

**THE EFFECT OF WEEKLY HANDLING ON THE TEMPERAMENT
OF PERI-PUBERAL CROSSBRED BEEF HEIFERS**

by

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Thesis submitted to the Faculty of the Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Animal and Poultry Sciences

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May 12, 2006

Blacksburg, Virginia

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ABSTRACT

The objective of this study was to determine the effects of handling peri-puberal heifers for 2 h each week on in-chute behavior, isolation behavior, and the time required for each heifer to leave the testing area. A secondary objective was to determine if the location of the facial hair whorl was associated with any of the behavior scores. Crossbred beef heifers (n = 146) were assigned to two treatment groups of HANDLED (walked through, moved in corral, sorted, moved through a chute) for 2 hr each wk for 20 wk (HANDLED) or allowed to remain on pasture unless handling was required to treat an injury or disease (CONTROL). Temperament and behavior of the heifers was observed and scored when heifers were in each of three settings. Behavior tested for in-chute behavior, isolation pen behavior, and exit times were recorded as the heifers moved the first 22 m from the testing area. Each test was performed at the beginning (0 wk), middle (10 wk), and end of the experiment (20 wk). The facial hair whorl on each heifer was classified as being high (located above the eyes), middle (in between the eyes), or low (below the eyes). At the end of the experiment pairs of heifers in the HANDLED group were allowed to compete for a feed source and social dominance order was estimated based on the relative time each heifer controlled the feed source. Differences in temperament scores or changes in temperament scores were analyzed by ANOVA using the general linear model procedure of SAS with animals in the HANDLED and CONTROL groups, facial hair whorl position or initial isolation score as main effects.

The regression procedure of SAS was used to determine the relationship between estimated social dominance order and the in-chute behavior score, isolation behavior scores, exit time, and final weight of each heifer. Weekly handling decreased in-chute behavior scores of heifers with facial hair whorl positions classified as medium or low, but not in heifers that exhibited a hair whorl high on their face. Cattle in the HANDLED treatment group which had an initial isolation score of 2 or 3 had the greatest improvement in temperament over the entire experiment when compared to CONTROL animals with the same initial isolation score. The calmest heifers were not negatively affected by the handling, while the most agitated animals in the HANDLED had a similar overall change in isolation score as those animals in the CONTROL group. This indicates that while weekly handling improved the temperament and behavior of heifers with intermediate temperament rating at the outset of the experiment, weekly handling seemed unnecessary for the calmest heifers and did not have a beneficial effect on the heifers rated as the most nervous and agitated at the beginning of the experiment. Social dominance rankings were positively correlated ($P < 0.10$) with final in-chute behavior scores, but not with the other behavior scores or heifer body weight. Overall, the results of this experiment indicate that behavior testing can reveal differences in the temperament of heifers and that, other than the most nervous and agitated heifers; repeated handling could serve to improve the temperament of the animals.

Key Words: beef heifer, temperament, behavior, facial hair whorl, social dominance

Acknowledgements

The past two years at Virginia Tech have been challenging and difficult, but extremely rewarding. I would like to thank the following people for helping me on this journey.

Dr. Bill Beal, for being an excellent teacher and advisor. I admire your teaching ability both in and out of the classroom. Thank you for being such a good mentor.

Mr. Henry Dickerson, for always being available to help out with my research and for teaching me to drive a manual.

Mrs. Mary Jane Thompson, for always having time to talk and keeping the refrigerator stocked with drinks for those hot days at the farm.

Mr. Lee Johnson, for being an expert on computers, statistics, and cattle. You were always the first person to go to whenever a problem arose.

Mr. Forrest Axson. Thank you for always being available to help out for whatever need to be done, even if it was performing social dominance tests for 5+ hours in 30 degree weather. I enjoyed learning how to bass fish and canoeing down the New River was always a fun day. You have been an amazing friend and I would have never made it if it wasn't for you.

The Animal Physiology Graduate Students: Mr. Brian Whitaker, Ms. Katie Jordan, and Ms. Susan Speight. Thank you for always being there to proofread papers, discuss research projects, and to just hang out with, especially on game nights.

My Family, for being supportive and helping me make it through the past two years. Thank you for everything you have done for me. I love you!

Table of Contents

CHAPTER 1 INTRODUCTION.....	1
CHAPTER 2 REVIEW OF LITERATURE	3
HEIFER GROWTH AND DEVELOPMENT.....	3
<i>The Onset of Puberty</i>	<i>4</i>
<i>Pre-weaning Growth and Development.....</i>	<i>5</i>
<i>Post-weaning Growth and Development</i>	<i>6</i>
<i>Reproductive Tract Scoring</i>	<i>8</i>
BEHAVIOR AND HANDLING PRACTICES	8
CATTLE BEHAVIOR.....	9
TEMPERAMENT SCORING SYSTEMS	13
FOREHEAD HAIR WHORL PATTERNS	14
SOCIAL DOMINANCE	17
CHAPTER 3 RATIONALE AND EXPERIMENTAL OBJECTIVES	20
CHAPTER 4 MATERIALS AND METHODS.....	21
CHAPTER 5 RESULTS	31
IN-CHUTE BEHAVIOR SCORES	31
ISOLATION BEHAVIOR SCORES	33
EXIT TIME RECORDINGS.....	36
TREATMENT EFFECTS BY INITIAL ISOLATION SCORE	37
HEIFER WEIGHTS.....	43
SERUM PROGESTERONE CONCENTRATIONS.....	43
SOCIAL DOMINANCE	44
CHAPTER 6 DISCUSSION	46
TESTING METHOD	46
IN-CHUTE BEHAVIOR SCORE.....	47
ISOLATION BEHAVIOR SCORE.....	47
EXIT TIME RECORDINGS.....	49
HANDLING EFFECTS ON HEIFERS WITH DIFFERENT INITIAL ISOLATION BEHAVIOR SCORES	49
FACIAL HAIR WHORL LOCATION AND BEHAVIOR	51
SOCIAL DOMINANCE	52
ANECDOTAL OBSERVATIONS.....	52
CHAPTER 7 IMPLICATIONS	54
LITERATURE CITED.....	55
VITA.....	61

List of Figures

Figure 2.1. Theoretical demonstration of age and weight requirements for puberty.....	5
Figure 4.1. Timeline of behavior evaluations and handling sessions for the duration of the experiment.....	23
Figure 4.2. Cattle with hair whorls classified as low (A), medium (B), and high (C).....	24
Figure 4.4. Social dominance pairing scheme.....	28
Figure 5.1. 1 st half changes in in-chute behavior scores by initial isolation score group.....	38
Figure 5.2. 2 nd half changes in in-chute behavior scores by initial isolation score group.....	39
Figure 5.3. Overall changes in in-chute behavior scores by initial isolation score group.....	39
Figure 5.4. 1 st half changes in isolation behavior scores by initial isolation score group.....	40
Figure 5.5. 2 nd half changes in isolation behavior scores by initial isolation score group.....	40
Figure 5.6. Overall changes in isolation behavior scores by initial isolation score group.....	41
Figure 5.7. 1 st half changes in exit time by initial isolation score group.....	42
Figure 5.8. 2 nd half changes in exit time by initial isolation score group.....	42
Figure 5.9. Overall changes in exit time by initial isolation score group.....	43

List of Tables

Table 2.1. Breed Comparison of Age and Weight at Puberty in Heifers (Gregory et al., 1991).....	5
Table 2.2. Reproductive tract scoring for determining cycling status in yearling heifers (Andersen et al., 1991).....	8
Table 4.1. In-chute behavior scoring from Grandin et al. (1995).....	24
Table 4.2. Isolation pen behavior scoring system from Laniar et al. (2000).....	25
Table 4.3. Isolation pen behavior scoring from Laniar et al. (2000). Animals that scored 3 or 4 in the isolation pen temperament scoring received an additional behavior score.....	26
Table 5.1. Average in-chute and isolation behavior scores and exit times at 0, 10, and 20 wk and the change in scores from the first half, second half, and overall for heifers with high, middle, and low hair whorls in the two treatment groups of control and handled.....	32
Table 5.2. Number of heifers that displayed aggressive or escape behavior with an isolation behavior score of 3 (gait faster than a walk with jerky movements) or 4 (attempted to climb, jump, or go through partitions) from both independent observers.....	36
Table 5.3. Correlations and p-values comparing social dominance ranking and final scoring session results (in-chute, isolation, and exit time); overall changes (0 to 20 wks) (in-chute, isolation, exit time); and final weights for the heifers in the HANDLED treatment group.....	45

Chapter 1 Introduction

Interest has increased in domestic animal behavior and animal welfare research in recent years. Handling facilities are being designed to decrease the labor and improve the safety of the animals and handlers when cattle are moved from one area to another.

