Figure 2. Average force in millivolts exerted by sham-, freeze-, and hot-iron-branded steers as measured by load cell and strain gauges attached to the headgate and squeeze chute. Values represent the difference between the force at time of branding minus the force exerted during the 10-s baseline period before branding. [a,b,c]Within measurement type, treatments with different superscripts differ ($P < .05$).

Table 1. Distribution of steers and the frequency of behaviors displayed at the time of branding

| Behavior category | Branding treatments[a] | | |
|---|---|---|---|
| | Sham | Freeze | Hot |
| Tail-flick | | | |
| 0 | 47$^{x}$ | 20$^{y}$ | 3$^{z}$ |
| 1–20 | 44$^{x}$ | 55$^{y}$ | 66$^{z}$ |
| > 20 | 7$^{x}$ | 24$^{y}$ | 29$^{z}$ |
| Kick | | | |
| 0 | 94$^{x}$ | 86$^{x}$ | 48$^{y}$ |
| 1–2 | 5$^{x}$ | 11$^{x}$ | 31$^{y}$ |
| > 3 | 1$^{x}$ | 3$^{x}$ | 20$^{y}$ |
| Fall in chute | | | |
| No | 95$^{b}$ | 95$^{b}$ | 85$^{c}$ |
| Yes | 5$^{b}$ | 5$^{b}$ | 14$^{c}$ |
| Vocalize | | | |
| No | 96$^{x}$ | 94$^{x}$ | 75$^{y}$ |
| Yes | 2$^{x}$ | 5$^{x}$ | 23$^{y}$ |

[a]Total number of animals observed in each behavior category may vary within treatment as a result of missing observations. At the start of the experiment n = 100, 101, and 99 for sham, freeze-brand, and hot-iron brand treatments, respectively.
[b,c]Within rows, treatments with different superscripts differ ($P < .05$).
[x,y,z]Within rows, treatments with different superscripts differ ($P < .005$).

kick. Falling and vocalization frequencies were collapsed into yes or no categories before being analyzed. A chi-square test indicated that the behavioral responses of SF and SH steers were not significantly different from one another. Therefore, in the final analysis, steers allotted to SF and SH treatments were combined to form a single group that was designated the sham (**S**) treatment.

The exertion intensity data were subjected to a General Linear Models ANOVA for a completely randomized design (SAS, 1990) with treatment and pen as main factors in the model. Pen was dropped from the model because it was not significant. Duncan's multiple range test was used to detect treatment differences in exertion (i.e., average, maximum, and duration). An ANOVA indicated that there were no differences in exertion forces obtained from SH and SF animals, and the two treatments were combined to form a single group that was designated the sham treatment.

An average entry order was calculated for animals allotted to S, F, and H treatments to accommodate the unequal allocation of branding treatments within each pen. The average entry order was ranked separately for S, F, and H treatments on the day of branding and on every 2nd d after branding for 10 d. A Freidmen's Rank Sum test was then used to determine the effects of treatment on the average entry order on each test day.

Handling ease data were collapsed from the original six categories to four because of low frequencies and analyzed using a chi-square test.

## Results

### *Behavior*

All behavioral frequencies, including tail-flicks, kicks, falls in the chute, and vocalizations, were greater ($P < .05$) in H steers during branding than in either F or S steers (Table 1) despite the fact that hot-iron branding took half as long to complete as freeze branding.

Hot-iron-branded steers had the lowest number of tail-flicks, kicks, falls in the chute, and vocalizations in the zero category, and S animals had the highest. Furthermore, H steers had tail-flick and kick frequencies 4 and 20 times higher, respectively, than S steers in the > 20 tail flick and > 3 kick categories (Table 1). Falls in the chute frequencies were three times higher in H than in S animals, and vocalizations were 10 times higher.

Freeze-branded steers had greater tail-flick frequencies ($P < .005$) than shams, and even though F steers had consistently greater kick, fall, and vocalization response frequencies than S steers, the differences were not significant.

