

JOURNAL OF ANIMAL SCIENCE

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J ANIM SCI 2012, 90:5067-5077.

doi: 10.2527/jas.2012-5447 originally published online September 5, 2012

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<http://www.journalofanimalscience.org/content/90/13/5067>



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Effects of temperament and acclimation to handling on feedlot performance of *Bos taurus* feeder cattle originated from a rangeland-based cow-calf system¹

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ABSTRACT: Two experiments evaluated the effects of temperament and acclimation to handling on performance of Angus × Hereford feeder cattle reared in extensive rangeland systems until weaning. In Exp. 1, 200 calves (n = 97 for yr 1; n = 103 for yr 2) were evaluated for temperament at weaning (average age ± SE = 152 ± 1 d) by chute score and exit velocity. Chute score was assessed on a 5-point scale according to behavior during chute restraining. Exit score was calculated by dividing exit velocity into quintiles and assigning calves a score from 1 (slowest) to 5 (fastest). A temperament score was calculated for each calf by averaging chute and exit scores. Calf temperament was classified according to temperament score as adequate (≤3) or excitable (>3). After weaning, calves were assigned to a 40-d preconditioning followed by growing (139 d) and finishing (117 d) phases until slaughter. Weaning BW was decreased ($P = 0.04$) in excitable calves compared with adequate calves. No differences were detected ($P \geq 0.21$) for ADG during preconditioning, growing, and finishing phases; hence, excitable calves tended ($P = 0.09$) to have decreased HCW compared with adequate calves. In Exp. 2, 60 steers (initial age ± SE = 198 ± 2 d) were weighed and

evaluated for temperament score 35 d after weaning (d -29). On d -28, steers were ranked by these variables and assigned to receive an acclimation treatment or not (control). Acclimated steers were processed through a handling facility twice weekly for 4 wk (d -28 to -1) whereas control steers remained undisturbed on pasture. On d 0, all steers were transported for 24 h and returned to the research facility (d 1). On arrival, steers were ranked by BW within treatment and randomly assigned to 20 feedlot pens for a 28-d feedlot receiving period. Acclimated steers had decreased temperament score and plasma cortisol compared with controls on d 0 ($P = 0.02$). During feedlot receiving, acclimated steers had decreased ADG ($P < 0.01$) and G:F ($P = 0.03$) and tended to have decreased DMI ($P = 0.07$) compared with controls. Acclimated steers had greater plasma haptoglobin on d 4 ($P = 0.04$) and greater ceruloplasmin from d 0 to 10 ($P \leq 0.04$) and tended to have greater cortisol on d 1 ($P = 0.08$) than controls. In conclusion, temperament affects productivity of beef operations based on *Bos taurus* feeder cattle reared in extensive rangeland systems until weaning whereas acclimation to handling ameliorated cattle temperament but did not benefit feedlot receiving performance.

Key words: acclimation, *Bos taurus*, feedlot, handling, temperament

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J. Anim. Sci. 2012.90:5067–5077
doi:10.2527/jas2012-5447

¹The Eastern Oregon Agric. Res. Center, including the Burns and Union Stations, is jointly funded by the Oregon Agric. Exp. Stn. and USDA-ARS. Financial support for this research was provided by the Oregon Beef Council. Appreciation is expressed to F. Cooke, T. Leiva, A. Bouck, F. Sanches, and A. Nyman (Oregon State Univ., Burns) for their assistance during this study as well as Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Brasília, Brazil; Grant # 4718/11-9) for the financial support provided to C. L. Francisco.

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Received May 7, 2012.

Accepted August 13, 2012.

INTRODUCTION

Temperament is defined as the behavioral responses of cattle when exposed to human handling (Fordyce et al., 1988) and has been shown to affect health and productive measures in feeder cattle. For example, feedlot cattle with excitable temperament have decreased performance and carcass quality compared with calmer cohorts (Fordyce et al., 1988; Voisin et al., 1997a; Nkrumah et al., 2007). Cattle with excitable

temperament also have heightened acute-phase response when a stress stimulus was applied (Hulbert et al., 2009). This latter outcome might help explain the lesser performance of excitable cattle, given that the magnitude of the acute-phase response on feedlot entry is negatively associated with health, DMI, and measures of growth (Berry et al., 2004; Qiu et al., 2007; Araujo et al., 2010).

The majority of studies associating temperament and feedlot performance have involved *Bos indicus* breeds (Voisinet et al., 1997a; Petherick et al., 2002) or *Bos taurus* cattle originated from herds reared in intensive operations (Nkrumah et al., 2007; Hoppe et al., 2010). Nonetheless, excitable temperament is frequently observed among young *Bos taurus* cattle reared in extensive rangeland-based systems (Fordyce et al., 1988; Morris et al., 1994). Our research has demonstrated that acclimation of heifers to human handling improved their temperament and decreased cortisol and acute-phase protein responses during handling (Cooke et al., 2012a). Hence, we hypothesized that temperament affects productivity and carcass quality whereas acclimation to human handling improves temperament and benefits feedlot performance of *Bos taurus* feeder cattle originated from a range cow-calf operation. To address these hypotheses, Exp. 1 associated temperament at weaning with growth and carcass traits, and Exp. 2 evaluated the effects of acclimation to handling on temperament, cortisol, and acute-phase protein responses to transport and feedlot receiving period performance of Angus × Hereford steers.

MATERIALS AND METHODS

Animals used in these experiments were cared for in accordance with acceptable practices and experimental protocols reviewed and approved by the Oregon State University Institutional Animal Care and Use Committee. Animal handling facilities used in both experiments were composed of a Silencer chute (Moly Manufacturing, Lorraine, KS) mounted on Avery Weigh-Tronix load cells (Fairmount, MN; readability 0.45 kg).

Experiment 1 was conducted from August 2009 to July 2011 and was divided into preconditioning, growing, and finishing phases. The preconditioning phase was conducted at the Oregon State University – Eastern Oregon Agricultural Research Center, Burns, whereas the growing (Top Cut, Echo, OR) and finishing (Beef Northwest, Boardman, OR) phases were conducted at commercial feedyards. Experiment 2 was conducted at the Eastern Oregon Agricultural Research Center, Burns, from September to November 2011 and was divided into an acclimation phase and a feedlot receiving phase.