Simple changes, such as brighter lights and solid walls, make handling cattle easier and safer for the handlers. Training employees to move cattle quietly and with minimal force also reduces stress on the animal and creates a safer environment for the handler.

Replacement heifers are the genetic pool in which future productivity of the farm is based. Most research on behavior and social dominance thus far has been based on beef steers and dairy cattle, due to the intensive handling in feedlots and in the milking parlor. Handling of heifers is minimal in most beef operations, as the animals are maintained on pasture and are not handled until herd health procedures, calving difficulty, or emergency care is necessary. Determining temperament earlier in production would allow the producer to make culling decisions if labor or facilities do not exist to handle nervous animals. It has been theorized that the facial hair whorl location could be a indication of cattle temperament, with cattle having hair whorls located above the eyes as being the most agitated.

This thesis will describe literature related to managing replacement heifers from weaning through the first breeding season. Literature related to cattle behavior and temperament testing, the relationship of hair whorls and temperament, and social dominance will also be discussed. Finally, an experiment will be described that was designed to test the hypothesis that heifers that were handled weekly for the 20 wk experiment would have lower behavior scores in all three testing situations (in-chute,

isolation, and exit time) when compared to the control animals that remained on pasture. Additionally, heifers with hair whorls high on the forehead would be more nervous and agitated than those heifers with hair whorls classified as middle or low on the forehead. Furthermore, it was hypothesized that the socially highest ranking heifers, among the handled treatment group, would be that animals with the calmest temperaments.

Chapter 2 Review of Literature

Heifer Growth and Development

Selection and management of replacement heifers involves many decisions that directly affect the future productivity of the herd. Reproductive performance is the single most important economic trait in a beef herd (Trenkle and Willham, 1977). Heifers should be selected for the ability to reach puberty early, conceive early in the first breeding season, calve unassisted, and to rebreed early for their second calf. Calving heifers at 2 yr of age increases lifetime production, and culling yearling heifers that fail to conceive at an early age allows for selection for improved reproductive performance (Nunez-Dominguez et al., 1991).

A recommended practice is to breed heifers several wk before the older cows in the herd. This allows more time and labor to be available for management of heifers during the breeding and calving seasons. Having heifers conceive earlier in the first breeding season also allows for a longer interval from calving to the beginning of the subsequent breeding season. This increases the likelihood of the first-calf heifer rebreeding early in the breeding season. Heifers that calve earlier in their first breeding season tend to have higher lifetime productivity than their later-breeding counterparts (Lesmesiter et al., 1973). In most production systems calves are weaned at a specific time that is manageable by the producer, rather than on a weight-constant or age-constant basis, which leads to those born later having a lower weaning weight, and thus, decreasing the total lifetime production of its dam (Lesmesiter et al., 1973). Cows that calve late tend to calve later or not at all in the subsequent year (Burris and Priode, 1958).

Breeding heifers early is a beneficial practice, however, this may cause some heifers to be bred on their puberal estrus when fertility is lower than those animals bred on their third estrus (Byerley et al., 1987; Perry et al., 1991). Selecting animals that reach puberty at an earlier age will allow a greater percentage of heifers to be cycling well before their first breeding season and the effects of lowered fertility at the puberal estrus to be minimized (Funston and Deutscher, 2004; Short and Bellows, 1971). Expecting heifers to calve at 24 mo requires that the heifers need to be cycling before 15 mo of age. Hence, the management of replacement beef heifers should focus on hastening the attainment of puberty.

The Onset of Puberty

The reproductive system is the last major organ system to mature in cattle, which begins with ovarian follicular growth from after birth and is followed by the initiation of mature gametogenesis and steroid production prior to puberty. The physiological onset of puberty is the stage of development in which the female expresses estrus and ovulates. While the first estrus and ovulation are a sudden event, ovarian and pituitary tissue and patterns of sexual behavior are fully developed and functional before regular estrous cycles are established.

Puberty can be estimated to occur at a genetically predetermined size in individual animals and recommended guidelines are that heifers should attain 60 to 66% of mature body weight before they are expected to reach puberty (Patterson et al., 1992; Figure 2.1). Therefore, in general, heavier and larger breeds are expected to reach a larger size and weight before puberty is attained. Gregory et al. (1991) reported considerable differences in the age of puberty among a variety of beef breeds (Table 2.1). They documented that

large-framed breeds that were selected for lean growth tended to reach puberty later than small-framed breeds with more moderate growth rates.

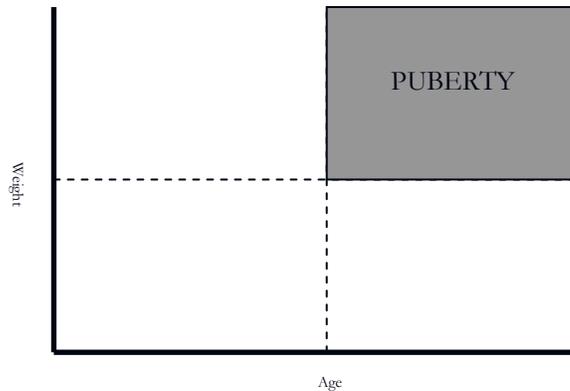


Figure 2.1 Theoretical demonstration of age and weight requirements for puberty. (Beal, 1999)

Table 2.1. Breed comparison of age and weight at puberty in heifers.^a

Breed	Adjusted wt (kg)	Age at Puberty (adjusted for 365-d wt)
Hereford	315	406 d
Angus	316	396 d
Limousin	337	409 d
Gelbvieh	338	353 d
Simmental	344	364 d
Charolais	369	392 d

^aGregory et al., 1991

Pre-weaning Growth and Development

Using pre-weaning growth stimulants and creep feeding during the suckling phase affects future reproductive performance and maternal ability of replacement heifers.

Anabolic agents are compounds containing estrogen, non-steroidal compounds that have estrogenic activity, or potent synthetic androgens. While the use of these implants in sucking heifers have been limited because of possible negative effects on fertility (Zarkawi et al., 1991), interest in implants used to decrease the cost of growing replacement heifers by increasing growth rate and feed efficiency while accelerating physical development remains (Staigmiller et al., 1983).

Creep feeding has been used extensively within the beef industry to produce calves with heavy weaning weights. However, excessive conditioning or fattening of young heifers may be detrimental to the development of desired maternal traits. Creep-fed heifers were reported to be heavier at weaning than controls, but that advantage was gone when the heifers were weighed as yearlings (Martin et al., 1981). Those researchers also found that creep feeding Angus heifers for 90 to 120 d before weaning decreased their lifetime calf production by 89 kg. Suckling heifers that were given access to creep feed experienced reduced productivity with decreased longevity, lower number of calves weaned, and a lower average weaning weight. Angus and Hereford heifers that were creep-fed for 90 d before weaning produced 28% less milk at 120 d of lactation (Hixon et al., 1982). While both growth stimulants and creep feed produce larger heifers that might reach puberty at an earlier age, there are possible long-term effects that must not be overlooked.

Post-weaning Growth and Development

Nutritional management after weaning must be continued to ensure replacement heifers reach an optimal size and weight to enhance the possibility of attaining puberty. Heifers that were given restricted diets post-weaning not only reached puberty at a later time, but fewer were bred and those that conceived did so later, and experienced increased greater pregnancy loss compared to their high-energy fed contemporaries (Short and Bellows, 1971). Heifers that were raised on lower levels of nutrition were smaller at calving and experienced an increase in dystocia.