### *Exertion Force and Duration*

Exertion force and duration measurements obtained from headgate load cells, headgate strain gauges, and squeeze chute load cells were different ($P < .001$) between branding treatments. Hot-iron-branded steers had higher ($P < .05$) average (Figure 2) and maximum (Figure 3) exertion forces, and greater ($P < .05$) exertion durations (Figure 4) than F or S animals, indicating that H animals experienced a greater amount of discomfort during branding.

Average forces exerted by F steers were not different from those exerted by S steers except for the measurements collected from the squeeze chute load cells. Freeze-branded steers had consistently higher average exertion values ($P < .05$) than S steers (Figures 2 and 3), implying that freeze branding caused more discomfort than sham branding.

Negative exertion force values were obtained for S and F steers after the branding exertion force was subtracted from baseline measurements (Figures 2 and 3). The negative values indicate that S and F animals moved less during branding than they did for the 10-s baseline period before branding.

### *Handling Ease and Entry Order*

The handling pressure required to move steers into the headgate and squeeze chute consistently increased for all steers, across all treatment groups, up to 6 d after branding (Table 2). However, neither handling ease nor the time that elapsed before the animal entered the chute were different between branding treatments over the 10-d period after branding. Branding treatment had no effect on the entry order of animals. Neither H nor F steers were more reluctant on subsequent days than S animals to enter the facility where they had been branded (Table 3).

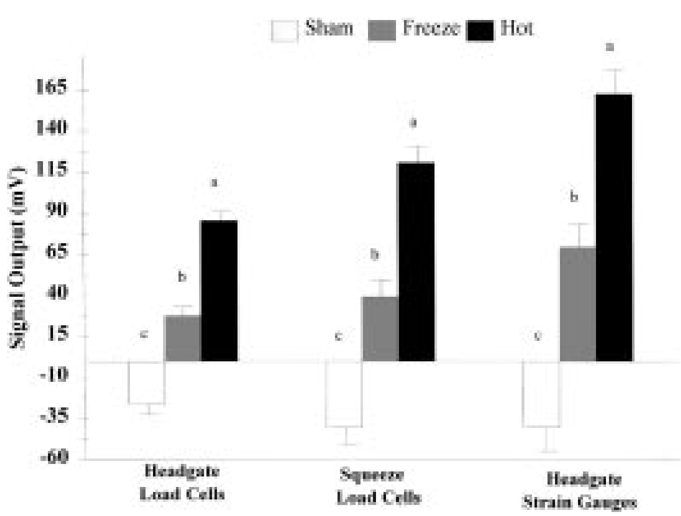


Figure 3. Maximum force in millivolts exerted by sham-, freeze-, and hot-iron-branded steers as measured by load cell and strain gauges attached to the headgate and squeeze chute. Values represent the difference between the force at the time of branding minus the force exerted during the 10-s baseline period before branding. [a,b,c]Within measurement type, treatments with different superscripts differ ($P < .05$).

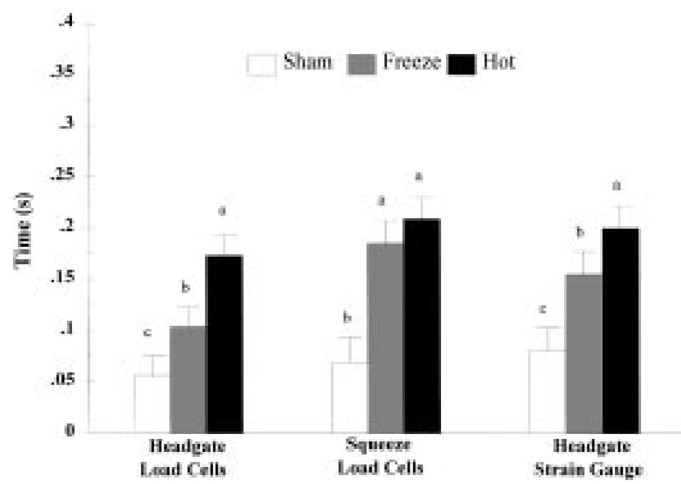


Figure 4. Average duration of force in millivolts exerted by sham-, freeze-, and hot-iron-branded steers as measured by load cell and strain gauges attached to the headgate and squeeze chute. Values represent the difference between the average duration of force at time of branding minus the average duration of force during the 10-s baseline period before branding. [a,b,c]Within measurement type, treatments with different superscripts differ ($P < .05$).