Experiment 1

Animals. Over 2 consecutive years, 200 Angus × Hereford calves (yr 1 = 62 heifers and 35 steers; yr 2 = 51 heifers and 52 steers) were assigned to the experiment. All calves were reared on semiarid rangeland pastures (Ganskopp and Bohnert, 2009) with their respective dams until weaning (August of each year). At weaning (d 0), calves were evaluated for BW and temperament (Cooke et al., 2012a) and transferred to a meadow foxtail (*Alopecurus pratensis*) pasture for a 40-d preconditioning period. Across year and sex, average BW and age at weaning were (\pm SE) 202 \pm 2 kg and 152 \pm 1 d, respectively. On d 41, all calves were loaded into a commercial livestock trailer and transported for 480 km to the growing lot, where they remained for 137 d in yr 1 and 142 d in yr 2 (growing phase). Subsequently, calves were moved to an adjacent feedyard, where they remained for 113 d in yr 1 and 121 d in yr 2 (finishing phase) until slaughter at a commercial packing facility (Tyson Fresh Meats Inc., Pasco, WA). All calves were managed similarly in a single group during the preconditioning, growing, and finishing phases.

Diets provided to calves during the growing and finishing phases are shown in Table 1. During the preconditioning phase, all calves received supplemental meadow foxtail and alfalfa (*Medicago sativa*) hay at a rate to provide a daily amount of 4.0 and 1.0 kg/calf, respectively. Water and a commercial mineral and vitamin mix (Cattleman's Choice; Performix Nutrition Systems, Nampa, ID) that contained 14% Ca, 10% P, 16% NaCl, 1.5% Mg, 6000 mg/kg Zn, 3200 mg/kg Cu, 65 mg/kg I, 900 mg/kg Mn, 140 mg/kg Se, 136 IU/g of vitamin A, 13 IU/g of vitamin D₃, and 0.05 IU/g of vitamin E (DM basis) were offered for ad libitum consumption. Hay samples were collected each year at the beginning of the experiment and analyzed for nutrient content by a commercial laboratory (Dairy One Forage Laboratory, Ithaca, NY) using wet chemistry procedures for concentrations of CP (method 984.13; AOAC Int., 2006), ADF (method 973.18 modified for use in an Ankom 200 fiber analyzer; Ankom Technology Corp., Fairport, NY; AOAC Int., 2006), and NDF (Van Soest et al., 1991; method for use in an Ankom 200 fiber analyzer; Ankom Technology Corp.). The TDN concentration was calculated using the equation proposed by Bath and Marble (1989) whereas NE_m and NE_g were calculated with the equations proposed by the NRC (1996). Averaged over the 2 yr of study, meadow foxtail and alfalfa hay quality were estimated at (DM basis), respectively, 58 and 63% TDN, 65 and 44% NDF, 33 and 26% ADF, 1.19 and 1.35 Mcal/kg of NE_m, 0.62 and 0.78 Mcal/kg of NE_g, and 5.2 and 22.0% CP.

All calves were administered Clostrishield 7 and Virashield 6 + Somnus (Novartis Anim. Health, Bucyrus,

Table 1. Ingredient composition of growing and finishing diets offered to cattle in Exp. 1

Ingredients, % as-fed	Growing phase ¹				Finishing phase ²				
	A	B	C	D	A	B	C	D	E
Alfalfa hay	44.0	34.5	20.0	11.8	25.8	17.3	8.6	3.4	3.4
Wet distillers grain	15.0	15.0	20.0	20.0	25.0	21.1	17.9	15.5	15.5
Corn silage	10.0	15.0	20.0	20.0	0.0	0.0	0.0	0.0	0.0
High-moisture corn	6.0	10.0	6.0	12.0	0.0	0.0	10.0	11.3	11.3
Steam-flaked corn	0.0	0.0	0.0	0.0	40.2	39.3	29.4	29.9	29.9
Wheat screenings	10.0	12.5	6.0	5.0	0.0	0.0	0.0	0.0	0.0
Potato slurry	10.0	10.0	25.0	30.0	0.0	10.0	16.8	22.5	22.5
Culled french fries	0.0	0.0	0.0	0.0	0.0	5.0	10.0	14.1	14.1
Vegetable oil	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3
Mineral and vitamin mix ³	5.0	3.0	3.0	3.0	9.0	7.0	3.0	3.0	3.0

¹A = offered for 10 d on receiving; B = offered for 10 d after diet A; C = offered for approximately 70 d after diet B; D = offered until transfer to the finishing phase.

²A = offered for 10 d on receiving; B = offered for 10 d after diet A; C = offered for 10 d after diet B; D = offered for 30 d after diet C; E = offered until slaughter.

³Cattleman's Choice (Permix Nutrition Systems, Nampa, ID) containing (DM basis) 14 % Ca, 10 % P, 16 % NaCl, 1.5 % Mg, 6,000 mg/kg Zn, 3,200 mg/kg Cu, 65 mg/kg I, 900 mg/kg Mn, 140 mg/kg Se, 136 IU/g of vitamin A, 13 IU/g of vitamin D₃, and 0.05 IU/g of vitamin E.

KS) at approximately 30 d of age and One Shot Ultra 7, Bovi-Shield Gold 5, TSV-2, and Dectomax (all from Pfizer Animal Health, New York, NY) at weaning. Twenty-eight days after weaning, calves received a booster of Bovi-Shield Gold 5, UltraChoice 7, and TSV-2. At the beginning of the growing phase, calves were again administered Bovi-Shield Gold 5 and Dectomax, and at the beginning of the finishing phase, all calves were administered Pyramid 5 (Fort Dodge Animal Health, Overland Park, KS), Caliber 7 (Boehringer Ingelheim Vetmedica Inc., St. Joseph, MO), Valbazen (Pfizer Animal Health), and ProMectin (Ivermectin, Vedco Inc., St. Joseph, MO). Steers were implanted with Component TE-S (VetLife, West Des Moines, IA) and heifers were implanted with Component TE-H (VetLife). No incidences of mortality or morbidity were observed during the entire experiment.