Milk production during lactation has also been linked to nutritional status prior to breeding (Buskirk et al., 1995). Heifers were fed to two nutritional planes, with ground

corn supplement at 3.68 kg/d (high) or 2.99 kg/d (low) for a post-weaning period of 136 d. While milk solids-not-fat, fat, and protein were not different between treatments, mean milk production was 10% greater for the heifers fed the higher amount of ground corn.

Managing heifers to reach puberty with minimal feed inputs and then taking advantage of compensatory gains when forages are available may have economic advantages (Lalman et al., 1993). Multiple researchers (Clanton et al., 1983; Lalman et al., 1993; Lynch et al., 1997) have reported that no adverse effects to reproductive performance in heifers that gained the majority of their weight during the final 90 d of the developmental period. Lynch et al. (1997) also reported that there were no differences in pre-calving pelvic areas, postpartum intervals, or calf birth and weaning weights of calves from heifers that gained weight continually or those who had a late weight gain. Another strategy reported to increase the efficiency of managing replacement heifers was to sort heifers into groups according to weight and feed each group accordingly. This practice has been reported to both decrease the average age at puberty and to increase pregnancy rates (Varner et al., 1977).

The correct nutritional plane must be met in order to optimize both the attainment of puberty and future productivity, however, care must be taken not to under or overfeed replacement beef heifers. Under-nutrition of both protein and energy can cause a delay in the onset of puberty, subnormal conception rates, and underdeveloped mammary glands. On the other hand, overfeeding can result in weak estrous behavior, reduced conception rates, high embryonic mortality, underdeveloped mammary glands, and decreased milk production (Short and Bellows, 1971).

Reproductive Tract Scoring

Being able to select heifers with the greatest reproductive potential before the breeding season starts has the potential to save time, labor, and money. Reproductive tract scoring, involving rectal palpation of the uterine horns and ovaries is the most common method producers use to determine cycling status of replacement heifers (Andersen et al., 1991). Each heifer is assigned a score ranging from 1 (small, toneless uterine horns and small ovaries with no significant structures) to 5 (good uterine size and tone with a corpus luteum present on the ovary; Table 2.2). Anderson et al. (1991) recommends beginning reproductive tract scoring about one mo before the start of the breeding season when heifers were 11 to 15 mo of age. Heifers scoring a 1 or a 2 had the lowest probability of exhibiting a fertile estrus early in the breeding season. Data from four studies (Andersen, 1987; Andersen et al., 1987; Brown, 1986; Odde et al., 1989) revealed that 28.2% of heifers scoring a 1 became pregnant by the end of a breeding season, compared to 94.1% and 85.0% of heifers that scored a 4 and 5 respectively.

Table 2.2. Reproductive tract scoring for determining cycling status in yearling heifers.^a

Reproductive Tract Score	Uterine Horns	Length (mm)	Height (mm)	Width (mm)	Ovarian Structures
1	Immature < 20 mm diameter, no tone	15	10	8	No palpable structures
2	20-25 mm diameter, no tone	18	12	10	8 mm follicles
3	25-30 mm diameter, slight tone	22	15	10	8-10 mm follicles
4	30 mm diameter, good tone	30	16	12	> 10 mm follicles, Corpus luteum possible
5	> 30 mm diameter, good tone, erect	> 32	20	15	> 10 mm follicles, Corpus luteum present

^a Andersen et al., 1991

Behavior and Handling Practices

Cattle are a prey species and are more likely to move away from a confrontation than to become aggressive. This principle can be used to the advantage of a handler to

easily move cattle between pens and through chutes for tasks such as vaccinations, injury treatment, estrous synchronization, and artificial breeding. The flight zone is an artificial circle around the animal and when the flight zone is penetrated the animal will move away until they feel safe again. Different cattle can have different size flight zones depending on temperament and prior handling experience. Tame cattle may not have a flight zone, while nervous cattle will stay as far away from the handler as possible. To keep cattle calm and moving at a slow speed, the handler should work around the edge of the flight zone.

Cattle Behavior

Ethology is the study of an animal's behavior in response to its environment. The behavior of cattle is important to the producer, veterinarian, and researcher to understand and incorporate in diagnosing, treating, and researching the animal. In intensive animal production units, such as free stall barns for dairy cattle, behavior must be considered in the attempt to make the animal as comfortable as possible (Arave and Albright, 1981). Overcrowding, uncomfortable stalls, and lack of ventilation can all be detrimental to milk production. In extensive environments, as with beef cattle, handling facilities must be designed with the comfort and safety of the animal and the handler, in mind. Despite improvements in facilities and enhanced training of handlers, cattle with excitable temperaments are still a safety concern.

Very few experiments have been performed to identify possible links between temperament and productivity. Cows with calm temperaments had a 25 to 30% increase in milk production (Drugociu et al., 1977). Researchers have also reported that more excitable cattle had lower live weights and weight gains (Fordyce et al., 1988a; Tulloh,

1961). Voisinet et al. (1997) scored the temperament of feedlot cattle using an in-chute behavior test with a scale of 1 (calm) to 4 (excitable). They compared the average daily gains of cattle with different temperament ratings. Both cattle with Brahman breeding and non-Brahman influence were used and results were classified accordingly. They indicated that non-Brahman cattle were less excitable than cattle with Brahman breeding, and that heifers had higher mean temperament scores than steers. Regardless of breeding influence, cattle with higher temperament scores had decreased average daily gains (Voisinet et al., 1997).

It has also been suggested that temperament scores could be used to improve performance in the feedlot. In handled *Bos indicus*-cross steers the most excitable animals received the highest bruising scores while the more docile animals received the lower bruising scores (Fordyce et al., 1985). In a follow-up study, the same authors estimated bruise trim per carcass increased by 0.3 kg per unit increase in temperament score. Meat was also less tender when harvested from animals with the worst temperament scores (Fordyce et al., 1988b). In one study, *Bos indicus* crossbreeds were evaluated for temperament, based on exit time recording, and that time was related to average daily gain, fat thickness, bruising, and dressing percentages. Cattle with the most excitable temperaments (exit times < 0.50 s; n = 14) had an average final liveweight of 297 kg, with a carcass weight of 167 kg. The calmest animals (exit times \geq 1.20 s; n = 4) had an average final liveweight of 346 kg and a carcass weight of 195 kg. Dressing percentages, fat thickness, and bruising were not different between the cattle from the two temperament extremes (Burrow and Dillon, 1997).

In other studies performed on extensively farmed animals, results indicated that behavioral responses to humans had effects on production. Lamb survival was influenced by the reaction of ewes to the presence of humans after parturition, with higher lamb mortality from those ewes which were the most stressed by human interaction (O'Connor et al., 1985). Horses which had little experience being handled were more likely to meet with accidental death than those accustomed to a human presence (Heird et al., 1986). The relationship between the handler and the animals under his care has direct consequences on productivity.

Reproductive function may also be compromised by restraint, isolation and handling by reducing estrus expression, ovulation and conception rates and increasing embryonic death (Moberg, 1987; Stoebel and Moberg, 1982a, 1982b). To decrease the stress of handling during breeding, cattle have been placed in dark stalls to prevent the animal from seeing people in its flight zone and by utilizing the calming effect of the dark. Masks have also been placed over the animal's eyes to calm the animal while in the squeeze chute (Andrade et al., 2001). This practice was beneficial, especially with those animals that were extremely agitated.

Breed of cattle plays a major role in temperament. *Bos indicus* crossbred cattle had higher temperament scores than did *Bos taurus* cattle in an Australian study (Fordyce et al., 1988a). Anecdotal reports from ranchers reveal increasing complaints about temperament problems in cattle breeds such as Charolais, Limousin, and Salers. Producers also report that there are excitable genetic lines within breeds (Grandin, 1993).

Methods for selecting and breeding quiet cattle depend primarily on an understanding of both environmental and genetic factors that regulate temperament.