Table 2. Distribution of steers (n = 300) and the category of assistance required to move cattle into the branding and restraint area where treatments were imposed

| | Days after branding | | | | | |
|---|---|---|---|---|---|---|
| Handling category (time)[a] | 0 | 2 | 4 | 6 | 8 | 10 |
| Sham (n = 100)[b] | No. | No. | No. | No. | No. | No. |
| 1) No assistance (0 to 5 s) | 53 | 55 | 37 | 23 | 37 | 40 |
| 2) Touch/voice (6 to 10 s) | 30 | 34 | 36 | 46 | 42 | 24 |
| 3) One-hand slap (11 to 20 s) | 12 | 5 | 17 | 19 | 10 | 17 |
| 4) Two-hand slap/voice (21 to 25 s) | 1 | 0 | 1 | 2 | 1 | 6 |
| 5) Tail-twist (26 to 35s) | 0 | 2 | 5 | 7 | 6 | 7 |
| 6) Push steer into chute (> 35 s) | 1 | 1 | 1 | 0 | 0 | 0 |
| Avg time ± SE (s) to enter chute | 5.5 ± .7 | 5.2 ± .9 | 8.5 ± 1.1 | 9.3 ± 1.1 | 8.2 ± .9 | 8.8 ± 1.1 |
| Freeze (n = 101) | | | | | | |
| 1) No assistance (0 to 5 s) | 66 | 57 | 34 | 31 | 55 | 56 |
| 2) Touch/voice (6 to 10 s) | 22 | 32 | 42 | 31 | 33 | 26 |
| 3) One-hand slap (11 to 20 s) | 10 | 7 | 12 | 24 | 10 | 11 |
| 4) Two-hand slap/voice (21 to 25 s) | 1 | 2 | 1 | 2 | 1 | 2 |
| 5) Tail-twist (26 to 35 s) | 1 | 3 | 11 | 9 | 2 | 5 |
| 6) Push steer into chute ( > 35 s) | 0 | 0 | 0 | 0 | 0 | 1 |
| Avg time ± SE (s) to enter chute | 5.1 ± .5 | 6.0 ± .6 | 9.4 ± .8 | 10.3 ± .8 | 6.0 ± .6 | 6.9 ± .8 |
| Hot (n = 99) | | | | | | |
| 1) No assistance (0 to 5 s) | 58 | 57 | 39 | 33 | 48 | 50 |
| 2) Touch/voice (6 to 10 s) | 25 | 31 | 38 | 47 | 35 | 33 |
| 3) One-hand slap (11 to 20 s) | 11 | 6 | 13 | 9 | 13 | 11 |
| 4) Two-hand slap/voice (21 to 25 s) | 3 | 2 | 4 | 1 | 1 | 2 |
| 5) Tail-twist (26 to 35 s) | 5 | 2 | 4 | 7 | 3 | 3 |
| 6) Push steer into chute (> 35 s) | 0 | 1 | 0 | 0 | 0 | 0 |
| Avg time ± SE (s) to enter chute | 5.9 ± .5 | 6.0 ± .6 | 7.9 ± .8 | 8.6 ± .8 | 6.5 ± .7 | 6.9 ± .8 |

[a]Duration of time pressure was applied to each animal prior to switching to the next pressure category if the animal did not enter the chute.

[b]Total number of animals on any day may not equal (n) because of missing observations.

## Discussion

### *Behavior*

Generally, cattle have been described as stoic in terms of their behavioral responses to pain or disturbance (Broom, 1993). However, several researchers have used behavioral responses to pain in cattle to compare the severity of various management procedures such as castration and tail-docking (Fell et al., 1986) and branding (Lay et al., 1992a,b,c).