Sampling. Calf BW was recorded at weaning and at the end of the preconditioning and growing phases. Final BW was estimated based on HCW adjusted to a 63% dressing percent (Loza et al., 2010). Preconditioning ADG was determined using BW values obtained at weaning and at the end of preconditioning phase. Growing lot ADG was determined using BW values obtained at the end of preconditioning and growing phases. Finishing phase ADG was determined from BW values obtained at the end of the growing phase and the estimated final BW. At the commercial packing plant, HCW was collected at slaughter, and after a 24-h chill, trained personnel assessed carcass fat thickness at the 12th-rib and LM area; all other carcass measures were recorded from a USDA grader.

Individual calf temperament was assessed at weaning by chute score and exit velocity as previously described by Cooke et al. (2012a). Chute score was assigned by a single technician based on a 5-point scale in which 1 = calm with no movement, 2 = restless movements,

3 = frequent movement with vocalization, 4 = constant movement, vocalization, and shaking of the chute, and 5 = violent and continuous struggling. Exit velocity was assessed by determining the speed of the calf exiting the squeeze chute by measuring rate of travel over a 1.9-m distance with an infrared sensor (FarmTek Inc., North Wylie, TX). Furthermore, within each year, calves were divided in quintiles according to their exit velocity and assigned a score from 1 to 5 in which 1 = calves within the slowest quintile and 5 = calves within the fastest quintile. Individual temperament scores were calculated by averaging calf chute score and exit score. Calves were classified according to the final temperament score (temperament type) as adequate temperament (temperament score ≤ 3) or excitable temperament (temperament score > 3), with the purpose of categorizing cattle within the same herd according to temperament characteristics (Cooke et al., 2011a, 2012a)

Statistical Analyses. All data were analyzed using calf as the experimental unit. Comparison of temperament score among year and sex were analyzed with the PROC MIXED procedure (SAS Inst. Inc., Cary, NC) and Satterthwaite approximation to determine the denominator degrees of freedom for the tests of fixed effects. The model statement contained the effects of sex, year, and the sex \times year interaction. Data were analyzed using calf nested within sex \times year combinations as a random effect. Incidence of excitable cattle was analyzed as a binomial distribution with the PROC GLIMMIX procedure of SAS and Satterthwaite approximation with the same model and random statement previously described. Feedlot performance and carcass traits were analyzed with the PROC MIXED procedure of SAS and Satterthwaite approximation. The model statement contained the effects of temperament type (adequate or excitable), sex, year, and all interactions. Data were analyzed using calf nested within temperament \times sex \times year combina-

tions as a random effect. The GLIMMIX procedure of SAS also was used with Satterthwaite approximation to evaluate the proportion of carcasses grading choice according to temperament type, as a binomial distribution and using the same model and random statement used for feedlot performance. Pearson correlations were calculated among individual temperament measurements (chute score, exit velocity, and temperament score), performance, and carcass traits with the CORR procedure of SAS. The GLM procedure of SAS was used to determine effects of sex and year on correlation coefficients. No effects or interactions were detected; therefore, correlation coefficients reported herein were determined across genders and year. Results are reported as least squares means, with differences among treatments separated using the LSD method protected by a preliminary *F*-test. Significance was set at $P \leq 0.05$, with $P > 0.05$ and ≤ 0.10 considered to reflect tendencies. Results are reported according to temperament effects when no interactions were significant or according to the highest-order interaction detected.

Experiment 2

Animals. Sixty Angus \times Hereford steers weaned at approximately 6 mo of age were assigned to the experiment. All calves were reared on semiarid rangeland pastures (Ganskopp and Bohnert, 2009) with their respective dams until weaning (August 2011). Steers were evaluated for BW and temperament 35 d after weaning (d -29) as described in Exp. 1. On d -28, steers were ranked by BW and temperament score and assigned to receive ($n = 30$) or not (control, $n = 30$) an acclimation treatment from d -28 to -1. Steer mean BW and age at the beginning of the experiment were (\pm SE) 206 ± 7 kg and 198 ± 2 d, respectively. On the morning of d 0, steers were combined into 1 group, loaded into a commercial livestock trailer, transported for 24 h to simulate the stress challenge of a long haul (approximately 1,200 km; Arthington et al., 2008), and returned to the research facility on d 1. On arrival, steers were ranked by BW within treatment and randomly assigned to 20 feedlot pens (10 pens/treatment; 3 steers/pen; 7 by 5 m), in a manner which all pens within treatment had equivalent average BW on d 1. Steers remained in feedlot pens until d 28 of the experiment. Steers received the same vaccination protocol at 30 d of age and weaning as in Exp. 1. Steers also received a booster vaccination against *Mannheimia (Pasteurella) haemolytica* (One Shot Ultra 7; Pfizer Animal Health) and respiratory diseases (Bovi-Shield Gold 5 and TSV-2 as in Exp. 1) at the beginning of the experiment (d -28). No mortality or morbidity was observed during the experiment.

Diets. During the acclimation phase (d -28 to 0), steers were maintained by treatment group on separate,

6-ha meadow foxtail pastures harvested for hay the previous summer. Steers were rotated between pastures on a weekly basis. Steers from both treatments received meadow foxtail and alfalfa hay at a daily rate of 5.0 and 1.0 kg of DM/steer, respectively. Water and the same commercial mineral and vitamin mix used during the preconditioning phase of Exp. 1 were offered for ad libitum consumption during the acclimation phase. Hay samples were collected at the beginning of the experiment and analyzed for nutrient content as in Exp. 1. Meadow foxtail and alfalfa hay quality were estimated at (DM basis), respectively, 57 and 63% TDN, 66 and 45% NDF, 33 and 27% ADF, 1.21 and 1.33 Mcal/kg of NE_m , 0.64 and 0.75 Mcal/kg of NE_g , and 5.5 and 21.2% CP.