Temperament has been found to be a moderately heritable trait and in beef cattle the heritability has been estimated at 0.40 (Shrode and Hammack, 1971), and 0.48 to 0.44 (Stricklin et al., 1980). Estimates of temperament heritability in dairy cattle are similar to those reported for beef cattle and have ranged from 0.40 (O'Blesness et al., 1960), 0.45 (Sato, 1981), to 0.53 (Dickson et al., 1970).

Handling experiences, especially those occurring early in life, appear to have a critical role in determining the temperament of cattle. Domestic animals managed in modern extensive range facilities often experience only neutral or negative contacts with people, causing those animals to be less tame (Le Neindre et al., 1996). Short periods of handling can help alleviate the animal's stress towards humans, while decreasing its impact on animal health (Maier et al., 1994), reproduction (Hemsworth et al., 1986), productivity (Apple et al., 1993), and welfare (Dawkins, 1980).

Research on cattle behavior has been limited. Grandin (1993) evaluated Gelbvieh X Simmental X Charolais bulls and steers every 30 d, in order to determine whether behavior, on both ends of the spectrum (calm to extremely agitated), was consistent for each animal over the 5-mo trial. Temperaments were recorded as the animal was locked into a stanchion, with ratings from 1 (calm, no movement) to 5 (rearing, twisting of body, and struggling violently). The same observer also classified balking behavior at the entrance to the squeeze chute as either 1 (not balking) or 2 (balked). Over time there was a group of animals that remained calm and a group that remained agitated over the entire trial. However, the majority of animals had variable ratings throughout the trial.

Temperament Scoring Systems

It is necessary to handle each animal individually to evaluate temperament, because when cattle were handled as a group in feedlot pens there were no observable signs of agitated behavior (Grandin, 1993). In-chute behavior is most often reported as it is the easiest data to collect while the animal is restrained in the chute for blood collection or weighing. Different temperament scoring scales have been used by different researchers. Grandin (1993) used a five point scale while evaluating steers and bulls in a stanchion chute. Fordyce et al. (1985, 1988) developed a seven point scoring system for evaluating temperament of cattle while the scorer moved around the head of an animal caught in a squeeze chute. Isolation pen behaviors were observed and reported in an auction ring by Lanier et al. (2001) and in a farm setting Fordyce et al. (1988). Flight speeds, also called exit times, were electronically recorded by Burrow and Dillon (1997) for each animal as it left a crush chute. Low exit times indicated a rapid exit from the crush for animals with excitable temperaments.

Some researchers have chosen to use a flight test that measures how close a human can come to a stationary animal before it moves away, to assess behavior. This measurement is an important factor and will influence the ease and efficiency of both driving and capturing cattle. Research that related flight distance to milk production in dairy cattle indicated that flight distance was not be related to milk production (Purcell et al., 1988; Uetake et al., 2002), but was related to conception rate at first artificial insemination (Hemsworth et al., 2000).

Blood cortisol levels have been used to determine the level of stress that an animal undergoes. However, cortisol is a time-dependent measured hormone; therefore, the delay before gluco-corticoids are released after stress or fear is at least 2 min, and

corticoid levels can remain elevated for up to 40 min after the stressful event. Therefore, prior handling procedures, such as moving the animal to the pen and into the chute can cause elevated levels and the actual sampling of blood and the stress of being confined in a chute can be confounded (Andrade et al., 2001).

Other possible measurements for determining behavior include recording vocalization, tail-flicking, kicking, and falling down during procedures such as freeze-branding (Lay et al., 1992; Schwartzkopf-Genswein et al., 1998). Image analysis and exertion force on the head gate have been utilized to determine head motion during hot iron and freeze branding (Schwartzkopf-Genswein et al., 1998).

Forehead Hair Whorl Patterns

Cattle that are excitable and unpredictable pose a threat to injure both themselves and handlers. Temperaments have been measured by various methods in older animals (Fordyce et al., 1988a; Grandin et al., 1995; Lanier et al., 2001; Tanner et al., 1994) but there is an interest in being able to predict temperaments in young animals.

Hair, skin and nervous tissue form from the same embryonic germ layer (Smith and Gong, 1974) so it has been hypothesized that differences in the neurological development of the fetus might be reflected in the differences in skin and hair pattern. In humans, hair whorl patterns have been linked to developmental disorders, such as Down's syndrome and Prader-willi syndrome (Pivnick et al., 1997; Smith and Gong, 1974). In addition, absent or abnormally placed scalp whorls have been associated with abnormal brain development in humans (Samlaska et al., 1989).

Grandin et al. (1995) used a four-point temperament scale for rating cattle in a hydraulic squeeze chute and related temperament to the position of the facial hair whorl

on the cattle. The temperament ratings were 1, calm, no movement; 2, restless shifting weight; 3, head throwing, squirming, and occasionally shaking the squeeze chute; and 4, violently and continually shaking the squeeze chute. A second rating was recorded based on behavior of the cattle when exiting the squeeze chute. The ratings upon exiting the chute were: 1, calm, exiting at a walk; 2, exited at a trot or backed up briefly into the rear tailgate before exiting at a trot; or 3, the animal immediately jumped out of the squeeze chute and ran, or it backed up against the rear tailgate and refused to exit until it was tapped on the hindquarters. Cattle which had hair whorls above the eyes were more agitated both in the squeeze chute and while exiting from the squeeze chute. Similar results were reported by Broucek et al. (2004). They indicated that both *Bos indicus* and *Bos taurus* crossbred cattle with a hair whorl located above the eyes became significantly more agitated while they were restrained in a squeeze chute than cattle with a hair whorl located either between the eyes or below the eyes.

Lanier et al. (2001) observed 1636 cattle at six different commercial auctions to determine if the forehead hair whorl position was related to the behavior in the auction ring. The temperament ratings were based upon the activity level and ranged from 1: walks and/or stands still, to 4: hits the ring fence, walls, or people with head. Cattle which had high hair whorls on the forehead had higher temperament scores. Cattle with whorls on the centerline had more variability in temperament than cattle with whorls off the centerline. The presence or absence of a whorl also was related to temperament ratings. Animals that did not have a hair whorl tended to become more agitated than cattle with normal hair whorls, as 52% of the cattle that received a 4 as a temperament score did not have a facial hair whorl.

In a study where beef cattle were individually scored on nineteen measures of personality, fourteen of which related to temperament, Randle (1998) reported that the response to unfamiliar humans was associated with facial hair whorl position. The cattle with low hair whorls were less wary of, and more interested in unfamiliar humans than cattle with mid whorls. Randle (1998) supported the observations of Grandin et al. (1996) by confirming that the relationship between hair whorl position and temperament was more easily assessed in cattle that had received little or no contact with humans, as compared to those animals that had been handled many times. Those handled repeatedly appeared to have become accustomed to humans and handling facilities.

Hair whorl patterns have been related to behavior of dairy cows entering a milking parlor (Tanner et al., 1994). While 53% of the animals showed no side preference, two percent had a very strong side preference and chose the same side of the parlor almost 100% of the time. Twenty-seven percent of the cattle with a single hair whorl in the middle of the forehead had a strong side preference. The 45 cows with two hair whorls were significantly less one-sided than the rest of the population. This finding is similar to observations from horse trainers that horses with two facial hair whorls were less right- or left-handed (Tellington-Jones and Bruns, 1985).

More recent research regarding hair whorl patterns has attempted to associate phenotypic relationships between hair whorl characteristics and spermatozoal attributes in bulls. The theory that the two are related was based on the fact both hair follicles and testicular development occur at approximately the same time during gestation. Testicular development begins at eight weeks and is complete at 16 weeks (Gilbert, 2000), and the patterning of hair follicles occurs between 10 to 18 weeks of gestation (Smith and Gong,

1974; Wunderlich and Heerema, 1975). Meola et al. (2004) compared breeding soundness exams conducted on 219 yearling bulls with forehead hair whorl position which was classified as either having a round or non-round epicenter. Bulls classified as having a round epicenter hair whorl had a higher percentage of morphologically normal spermatozoa when compared to those animals with non-round centers. Eighty-two percent of bulls with facial hair whorls with round epicenters had satisfactory sperm morphology scores, while only 57% of bulls with non-round epicenters had satisfactory sperm morphology scores (Meola et al., 2002; Meola et al., 2004). In contrast to Meola's work with Angus cattle, work done with Holstein stud bulls indicated that facial hair whorls were not related to sperm morphology (Evans et al., 2005). While it is a possibility that the facial hair whorl could be used as a visual aid in determining the quality of sperm morphology, much more research must be conducted in this area.