Hot-iron branding clearly caused a more pronounced behavioral response than F or S branding at the time the irons were applied, suggesting that H steers experienced more pain (Table 1). This conclusion is consistent with results obtained in several other studies comparing behavioral and physiological responses to hot-iron and freeze branding procedures (Lay et al., 1992a,b,c). For example, H-branded animals were found to have a greater escape-avoidance reaction and higher plasma epinephrine and norepinephrine levels 5 min after branding (Lay et al., 1992a,c). In another study on branding, H steers had higher plasma cortisol levels than S or F animals 40 min after branding (Schwartzkopf-Genswein et al., 1996b). Furthermore, H animals in the present study were found to vocalize more than F- or S-branded animals (23 vs 6 and 5%, respectively). Similar results were reported by Lay et al. (1992b), who found that between 4 and 57% of the animals vocalized during hot-iron branding.

Even though H-branded animals in the current study exhibited the greatest frequency of behavioral responses indicative of pain, there was some evidence that freeze branding also caused discomfort (Table 1). Freeze-branded steers were found to have greater tail-flick frequencies than S animals (Table 1), and tail movements have been specifically associated with cutaneous irritation in cattle (Kiley-Worthington, 1976). In addition, F steers had consistently higher numerical values for kick, fall, and vocalization frequencies than S steers, but the differences were not significant (Table 1). Conversely, S steers usually responded to sham branding by moving away from the pressure of the iron slowly or not at all. Additional evidence to support that freeze branding causes discomfort is found in a previous branding study in which freeze-branded steers had cortisol levels as high as those obtained in hot-iron-branded animals for up to 20 min after branding (Schwartzkopf-Genswein et al., 1996b). However, cortisol levels remained elevated for a shorter period in F than in H animals, implying that the stress may not have been as severe. From the behavioral data it seems that hot-iron branding caused the greatest amount of discomfort.

Table 3. Average entry order of all steers within pens allocated to sham, freeze, or hot-iron branding treatments[a]

| | Days after branding | | | | | |
|---|---|---|---|---|---|---|
| Branding treatment | 0 | 2 | 4 | 6 | 8 | 10 |
| Sham (n = 100) | 1.95 | 2.23 | 1.84 | 1.90 | 2.18 | 1.90 |
| Freeze (n = 101) | 1.96 | 1.72 | 1.70 | 1.84 | 1.74 | 2.06 |
| Hot (n = 99) | 1.86 | 1.82 | 2.22 | 2.02 | 1.84 | 1.80 |

[a]The largest number per column represents the treatment group that on average entered the facility after the other treatment groups within their pen, on a per-pen basis.

Freeze branding caused less discomfort than hot-iron branding. However, freeze-branded animals exhibited more behaviors indicative of discomfort than sham-branded steers.

### *Exertion Force and Duration*

The extent to which an animal exhibits an escape-avoidance reaction to a particular stimulus has been associated with the degree of pain sensation experienced; the greater the escape-avoidance the greater the pain sensation (Morton and Griffiths, 1985; Wall, 1992). The average and maximum exertion forces exhibited by H steers as well as exertion durations indicated that the escape response in H animals was much stronger than in F or S steers, implying that hot-iron branding caused more pain. These findings are similar to those reported by Lay et al. (1992a), who concluded that H animals had greater escape-avoidance responses (quantified as the amount of vertical movement in the chute) than F or S animals. One difference between the findings in this study and those reported by Lay et al. (1992a) was that F steers clearly exhibited a greater escape response than S animals. Lay et al. (1992a) were unable to detect differences between sham- and freeze-branded animals. The differences obtained in this study may be partially due to the more sensitive measure of the escape response obtained using load cells and strain gauges attached to the squeeze and headgate and the larger sample size.