During the feedlot receiving phase (d 1 to 28), steers were offered (DM basis) alfalfa-grass hay for ad libitum consumption and 2.3 kg/(steer·d) of a concentrate containing (as-fed basis) 84% corn, 14% soybean meal, and 2% mineral mix, which was offered separately from hay. Samples of hay and concentrate ingredients were collected weekly, pooled across all weeks, and analyzed for nutrient content as in Exp. 1. Hay nutritional profile was (DM basis) 58% TDN, 57% NDF, 38% ADF, 1.18 Mcal/kg of NE_m , 0.60 Mcal/kg of NE_g , and 12.5% CP. Concentrate nutritional profile was (DM basis) 85% TDN, 9.0% NDF, 4.6% ADF, 2.12 Mcal/kg of NE_m , 1.46 Mcal/kg of NE_g , and 14.5% CP. The mineral mix was the same used during the preconditioning phase of Exp. 1 whereas water was offered for ad libitum consumption throughout the experiment.

Acclimation Procedure. Acclimated steers were exposed to a handling acclimation process twice weekly (Tuesday and Thursday) for 4 wk (d -28 to -1 of the experiment). The acclimation treatment was applied individually to steers by processing them through a handling facility as previously described by Cooke et al. (2009). During wk 1 of acclimation, steers were individually processed through the handling facility but not restrained in the squeeze chute. During wk 2, steers were individually processed through the handling facility and restrained in the squeeze chute for approximately 5 s. On wk 3 and 4, steers were similarly processed as in wk 2, but they were restrained in the squeeze chute for 30 s. During the initial 3 wk, steers were allowed to return to their pasture immediately after processing whereas during wk 4, steers remained in the handling facility for 1 h and were processed again through the handling facility and then returned to pasture. For each handling acclimation process, acclimated steers were gathered in the pasture and required to walk to the handling facility whereas control steers remained undisturbed on pasture. The total distance traveled by acclimated steers during each of the acclimation events was approximately 0.6 km (round-trip). Each acclimation process was com-

pleted within 1 h during the initial 3 wk and within 2 h during wk 4 of the acclimation period.

Sampling. Steer shrunk BW was collected at the beginning (d -27) and at the end of the experiment (d 29) after 16 h of feed and water restriction. Shrunk BW also was recorded on d 1 immediately after unloading. Values obtained on d -27 and 1 were used to calculate ADG during the acclimation phase whereas values obtained on d 1 and 29 were used to calculate ADG during the feedlot receiving phase. Concentrate, hay, and total DMI were evaluated daily from d 1 to 28 for each pen by collecting and weighingorts. Samples of the offered and nonconsumed feed were collected daily from each pen and dried for 96 h at 50°C in forced-air ovens for DM calculation. Total BW gain and DMI from d 1 to 28 were used for feedlot receiving G:F calculation. Steer temperament was also evaluated on d 0 as described in Exp. 1.

Blood samples were collected on d -28 (before vaccination), 0 (before loading), 1 (immediately after unloading), 4, 7, 10, 14, 21, and 28 via jugular venipuncture into commercial blood collection tubes (Vacutainer, 10 mL; Becton Dickinson, Franklin Lakes, NJ) containing 158 United States Pharmacopeia (USP) units of freeze-dried sodium heparin for plasma collection. Blood samples were placed immediately on ice, centrifuged at $2,500 \times g$ for 30 min at 4°C for harvesting plasma, and stored at -80°C on the same day of collection. Plasma concentrations of cortisol were determined using a bovine-specific commercial ELISA kit (Endocrine Technologies Inc., Newark, CA). Plasma concentrations of ceruloplasmin and haptoglobin were determined according to procedures described previously by Demetriou et al. (1974) and Cooke and Arthington (2012). The intra- and interassay CV were, respectively, 7.8 and 9.2% for cortisol, 9.6 and 6.0% for ceruloplasmin, and 3.2 and 8.1% for haptoglobin.

Statistical Analyses. All data were analyzed using steer as the experimental unit, with the PROC MIXED procedure (SAS Institute Inc., Cary, NC) and Satterthwaite approximation. The model statement used for ADG contained the fixed effect of treatment. Data were analyzed using steer nested within treatment or steer nested within treatment \times pen combination as random effects for ADG during the acclimation and feedlot receiving phases, respectively. The model statement used for temperament and plasma measurements obtained at the end of the acclimation phase (d 0) contained the effects of treatment and values obtained on d -28 as covariate. Data were analyzed using steer nested within treatment as a random effect. The model statement used for DMI and G:F during feedlot receiving contained the effects of treatment as well as day and the treatment \times day interaction for DMI only. Data were analyzed using pen nested within treatment as a random effect in the

model. The model statement used for plasma measurements obtained during the feedlot receiving phase contained the effects of treatment, day, and the treatment \times day interaction. Data were analyzed using steer nested within treatment \times pen combinations as a random effect. The subject of the repeated statements for day was pen nested within treatment or steer nested within treatment \times pen combination for DMI or temperament and plasma measurements, respectively, and the covariance structure used was based on the Akaike information criterion. The model statements used to evaluate the effects of temperament on physiological responses from d 0 to 29 as well as ADG during feedlot receiving were similar to those described previously but contained the effect of temperament type (adequate or excitable, as in Exp. 1) instead of treatment. Results are reported as least squares means, and differences among treatment means were separated using the LSD method protected by a preliminary *F*-test. As in Exp. 1, significance was set at $P \leq 0.05$, with $P > 0.05$ and ≤ 0.10 considered to reflect tendencies. In addition, results are reported according to temperament effects when no interactions were significant or according to the highest-order interaction detected.

RESULTS AND DISCUSSION

Experiment 1

No interactions involving treatment, sex, and year were detected ($P \geq 0.24$) for the variables analyzed and reported herein; therefore, results are reported across years, steers, and heifers. Based on the temperament evaluation criteria we used, the calf crop from both years had similar ($P \geq 0.35$; data not shown) mean temperament score (2.72 vs. 2.75 temperament score in yr 1 and 2, respectively; SEM = 0.10) and proportion of excitable animals (27.8 vs. 33.9% of excitable animals/total animals in yr 1 and 2, respectively; SEM = 4.7). Similarly, no differences between steers and heifers ($P \geq 0.34$; data not shown) were noted for mean temperament score (2.67 vs. 2.80 temperament score for heifers and steers, respectively; SEM = 0.09) and proportion of excitable animals (28.7 vs. 33.0% of excitable animals/total animals in yr 1 and 2, respectively; SEM = 4.6). In contrast to our results, previous research suggested that excitable temperament is more common in female than in male cattle (Voisinet et al., 1997a). It is important to note that the goal of the present experiment was to determine whether temperament at weaning affects overall productivity and not to determine the incidence of excitable temperament in *Bos taurus* feeder cattle originated from a rangeland-based cow-calf operation. The methods and criteria used herein to evaluate cattle

for temperament were similar those used in our previous research with *Bos indicus* and *Bos taurus* cattle (Cooke et al., 2009, 2011a, 2012a) and have the purpose of classifying cattle according to temperament characteristics within a herd by using techniques that can be feasibly completed during routine cattle processing (Cooke et al., 2011a). Furthermore, evaluating temperament at weaning has been shown to properly estimate cattle temperament and its potential effects on feedlot performance as well as carcass quality traits (Fell et al., 1999; Behrends et al., 2009; Petherick et al., 2009).