Social Dominance

Traditionally, dominance relationships among animals have been determined by observations of aggressive and submissive behavior. When three or more animals were involved, dominance rankings were reported to be complex because of pecking triangles and social alliances. Younger animals typically worked out their dominance relationships with each other at a much slower rate if kept in intact rearing groups than if mixed with strangers (Guhl, 1958). Young animals that did not need to compete for necessities learned their dominance relationships in mock fighting and playful trials of strength. Relationships between mature animals, when brought together as strangers, are frequently determined during aggressive interactions involving physical contact (Arave and Albright, 1981).

There are many methods for characterizing social dominance within a herd of animals; however most represent a tremendous undertaking. The most accurate method would be to observe animals within their natural environment for long periods of time and observe the behavior of all animals interacting with each other. Under research conditions pair contests are often used with animals of the same sex, age, and weight. This method speeds up the process of evaluating social dominance. However, staged pair-wise contests represent highly artificial conditions and outcomes may be influenced by other variables, including the animals' fearfulness of being handled (Craig, 1986).

Galindo and Broom (2000) directly observed dairy cattle in a free-stall facility to determine social rank. They used a displacement index to reflect the social status of each animal, where the index of each cow could range from 0 to 1:

$$\text{Index of displacements} = \frac{\text{\# of times she displaces other individuals}}{\text{\# of times she displaces another cow} + \text{\# of times she is displaced}}$$

Cows with an index of displacements between 0.4 and 0.6 were considered middle-ranking cows, while those with an index above 0.6 were the high-ranking animals and those under 0.4 were the low-ranking cows. These researchers noted that the low-ranking animals spent the more time laying in the stalls and standing in alleys as compared to the middle- and high-ranking animals (Galindo and Broom, 2000). Elkins and Rorie (2005) also used the index of displacements to compare social ranking with the expression of estrus and fertility. While the number of mounts declined with decreasing social status ($P < 0.01$), pregnancy rates were not affected by social status.

In summary, the management of replacement heifers is critical to the future productivity of the herd. Heifers need to reach an age and weight threshold in order to reach puberty before the breeding season begins. Cattle behavior has been primarily compared to production measures, such as carcass characteristics in beef steers and milk production in dairy cattle. The location of

the facial hair whorl has been associated with cattle temperament in a variety of testing situations. Finally, the relationship between social dominance ranking and temperament of cattle has not been examined closely.

Chapter 3 Rationale and Experimental Objectives

There are many factors that can affect a heifer's temperament including genetics as well as the animal's prior experience with humans and handling facilities. Cattle that have had positive handling experiences are easier to work through chutes, scales, and pens. Facial hair whorls in cattle have been compared in a variety of testing scenarios including the auction ring and the milking parlor to suggest that temperament can be "estimated" by examining the hair whorl. Social dominance research in cattle has been limited to grazing behavior and production measures in both dairy and beef heifers and mature cows. However, there has been little research regarding handling procedures, facial hair whorl locations, and social dominance for heifers that have had little or no human exposure.

The objectives of this experiment were threefold. First, to determine the effects of handling peri-puberal heifers weekly for 20 wk on behavior in three testing scenarios; restrained in a chute, isolated from other herdmates, and in returning to the home pasture after testing. Second, to determine if the location of the facial hair whorl affected behavior scores. Finally, we set out to determine if there was a relationship between social dominance ranking and behavior scores or weight in heifers in the HANDLED treatment.

Chapter 4 Materials and Methods

One hundred and fifty $\frac{3}{4}$ Angus x $\frac{1}{2}$ Hereford (n = 48) or $\frac{1}{2}$ Angus x $\frac{1}{2}$ Hereford heifers (n = 102) were purchased from a single ranch in Waurika, OK. Heifers were transported from Oklahoma to Virginia and arrived June 2, 2005. Upon arrival heifers were maintained in a single group for 4 d prior to initial processing and housed in a 30-acre pasture (fescue/red clover) with ad libitum access to water and trace mineral salt.

During the first wk after arrival, heifers began receiving increasing amounts of a 14% CP supplement containing 57 g/t of lasalocid. Throughout the experiment the supplementation was expected to achieve a target average daily gain of 0.78 kg/d. Supplement was initially provided at the rate of 0.93 kg/head/d and increased 0.7 kg/head/wk, until average daily feed intake equaled 1.3% of the average estimated body wt/d. Heifers remained on pasture and received this level of supplementation until the 19th wk after arrival. At that time, they remained on fescue/clover pasture and began receiving a silage-based ration containing 9% CP. Coincident with the initiation of silage feeding, trace mineral salt containing 1440 g/t lasalocid was offered free choice.

Four d after arrival (June 6) heifers were processed, tagged for individual identification and weighed. At the time of processing each heifer received an intranasal vaccine for IBR/PI₃ (Nasalgen IP, Schering-Plough, Kenilworth, NJ). To facilitate processing each heifer was restrained in a chute (non-squeeze) with a self-catching head catch. Before ear tagging, a preliminary in-chute behavior test was conducted. The temperament of each heifer as it was caught, during the first 20 s of restraint, before any processing or handling occurred, and during handling to remove and replace an ear tag for identification, was rated using the temperament ratings described by Grandin et al.

(1995). After the heifers were individually identified with plastic ear tags, each heifer was examined to determine the facial hair whorl position (as described below).

The preliminary in-chute behavior score was used to assign each heifer to an experimental group. The groups of $\frac{3}{4}$ Angus x $\frac{1}{4}$ Hereford and $\frac{1}{2}$ Angus x $\frac{1}{2}$ Hereford heifers were each blocked by the preliminary temperament score and were randomly assigned to one of two treatment groups for the remainder of the experiment. One half of the heifers were assigned to be housed together and moved from the pasture to the working facility to be handled for 2 h once-a-wk for 20 wk (HANDLED; n = 75). The remaining heifers were housed together and were only moved to the working facility and handled if treatment of symptoms of disease or injury was necessary (CONTROL; n = 75).

Weekly handling sessions for the HANDLED group consisted of a 2-h period during which one or two handlers worked the animals. The heifers were collected from the pastures and brought to the working facilities before each handling period. These sessions included the handler(s) walking through the pen of heifers, moving heifers in single file, sorting heifers into groups, moving heifers through chutes, over scales, and through a breeding box. During the handling sessions efforts were made not to duplicate the conditions used during the in-chute or isolation behavior testing. After the handling session the heifers were returned to the pasture.

At 0, 10, and 20 wk after assignment to a treatment group each heifer was evaluated for in-chute behavior, isolation behavior, and the elapsed time required to exit

the testing area using standardized procedures (described below; Figure 4.1).



Figure 4.1. Timeline of behavior evaluations and handling sessions for the duration of the experiment.

Four animals were removed from the experiment (HANDLED, n = 1; CONTROL, n = 3); following diagnosis of persistent BVD or severe lameness.

At the end of the experimental period two blood samples were collected via venipuncture at a 10 d interval for progesterone analysis and a final weight was recorded. After the final weight was recorded, a CIDR was placed into each heifer to prevent estrus behavior during social dominance testing (see below).

Forehead Hair Whorl Identification

After the heifers were individually identified with plastic ear tags, each heifer was examined to determine the facial hair whorl position (Grandin et al., 1995). The hair whorl position was categorized as: “high” if the center of the whorl was above a line extending from the top of the left to the top of the right eye; “middle” if the center of the whorl was located between the top and the bottom of the eyes; “low” if the center of the

whorl was located below a line extending from the bottom of the left to the bottom of the right eye (Figures 4.2).