A possible reason for the negative exertion values obtained during branding for F and S steers may have been that the animals responded to branding by becoming very still in the chute or by increasing their muscle tension. Broom and Johnson (1993) reported that a common response of fearful animals is to stop moving or freeze. It is possible that this “freezing” response was initiated when the animals were touched with the branding iron. This could have resulted in exertion values during branding being lower than forces recorded during the 10-s baseline period before the brand was applied. This is in sharp contrast to the exertion forces exhibited by H animals, which were always higher than the values obtained during the baseline sampling. This implies that the immediate sensation experienced by hot-iron-branded animals is acute pain. Even though freeze-branded animals may experience fear, they also exhibit a less severe pain sensation.

The exertion data follow the same pattern as the behavioral data. Both data sets indicate that hot-iron-branded animals experience more discomfort during branding than F animals. Sham-branded steers were the least disturbed by their experience and exerted the least force and fewest escape responses.

### *Handling Ease and Entry Order*

The ease of animal handling following a painful procedure has been used as an indicator of the relative amount of stress or pain experienced by the animals (Grandin et al., 1986; Rushen, 1986; Hinch and Lynch, 1987). Similarly, entry order has been used as an indicator of agitation or fear of re-entering a facility. Orihuela and Solano (1994) found that the cattle that were first in order to enter a slaughterhouse came in more quickly than those that were last in order, concluding that the first animals were less disturbed by handling and noise.

However, unlike the studies previously mentioned, the findings of the present study indicate that branding treatment did not affect the handling ease or entry order of cattle over a 10-d period after branding. This can be interpreted in several ways; perhaps one exposure to a negative experience is not sufficient enough to be reflected in the subsequent handling difficulty. For example, previous studies on the aversiveness of sheep to electro-immobilization were designed such that the animals were exposed to the experience repeatedly (8 to 12 times) over a period of 3 to 4 d (Grandin et al., 1986; Rushen, 1986). However, in this study steers were only branded once. Another explanation for why branding had no measurable effect on handling ease could be that the discomfort and fear associated with branding is so short-lived that it does not affect the cattle’s future response to handling. It is also possible that treatment differences could have been masked by the effects of previous experiences prior to branding, such as castration or dehorning, that may have occurred across all treatments when the steers were calves.

Boivin et al. (1992) reported that previous experiences of cattle had a substantial effect on their subsequent handling ease. For example, animals that were habituated to handling as calves were easier to handle as adults, and vice versa.

Although no treatment differences in handling ease or entry order were observed, steers in all treatment groups required more handling effort up to 6 d after branding. This indicates that the force and time required to move the animals was not related to branding. A reasonable explanation would be that the animals required a certain number of times through the chute before they became habituated to the procedure. The increasing time required to move animals into the chute up to 6 d after branding likely represents the period before the habituation, and the decreasing time on d 8 and 10 represents the period following habituation to the handling. Similar results were obtained by Schwartzkopf-Genswein et al. (1996a), cattle across all treatments required more pressure and more time to re-enter the branding area for up to 6 d following branding. The results of both studies indicate that three or more exposures to handling are required before animals become habituated to the handling facility. Similar findings were reported by Alam and Dobson (1986), who found that cattle adapted quickly (two exposures) to repeated nonpainful procedures, such as moving through a race or having blood sampled.

The use of subsequent handling ease and entry order as indicators of past experiences (i.e., negative or painful) must be used with caution. It may not accurately reflect the relative stress experienced by the animal at the time of the procedure. Clearly, hot-iron branding resulted in a more pronounced response at the time of brand application, yet no treatment differences were detected by measuring subsequent handling ease. For this reason, the quantification of behavioral responses during the actual procedure seems to be a more sensitive indicator of what the animals actually experience.

## Implications

Hot-iron and freeze branding methods cause animals to respond with behaviors indicative of discomfort. The behavioral responses, and the exertion force applied against a headgate and squeeze chute indicate that hot-iron-branded steers experience more discomfort than freeze-branded steers at the time of brand application. Advising producers not to use hot-iron branding may be correct on welfare grounds; however, even freeze branding produced behavioral and physiological signs of discomfort. Freeze branding will increase the processing time and cost compared to hot-iron branding and would be equal to hot-iron branding in terms of the animal's subsequent response to handling.

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