No significant Pearson correlation coefficients were detected ($P \geq 0.12$) between chute score, exit velocity, and temperament score with weaning, preconditioning, and feedlot performance variables (data not shown). Nonetheless, temperament type (adequate or excitable temperament) influenced some of the performance variables evaluated herein (Table 2). Weaning age did not differ ($P = 0.93$) between calves with excitable and adequate temperament. Excitable calves had decreased ($P = 0.04$) weaning BW compared with cohorts with adequate temperament (Table 2). No differences were detected for ADG during preconditioning ($P = 0.22$), growing ($P = 0.51$), and finishing ($P = 0.21$) phases between calves with excitable and adequate temperament. Hence, excitable calves tended ($P = 0.09$) to have decreased BW at the end of preconditioning as well as final BW compared with cohorts with adequate temperament (Table 2). These results suggest that rangeland-originated Angus \times Hereford calves with excitable temperament were lighter at weaning than cohorts with adequate temperament and that this difference persisted until slaughter. In contrast to these findings, other research studies have demonstrated that cattle with excitable temperament have decreased ADG (Voisinet et al., 1997a; Cafe et al., 2011; Turner et al., 2011) during the feedlot phase, which is often explained by decreased DMI (Fox et al., 2004; Nkrumah et al., 2007) and feed efficiency measurements (Petherick et al., 2002). Conversely, and supporting our results, similar feedlot ADG between excitable and calm cattle also has been documented (Holroyd et al., 2000; Petherick et al., 2002; Hall et al., 2011). The effects of temperament on weaning BW reported herein are novel and affected the BW of excitable calves throughout their productive lives. The specific reasons for decreased weaning BW in excitable cattle are not known and deserve further investigation. This outcome, however, should not be attributed to temperament of the dam given that Cooke et al. (2012a) reported similar weaning BW of calves born to excitable and calmer dams originated from the same cow-calf herd evaluated in the present study.

No significant Pearson correlation coefficients were detected ($P \geq 0.14$) between chute score, exit velocity, and temperament score with the carcass traits we evaluated. As expected based on final BW, excitable calves

Table 2. Performance by *Bos taurus* feeder cattle originated from a rangeland-based cow-calf system according to temperament assessed at weaning

Item ²	Temperament type ¹		SEM	P-value
	Adequate (n = 139)	Excitable (n = 61)		
Weaning age, d	152	152	1	0.93
Weaning BW, kg	204	197	2	0.04
Preconditioning final BW, kg	219	213	2	0.09
Preconditioning ADG, kg/d	0.37	0.40	0.02	0.22
Growing phase final BW, kg	369	365	3	0.49
Growing phase ADG, kg/d	1.08	1.09	0.01	0.51
Finishing phase final BW, kg	587	576	5	0.09
Finishing phase ADG, kg/d	1.85	1.80	0.02	0.21

¹Calculated based on calf temperament score (adequate temperament, temperament score ≤ 3 ; excitable temperament, temperament score > 3). Temperament score was calculated by averaging calf chute score and exit score. Exit score was calculated by dividing exit velocity results into quintiles and assigning calves a score from 1 to 5 (exit score: 1 = slowest calves; 5 = fastest calves).

²All calves were managed similarly in a single group during the preconditioning (40 d), growing (average \pm SE = 139 ± 2 d), and finishing (average \pm SE = 117 ± 4 d) phases. Calf BW was determined at the end of preconditioning and growing phases. Finishing BW was calculated from hot carcass weight, assuming 63% dress; Loza et al., 2010).

tended ($P = 0.09$) to have decreased HCW compared with cohorts with adequate temperament (Table 3). No temperament type effects were detected ($P \geq 0.23$) on carcass fat thickness, LM area, KPH, yield grade, marbling, percent retail product, and percent of carcasses grading USDA Choice (Table 3). Previous research demonstrated that excitable temperament affected carcass merit traits such as LM area (Behrends et al., 2009) or marbling (Hall et al., 2011). Temperament seems to have a greater effect, however, on traits associated with meat tenderness (Voisinet et al., 1997b; Behrends et al., 2009; Gruber et al., 2010) or carcass discounts, such as the incidence of dark cutters (Voisinet et al., 1997b) or bruised carcasses (Fordyce et al., 1988), which were not evaluated in the present experiment. Supporting our results, King et al. (2006) also reported that temperament did not affect the same carcass traits evaluated herein in *Bos indicus*- and *Bos taurus*-influenced feeder cattle.

In conclusion, results from Exp. 1 demonstrated that rangeland-originated *Bos taurus* feeder cattle with excitable temperament had decreased weaning BW compared with cohorts with adequate temperament, and this difference in BW persisted until slaughter, resulting in decreased HCW. Additional research is still required to determine how calf temperament affects weaning weight. Nevertheless, our results suggest that temperament directly affects productivity of beef operations based *Bos taurus* feeder cattle reared in extensive rangeland systems until weaning.