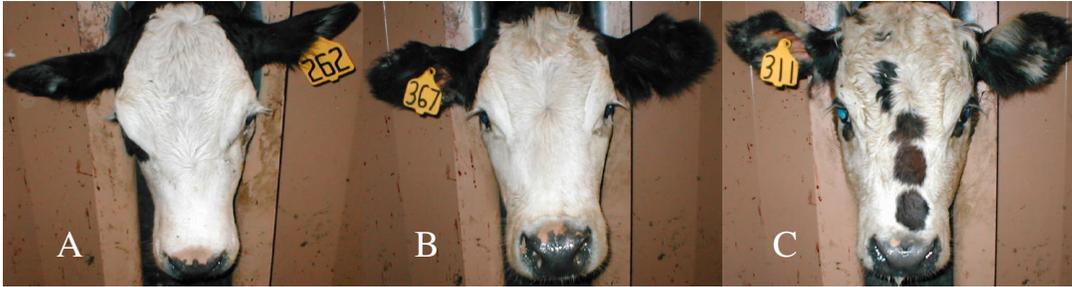


Figure 4.2. Cattle with hair whorls classified as low (A), medium (B), and high (C).

In-Chute Behavior Test

Temperament scores were recorded by two independent observers. The temperament of each heifer as it was caught in a self-catching head catch, during the first 20 s of restraint was recorded. Temperament ratings for the in-chute behavior test ranged from 1 to 4: 1, calm, no movement; 2, restless, shifting weight; 3, head throwing, squirming and occasional movement in the chute; 4, violently and continually moving in the chute. Animals attempting to rear and escape from the chute were also assigned a temperament rating of a 4 (Grandin et al. 1995; Table 4.1).

Table 4.1. In-chute behavior scoring from Grandin et al. (1995)

In-Chute Behavior Scoring	
Score	Action
1	Calm, no movement
2	restless, shifting weight
3	Head throwing, squirming and occasional movement in chute
4	violently and continually moving in the chute, rearing and trying to escape

Isolation Behavior Test

Immediately following completion of the in-chute behavior test each heifer was moved to a 2.4 m x 10.9 m pen for observation of isolation behavior. Each heifer was held in the pen for 20 seconds before being released and returned to their respective

pasture. During isolation, no other cattle within 457 m were visible. Two independent observers assigned a behavior rating and a temperament rating to each heifer based on the behavior exhibited during 20 s of isolation and movement to and from the pen. Behavior and temperament scores (Tables 4.2 and 4.3) were assigned using a system modified from that reported by Lanier et al. (2000). Behavior ratings were based on the activity level of the heifer in the isolation pen: 1, walked and/or stood, slow smooth movement, head and neck in a lowered, relaxed position; 2, continuously walked or trotted, vigilant, head and neck slightly raised; 3, gait faster than trot, fast, abrupt, jerky movement, very vigilant; 4, struck pen partitions or handler with head, attempted to jump, climb, or go through partitions. Animals receiving a behavior score of 3 or 4 were further rated as exhibiting aggressive (A) and/or escape (E) behavior when moving past the handler to exit the pen.

Table 4.2. Isolation pen behavior scoring system from Lanier et al. (2000).

Isolation Pen Behavior Scoring	
Score	Action
1	<ul style="list-style-type: none"> • Walks and/or stands • Slow smooth movement • Head and neck in a lowered, relaxed position
2	<ul style="list-style-type: none"> • Continuously walks or trots • Vigilant • Head and neck slightly raised
3	<ul style="list-style-type: none"> • Gait faster than a trot • Fast, abrupt, jerky movement • Very vigilant
4	<ul style="list-style-type: none"> • Strikes pen partitions or handler with head • Attempts to jump, climb, or go through partitions

Table 4.3. Isolation pen behavior scoring from Laniar et al. (2000). Animals that scored 3 or 4 in the isolation pen temperament scoring received an additional behavior score.

Isolation Pen Behavior Scoring	
Score	Action
A	Aggressive behavior displayed
E	Escape behavior displayed

Exit Time Recording

Following each isolation behavior scoring, each heifer was released from the isolation pen by a single handler and allowed to return to the 30-acre pasture. During this time all personnel remained motionless and each heifer was allowed to return at will. The time required for each heifer to progress the first 22 m from the isolation pen toward the pasture was recorded (adapted from Fell et al., 1999).

Progesterone Analysis

Immediately upon collection of the blood samples, tubes were stored at room temperature. The blood was allowed to clot for 5 h before centrifugation at 1678 g for 20 min. Serum was collected, frozen and stored -20°C until a solid-phase RIA procedure (Coat-A-Count, Diagnostic Products) was used to quantify serum progesterone concentrations. Each heifer with a serum progesterone concentration ≥ 1 ng/ml at either of the two sampling periods was considered to be exhibiting estrous cycles. The intra-assay coefficient of variation was 9.91%, and the inter-assay coefficient of variation was 13.55%. After the second blood sample was taken, a CIDR was inserted in each heifer for the social dominance testing.

Social Dominance

The heifers in the HANDLED treatment group were tested to determine a social dominance ranking within their treatment group. Each heifer was randomly assigned a number from 1 to 70 in order to randomly pair each animal to six other animals, for a

total of 210 pairings. The pairings were made using a circular system (Figure 4.3). Each heifer number was paired to the 2 numbers adjacent to it and to the number of animals 7 and 10 numbers away from it. For example, the heifer that was assigned number 1 was paired to the animals numbered 2, 8, 11, 61, 64 and 70. This was done due to the inability to test all possible pairs of animals but to still allow for the ability to prepare a social dominance ranking for each heifer.

All of the handled heifers were held off feed for 24 hr prior to the social dominance testing. The paired heifers were released from the chute and placed into an 8' x 36' pen. In the pen there was a small bucket containing feed. The size of the bucket allowed only one heifer to reach the feed. The pair was observed for 2 min and the time that each heifer held control over the feed source was recorded.

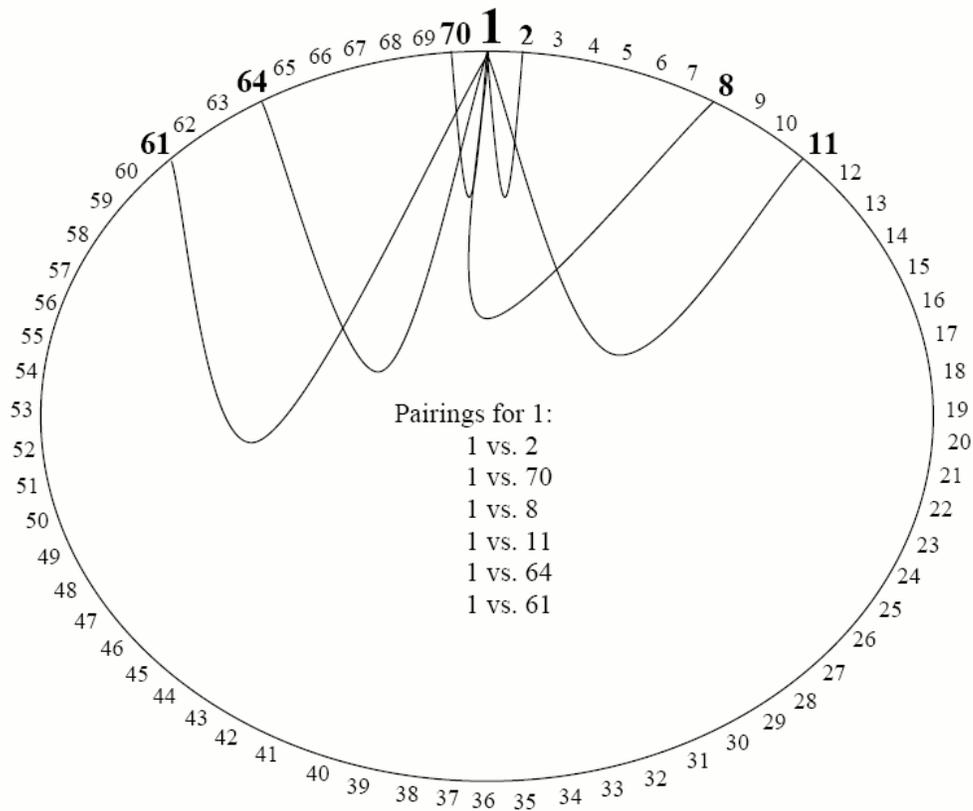


Figure 4.4. Social Dominance Pairing Scheme

Statistical Analysis

Dependent variables in this experiment were in-chute behavior score, isolation score, and exit time recorded at 0, 10, and 20 wk. The difference in scores or times recorded at 0 and 10 wk (1st half), 10 and 20 wk (2nd half), and 0 and 20 wk (Overall) were also calculated. Body weight was recorded at the beginning and end of the experimental period. A social dominance score was calculated based on the pair wise competitions amongst heifers for control of a feed source.