Table 3. Carcass traits of *Bos taurus* feeder cattle originated from a rangeland-based cow-calf system according to temperament assessed at weaning

Item	Temperament type ¹		SEM	P-value
	Adequate (n = 139)	Excitable (n = 61)		
HCW, kg	370	362	3.0	0.09
12th rib fat, cm	1.36	1.33	0.03	0.63
LM area, cm ²	90.8	89.5	0.9	0.29
KPH, %	2.41	2.31	0.06	0.23
Marbling ²	460	458	7	0.90
Yield grade ³	2.93	2.89	0.06	0.66
Retail product ⁴ , %	49.9	50.0	0.2	0.64
Choice, %	74.2	78.4	4.4	0.51

¹Calculated based on calf temperament score (adequate temperament, temperament score ≤ 3 ; excitable temperament, temperament score > 3). Temperament score was calculated by averaging calf chute score and exit score. Exit score was calculated by dividing exit velocity results into quintiles and assigning calves with a score from 1 to 5 (exit score: 1 = slowest calves; 5 = fastest calves).

²Marbling score: 400 = Small⁰⁰, 500 = Modest⁰⁰.

³Calculated as reported by Lawrence et al. (2010).

⁴USDA retail yield equation = $51.34 - (5.78 \times \text{backfat}) - (0.0093 \times \text{HCW}) - (0.462 \times \text{KPH}) + (0.74 \times \text{LM area})$.

Experiment 2

During the acclimation phase, no treatment effects were detected ($P = 0.36$) on steer ADG (Table 4). These outcomes were expected given that steers from both treatments were maintained in similar pastures and provided the same diet. Likewise, no differences in ADG were detected in our previous study with replacement heifers receiving or not receiving an acclimation process similar to the one used in the present study (Cooke et al., 2012a).

After the end of the acclimation process and before transport (d 0), acclimated steers had decreased chute score ($P < 0.01$), exit velocity ($P = 0.05$), and temperament score ($P = 0.02$) compared with control cohorts (Table 4). Moreover, acclimated steers had lower ($P = 0.02$) plasma concentrations of cortisol than control cohorts (Table 4). Supporting these results, our previous findings and those of other research groups have indicated that acclimation of cattle to handling procedures is an alternative to improve temperament (Krohn et al., 2001; Cooke et al., 2009, 2012a) and prevent elevated concentrations of cortisol in response to handling stress (Curley et al., 2006; Cooke et al., 2009, 2012a). No treatment effects were detected for plasma haptoglobin on d 0 ($P = 0.29$) whereas acclimated steers had greater ($P = 0.03$) plasma ceruloplasmin concentrations than control cohorts on d 0 (Table 4). Although cortisol is known to elicit inflammatory and acute-phase reactions that increase circulating concentrations of acute-phase proteins (Cooke and Bohnert, 2011), ceruloplasmin is also modulated by Cu intake (Arthington et al., 1996). A mineral supplement containing 3,200 mg/kg of Cu was

Table 4. Average daily gain, plasma concentrations of cortisol, haptoglobin, and ceruloplasmin, and temperament measurements obtained at the end of the acclimation period in steers exposed (n = 30) or not (control; n = 30) to handling acclimation procedures¹

Item	Acclimated	Control	SEM	P-value
ADG ² , kg/d	0.32	0.38	0.05	0.36
Cortisol, ng/mL	20.0	25.3	1.6	0.02
Haptoglobin, $\mu\text{g/mL}$	261	341	53	0.29
Ceruloplasmin, mg/dL	23.4	20.8	0.8	0.03
Chute score	1.65	2.04	0.09	< 0.01
Exit velocity, m/s	1.98	2.27	0.10	0.05
Temperament score ³	2.22	2.63	0.12	0.02

¹Acclimated steers were exposed to a handling process 2 times weekly for 4 wk (d -28 to -1), which was applied individually to steers by processing them through a handling facility. Control steers remained undisturbed on pasture. Values reported are least squares means adjusted by covariance analysis for values obtained at the beginning of the acclimation period (d -28).

²Calculated using initial (d -27) and final (d 1) shrunk BW.

³Calculated by averaging steer chute score (Cooke et al., 2012a) and exit score. Exit score was calculated by dividing chute exit velocity results into quintiles, and assigning steers a score from 1 to 5 (exit score; 1 = slowest steers; 5 = fastest steers).

offered free choice during the acclimation phase; hence, treatment effects detected for plasma ceruloplasmin on d 0 might be a result of differences in mineral supplement intake rather than a heightened acute-phase protein reaction in acclimated steers compared with control cohorts, particularly when one considered the decreased plasma cortisol on d 0 in acclimated steers. Mineral supplement intake was not measured in the present study, however, so it is not possible to determine its role in affecting the plasma ceruloplasmin responses that we observed.

During the feedlot receiving phase, acclimated steers had decreased ($P < 0.01$) ADG, tended to have decreased total DMI ($P = 0.07$), and had decreased ($P = 0.03$) G:F compared with control cohorts (Table 5). This outcome was not expected given that the acclimation process improved steer temperament, which is known to affect feedlot DMI (Fox et al., 2004; Nkrumah et al., 2007), feed efficiency (Petherick et al., 2002), and growth (Voisinet et al., 1997a; Cafe et al., 2011; Turner et al., 2011). Moreover, results from Exp. 1 indicated that rangeland-originated *Bos taurus* feeder cattle with adequate temperament had at least similar feedlot performance to excitable cohorts. Treatment \times day interactions were detected during the feedlot receiving phase for plasma cortisol ($P = 0.05$; Figure 1) and ceruloplasmin ($P = 0.03$; Figure 2), and a tendency ($P = 0.09$; Figure 3) for the same interaction was detected for plasma haptoglobin. Following transport and feedlot entry, acclimated steers had greater ($P = 0.05$) haptoglobin concentrations on d 4, greater ($P \leq 0.05$) ceruloplasmin concentrations from d 1 to 10, and tended ($P = 0.08$) to have greater cortisol concentration on d 1 than control steers.

Table 5. Feedlot receiving performance of steers exposed (n = 30) or not (control; n = 30) to handling acclimation procedures¹

Item	Acclimated	Control	SEM	P-value
ADG ² , kg/d	1.13	1.32	0.04	<0.01
DMI, kg/d				
Hay	4.88	5.16	0.11	0.10
Concentrate	2.21	2.24	0.04	0.66
Total	7.09	7.40	0.11	0.07
G:F ³ , g/kg	166	185	6	0.03

¹Acclimated steers were exposed to a handling process 2 times weekly for 4 wk (d -28 to -1), which was applied individually to steers by processing them through a handling facility. Control steers remained undisturbed on pasture. On d 0, all steers were transported for 24 h and returned to the research facility (d 1). Upon arrival, steers were assigned to feedlot pens for a 28-d feedlot receiving (d 1 to 28).