The mean in-chute behavior scores, isolation behavior scores, and exit times measured at 0, 10, and 20 wk, and the changes in behavior scores or exit times during the 1st half, 2nd half, or entire experiment were analyzed by ANOVA using the GLM procedure of SAS (SAS Institute Inc., Cary, NC) with animals in the HANDLED and

CONTROL groups and hair whorl position as main effects (Statistical Analysis System v. 8.02, Cary, NC).

To further characterize differences among animals in the HANDLED and CONTROL groups that exhibited average initial (0 wk) isolation scores (two observers) of 1-1.5 (walked or stood; classified as 1), 2-2.5 (continuously walked or trotted; classified as 2), 3-3.5 (gait faster than a walk or trot with jerky movements; classified as 3), or 4 (attempted to climb, jump, or go through partitions; classified as 4), the mean changes in behavior scores or exit times during the 1st half, 2nd half, or entire experiment were calculated and analyzed by ANOVA using the GLM procedure of SAS with animals in the HANDLED and CONTROL groups and initial isolation score as main effects. The analysis revealed that the variances for changes in isolation behavior scores and exit times among animals with different initial isolation scores were heterogeneous. Therefore, changes in isolation behavior scores and exit times among animals with different initial isolation scores were analyzed by one-way ANOVA for animals in HANDLED and CONTROL groups within the groups of animals with same initial isolation score.

To determine social dominance rankings the solutions from the mixed procedure of SAS was the predicted time advantage/disadvantage of each animal relative to the mean, controlling for the proportion of the variance which was repeatable between trails. The solutions were then correlated using the regression procedure of SAS with the in-chute behavior and isolation scores, exit times, and final weight. Facial hair whorl and social dominance ranking was compared using Proc GLM using the mean social ranking for each hair whorl group; high, medium, and low.

Means and least-square means are depicted \pm SE unless otherwise stated.

Chapter 5 Results

In-Chute Behavior Scores

Weekly handling did not significantly influence the behavior of heifers caught in a self-catching head catch (Table 5.1). At the first scoring session (0 wk), before any handling, both the HANDLED and CONTROL heifers had an average chute score of 2.8 ± 0.1 . After 10 wk of being handled for 2 hr/wk, the average chute score reported for HANDLED heifers was slightly lower at 2.6 ± 0.1 , while the average scores of the CONTROL heifers remained 2.8 ± 0.1 ($P < 0.30$). At the third, and final, scoring session, both the HANDLED and CONTROL heifers recorded the same mean in-chute behavior scores of 2.6 ± 0.1 . Like the effects of handling, position of the facial hair whorl did not affect in-chute behavior score nor was there an interaction between the effects of hair whorl position and treatment.

To characterize the effect of handling or hair whorl position, changes in behavior over time were calculated as the differences in behavior scores for each heifer that were recoded at 0 and 10 wk (1st half), 10 and 20 wk (2nd half), or 0 and 20 wk (overall). During the first half of the 20-wk experimental period there was a significant difference in the change in in-chute behavior scores between the HANDLED and CONTROL groups ($P < 0.10$). The heifers that were handled weekly exhibited an average decrease in chute scores from the first to second scoring session of -0.23 ± 0.1 . Whereas the CONTROL heifers exhibited an increase of 0.04 ± 0.1 . This trend was reversed during the second half when heifers in the CONTROL group exhibited a greater decrease in average in-chute behavior score (-0.20 ± 0.1) and the average in-chute behavior scores of heifers in the HANDLED group changed very little (0.04 ± 0.1).

Table 5.1. Average in-chute and isolation behavior scores and exit times at 0, 10, and 20 wk and the change in scores from the first half, second half, and overall for heifers with high, middle, and low hair whorls in the two treatment groups of control and handled.

Facial Hair Whorl Location N	CONTROL			HANDLED		
	High	Middle	Low	High	Middle	Low
	5	30	35	7	28	33
In-chute Behavior¹						
Behavior Scores²						
0 wk	3.0 ± 0.4	2.6 ± 0.2	2.7 ± 0.1	2.6 ± 0.3	2.8 ± 0.2	3.0 ± 0.1
10 wk	2.9 ± 0.4	2.8 ± 0.2	2.8 ± 0.1	2.6 ± 0.3	2.6 ± 0.2	2.6 ± 0.2
20 wk	2.4 ± 0.4	2.7 ± 0.2	2.8 ± 0.2	2.6 ± 0.3	2.6 ± 0.2	2.6 ± 0.2
Change in Score³						
1 st half	-0.1 ± 0.3	0.1 ± 0.1	0.1 ± 0.1	0.0 ± 0.2	-0.3 ± 0.1	-0.4 ± 0.1
2nd half	-0.5 ± 0.3	-0.1 ± 0.1	0.0 ± 0.1	0.1 ± 0.2	0.0 ± 0.1	0.0 ± 0.1
Overall	-0.6 ± 0.3	0.0 ± 0.1	0.1 ± 0.1	0.1 ± 0.3	-0.2 ± 0.1	-0.4 ± 0.1
Isolation Behavior⁴						
Behavior Scores²						
0 wk	1.8 ± 0.5	2.3 ± 0.2	2.5 ± 0.2	2.2 ± 0.4	2.5 ± 0.2	2.9 ± 0.2
10 wk	1.9 ± 0.5	1.9 ± 0.2	2.3 ± 0.2	2.0 ± 0.4	1.7 ± 0.2	2.1 ± 0.2
20 wk	1.7 ± 0.5	2.0 ± 0.2	2.3 ± 0.2	1.9 ± 0.4	1.7 ± 0.2	2.1 ± 0.2
Change in Score³						
1st half	0.1 ± 0.3	-0.4 ± 0.1	-0.2 ± 0.1	-0.2 ± 0.2	-0.8 ± 0.1	-0.8 ± 0.1
2nd half	-0.2 ± 0.3	0.1 ± 0.1	0.0 ± 0.1	-0.1 ± 0.2	-0.1 ± 0.1	0.0 ± 0.1
Overall	-0.1 ± 0.3	-0.3 ± 0.1	-0.2 ± 0.1	-0.4 ± 0.3	-0.9 ± 0.1	-0.8 ± 0.1
Exit Times⁵						
Behavior Scores²						
0 wk	16.0 ± 2.8	11.3 ± 1.1	10.5 ± 1.1	15.2 ± 2.3	10.9 ± 1.2	9.9 ± 1.1
10 wk	18.5 ± 4.0	17.2 ± 1.6	12.2 ± 1.5	14.6 ± 3.3	13.8 ± 1.7	14.5 ± 1.5
20 wk	16.6 ± 6.4	13.2 ± 2.6	12.4 ± 2.4	18.9 ± 5.4	16.3 ± 2.7	18.6 ± 2.5
Change in Score³						
1st half	2.5 ± 2.7	5.6 ± 1.1	1.9 ± 1.0	-0.5 ± 2.3	3.0 ± 1.2	4.5 ± 1.0
2nd half	-1.9 ± 4.4	-4.0 ± 1.8	-0.0 ± 1.7	4.3 ± 3.7	2.5 ± 1.9	4.0 ± 1.7
Overall	0.6 ± 4.9	1.7 ± 2.0	1.9 ± 1.8	3.8 ± 4.1	5.4 ± 2.1	8.5 ± 1.9