²Calculated using initial shrunk BW collected at unloading (d 1) and at the end of feedlot receiving (d 29).

³Calculated from total DMI and BW gain from d 0 to 28.

It also is important to note that during feedlot receiving, steers did not receive the mineral supplement for ad libitum consumption, and concentrate intake was similar between acclimated and control steers; therefore, treatment effects detected on plasma ceruloplasmin during feedlot receiving should be associated with treatment differences on acute-phase measurements rather than differences in mineral intake. Hence, acclimated steers had a more severe neuroendocrine stress and acute-phase protein responses elicited by transportation and feedlot entry (Sapolsky, et al., 2000; Arthington et al., 2003; Cooke et al., 2011b) compared with control cohorts, which likely contributed to their decreased feedlot receiving performance. Accordingly, circulating concentrations of acute-phase proteins in transported feeder cattle were negatively associated with feedlot receiving performance (Berry et al., 2004; Qiu et al., 2007; Araujo et al., 2010). Such an outcome can likely be attributed

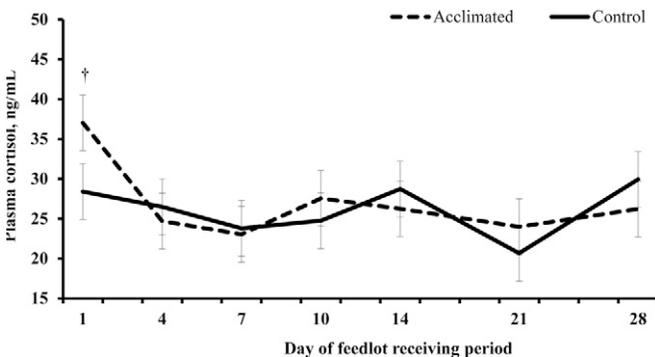


Figure 1. Plasma cortisol concentrations during the feedlot receiving period (d 1 to 28) of beef steers exposed (acclimated; n = 30) or not (control; n = 30) to handling acclimation procedures (d -28 to -1) and transported for 24 h for 1,200 km (d 0 to 1). Acclimated steers were exposed to a handling process twice weekly for 4 wk, which was applied individually to steers by processing them through a handling facility, whereas control steers remained undisturbed on pasture. A treatment × day interaction was detected ($P = 0.05$). Treatment comparison within day; † $P = 0.08$.

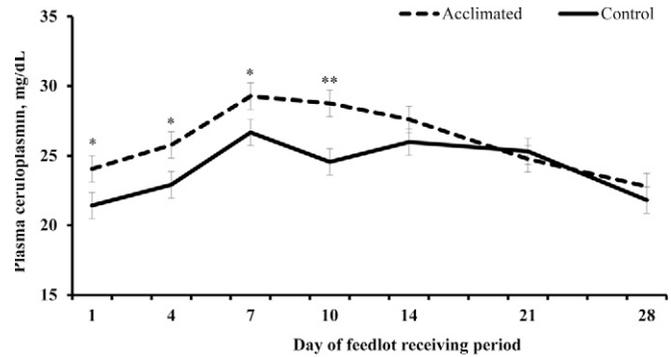


Figure 2. Plasma ceruloplasmin concentrations during the feedlot receiving period (d 1 to 28) of beef steers exposed (acclimated; n = 30) or not (control; n = 30) to handling acclimation procedures (d -28 to -1) and transported for 24 h for 1,200 km (d 0 to 1). Acclimated steers were exposed to a handling process twice weekly for 4 wk, which was applied individually to steers by processing them through a handling facility, whereas control steers remained undisturbed on pasture. A treatment × day interaction was detected ($P = 0.03$). Treatment comparison within day; * $P \leq 0.05$; ** $P < 0.01$.

altered basal metabolism, increased tissue catabolism, depressed feed intake, and decreased feed efficiency during an acute-phase response (Johnson, 1997).

The reason why acclimated steers had increased cortisol and acute-phase protein responses during feedlot receiving is not known and deserves further investigation. The hypothesis of the present experiment was that the acclimation process would improve cattle temperament, alleviate the cortisol and acute-phase protein responses during handling and following the stress of transport and feedlot entry, and consequently benefit feedlot receiving performance. This hypothesis was based on previous research from our group indicating that acclimation to handling improves temperament and decreases cortisol (Cooke et al., 2009, 2012a), which is paramount to the neuroendocrine stress response that elicits an acute-phase reaction in beef cattle (Sapolsky, et al., 2000; Cooke and Bohnert, 2011; Cooke et al., 2012b), including after transport and feed-

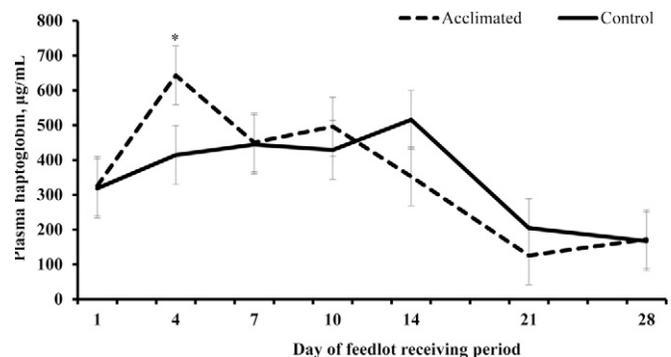


Figure 3. Plasma haptoglobin concentrations during the feedlot receiving period (d 1 to 28) of beef steers exposed (acclimated; n = 30) or not (control; n = 30) to handling acclimation procedures (d -28 to -1) and transported for 24 h for 1,200 km (d 0 to 1). Acclimated steers were exposed to a handling process twice weekly for 4 wk, which was applied individually to steers by processing them through a handling facility, whereas control steers remained undisturbed on pasture. A tendency ($P = 0.09$) for a treatment × day interaction was detected. Treatment comparison within day; * $P = 0.05$.

lot entry (Cooke et al., 2011b). Accordingly, Hulbert et al. (2009) reported increased acute-phase response elicited by LPS infusion in bulls with excitable temperament compared with calm cohorts. In the present study, however, acclimated steers had a greater cortisol response immediately following transport than control cohorts, which likely contributed to greater concentrations of haptoglobin and ceruloplasmin detected during the feedlot receiving period. In our previous research with replacement heifers, the acclimation process improved heifer temperament, decreased plasma cortisol concentrations during handling, and hastened reproductive development (Cooke et al., 2009, 2012a). Nevertheless, heifers were maintained throughout these experiments under the circumstances to which they were acclimated: on pasture with brief human interaction for feeding and gathering as well as handling for blood collection. In the present experiment, one could speculate that the acclimation process effectively improved steer temperament and alleviated the resultant neuroendocrine stress response during the instances comprised within the acclimation process, including gathering on pasture and handling at the working facility. When exposed, however, to a novel occurrence, more specifically road transport and all changes associated with feedlot entry, acclimated steers might have experienced a greater psychological stress reaction than control cohorts, resulting in the treatment effects detected on physiological and performance measurements during feedlot receiving. Further research is required to properly address these assumptions.

As previously discussed, excitable cattle have greater inflammatory and acute-phase responses following a stress stimulus (Hulbert et al., 2009), which could help explain the decreased feedlot performance of excitable cattle reported by others (Voisinet et al., 1997a; Cafe et al., 2011; Turner et al., 2011), particularly given that the magnitude of the acute-phase response on feedlot entry is negatively associated with cattle health, DMI, and growth (Berry et al., 2004; Qiu et al., 2007; Araujo et al., 2010). In the present experiment, when steers were classified across treatments according to temperament type (excitable or adequate temperament, as in Exp. 1) based on the temperament score assessed on d 0, excitable steers ($n = 14$) had greater plasma haptoglobin and ceruloplasmin responses (Figure 4) as well as decreased ADG ($P = 0.05$; data not shown) compared with cohorts with adequate temperament ($n = 46$) during feedlot receiving (1.10 vs. 1.26 kg/d, respectively, SEM = 0.05). No differences were detected ($P = 0.77$) in plasma cortisol between calves with excitable and adequate temperament (27.3 vs. 25.9 ng/mL, respectively; SEM = 3.0) although other research has demonstrated that excitable temperament is associated with increased cortisol concentrations in beef cattle (Curley et al., 2008; Cooke et al., 2009, 2012a). Nonetheless, these findings demonstrate that temperament modulates

the acute-phase protein reaction elicited by road transport and feedlot entry and directly affects subsequent feedlot receiving performance of feeder cattle. The lack of similar temperament-type effects on feedlot ADG between Exp. 1 and Exp. 2 might be attributed to several factors, including duration of road transport, feedlot management and diets, and the length of the receiving period in Exp. 2. Moreover, perhaps the longer growing and finishing phases in Exp. 1 diluted potential ADG differences between cattle with excitable and adequate temperament during the initial 28 d after feedlot entry. Furthermore, temperament in Exp. 1 was evaluated at weaning whereas in Exp. 2, temperament was evaluated immediately before transport (d 0) to account for temperament changes from weaning to transport associated with the acclimation treatment. Still, temperament evaluation before transport also been used to evaluate the effects of this trait on feedlot performance of beef cattle (Petherick et al., 2002, 2009; King et al., 2006).

In conclusion, results from Exp. 2 indicate that acclimation of rangeland-originated *Bos taurus* steers to handling procedures and human interaction improved steer temperament before road transport and feedlot entry, but increased cortisol and acute-phase protein re-

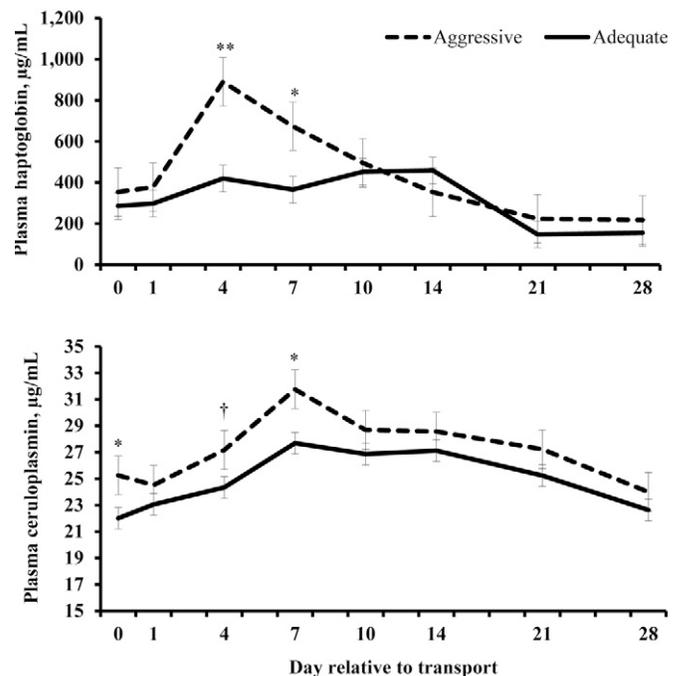


Figure 4. Plasma haptoglobin and ceruloplasmin concentrations prior to transport (d 0) and during feedlot receiving (d 1 to d 28) of beef steers according to temperament type, which was calculated based on steer temperament score [adequate temperament ($n = 46$), temperament score ≤ 3 ; excitable temperament ($n = 14$), temperament score > 3]. Temperament score was calculated by averaging steer chute score and exit score on d 0, before 24-h road transport for 1,200 km and feedlot entry (d 1). Exit score was calculated by dividing exit velocity results into quintiles and assigning steers with a score from 1 to 5 (exit score: 1 = slowest steers; 5 = fastest steers). Treatment comparison within day: † $P = 0.07$; * $P \leq 0.05$; ** $P < 0.01$.

sponses and decreased ADG during feedlot receiving. Therefore, acclimation to human handling after weaning and transport to feedlot, such as during a preconditioning program, was detrimental to feedlot performance of *B. taurus* feeder cattle reared in extensive rangeland-based systems until weaning.

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