¹ In-chute Behavior Scores: 1 = still, 2 = restless, 3 = head throwing and squirming, 4 = violently struggling

² Behavior Scores is the average score within each treatment and facial hair whorl position at the three scoring sessions at 0, 10, and 20 wk

³ Change in score is the average difference in score for 0 to 10 wk (first half), 10 and 20 wk (second half), and 0 and 20 wk (overall)

⁴ Isolation Behavior Scores: 1 = walks or stands, 2 = continuously walks or trots, 3 = gait faster than a trot with jerky movements, 4 = attempts to climb, jump, or go through partitions

⁵ Exit Time, in s, it takes heifer to travel 22 m from the isolation pen to pasture

There was a significant interaction between the effects of facial hair whorl position and handling treatment on the overall change in in-chute behavior score ($P < 0.03$; Table 5.1). Handling treatment decreased in-chute behavior scores of heifers with facial hair whorl positions classified as medium or low, but not in heifers that exhibited a hair whorl high on their face.

Isolation Behavior Scores

The behavior of the heifers within the isolation pen was significantly influenced by weekly handling sessions and facial hair whorl position (Table 5.1). In the first scoring session, the HANDLED and CONTROL heifers had similar average isolation scores of 2.5 ± 0.1 and 2.2 ± 0.2 , respectively. However, isolation scores were greater for heifers with the lowest hair whorl position (2.7 ± 0.1) than for heifers with the highest hair whorl position (2.0 ± 0.3). Heifers with the hair whorl position that was in the middle of the face recorded an intermediate average isolation behavior score (2.4 ± 0.1).

After the first 10 wk of handling the observers recorded an average isolation score for the HANDLED heifers of 1.9 ± 0.2 . The CONTROL heifers recorded an average isolation behavior score of 2.0 ± 0.2 . Likewise, at the final scoring session the HANDLED and CONTROL heifers were scored similarly at 1.9 ± 0.1 and 2.0 ± 0.2 , respectively. Hair whorl position did not affect the average isolation behavior score measured at 10 or 20 wk into the experiment. Despite the fact there was no significant difference in the average isolation score in the handled and control groups at any of the three scoring sessions, there was a small but significant difference in the change in behavior score for heifers in the handled group.

The HANDLED heifers had an average decrease in isolation behavior score of -0.62 ± 0.1 during the first half of the experiment and that was greater ($P < 0.001$) than the change in the mean scores of the CONTROL heifers during the same period (-0.16 ± 0.1). There was also a greater decrease in isolation behavior score of heifers with facial hair whorls in a medium (-0.59 ± 0.1) or low (-0.52 ± 0.1) position than in heifers in which the hair whorl was positioned high on the face (-0.06 ± 0.2)

During the second half of the experiment there was no significant difference in the change in isolation scores between heifers in the HANDLED or CONTROL groups. However, when calculated over the entire handling period, the HANDLED heifers exhibited a greater ($P < 0.01$) reduction in isolation score (-0.69 ± 0.1) than the CONTROL heifers (-0.18 ± 0.1). Significant differences in changes in isolation behavior score occurred despite the failure to detect significant differences in the average scores recorded by heifers in the handled and control group at any of the three scoring sessions. The significant change was due in part to the small but non-significant difference in isolation scores of the two groups (2.5 vs. 2.2) at the outset of the experiment.

Aggressive/Escape Behaviors Displayed During the Isolation Behavior Test

At each testing session (0, 10, and 20 wk) any animal that received an isolation behavior score of either a 3 (gait faster than a trot with jerky movement), or 4 (attempted to climb, jump, or go through partitions) also received a temperament rating for the actions displayed as either escape or aggression (Table 5.2). During the first testing session (0 wk) sixty heifers (HANDLED, $n = 36$; CONTROL, $n = 24$) received an isolation behavior score of 3 or 4 from both observers. Fourteen of the sixty heifers scoring either a 3 or 4 (23.3%) behaved aggressively at the first scoring session

(HANDLED, n = 6; CONTROL, n = 8). Sixteen of the heifers displaying the escape behavior were in the control group and thirty were from the handled group. After the first half of the handling sessions, at 10 wk, forty heifers were scored as a 3 or 4 by both observers (HANDLED, n = 23; CONTROL, n = 17). Aggressiveness towards the handlers was seen in 11 heifers (HANDLED, n = 3; CONTROL, n = 8), and escape behavior was seen in 15 heifers in the CONTROL group and 14 heifers that had been HANDLED. At 20 wk, the final scoring session, 42 heifers received either an isolation score of 3 or 4 from both observers. Twenty-three heifers were from the CONTROL group (escape, n = 14; aggressive, n = 9), while 19 heifers were from the HANDLED group (escape, n = 17; aggressive, n = 2).

The Chi-Square test was used to determine if there was a difference in the number of aggressive animals between treatments at each of the three testing sessions. At both 0 wk and 20 wk there was no difference in the number of animals that displayed aggressive behavior during the isolation behavior test (0 wk: $P < 0.2$; 10 wk: $P < 0.3$). There was a significant difference ($P < 0.02$) in the number of animals that displayed aggression between the treatment groups at the final scoring session. There were more aggressive heifers in the CONTROL group compared to the HANDLED group.

Table 5.2. Number of heifers that displayed aggressive or escape behavior with an isolation behavior score of 3 (gait faster than a walk with jerky movements) or 4 (attempted to climb, jump, or go through partitions) from both independent observers.

		Aggressive	Escape
Scoring Session			
0 wk	Control	8	16
	Handled	6	30
10 wk	Control	8	15
	Handled	3	14
20 wk	Control	9	14
	Handled	2	17

Exit Time Recordings

Following isolation behavior scoring, each heifer was released from the isolation pen and allowed to return to pasture. The time required for each heifer to progress the first 22 m from the isolation pen was recorded. Least-squares mean exit times for all heifers were 11.1, 14.6, and 15.3 s at weeks 0, 10, and 20, respectively. At the beginning of the experiment (0 wk) the HANDLED and CONTROL heifers had similar average exit times of 12.0 ± 0.1 and 12.7 ± 1.1 s, respectively. Heifers with the high facial hair whorl position took more time to exit the isolation pen (15.6 ± 1.8 s) than heifers with the hair whorl in a middle (11.2 ± 0.8) or low (10.2 ± 0.8) position on the face (Table 5.1).

After the first 10 wks of handling, there was no difference in the mean exit times of the heifers in the two treatment groups. At the second scoring session the HANDLED heifers had an average exit time of 14.3 ± 1.3 s and the CONTROL heifers had an average exit time of 16.0 ± 1.5 s. At the end of the third scoring sessions the difference of the average exit times was 3.8 s between the two groups; however this difference was not significant ($P < 0.24$). The HANDLED heifers took an average of 17.9 ± 2.2 s to leave the handling area, while the CONTROL heifers took an average of 14.1 ± 2.4 s to

leave the area at the end of the experiment. Hair whorl position did not significantly influence exit times when measured at 10 or 20 wk into the experiment.

The overall change in exit times for the experiment was greater for heifers in the HANDLED group. Exit time at the end of the experiment was 5.9 s longer for heifers in the HANDLED group and only 1.4 s longer for heifers in the CONTROL group. Most of the change in time it took to exit the isolation pen occurred during the second half of the experiment. Exit times for heifers in the handled group increased 3.6 s during the second half while exit times for heifers in the CONTROL group decreased 2.0 s. The main effect of facial hair whorl position did not significantly influence the change in exit times recorded throughout the experiment.

Treatment Effects by Initial Isolation Score

To further characterize differences among animals in the HANDLED and CONTROL groups, data were sorted based on the initial isolation score recorded for each heifer. The mean changes in behavior scores or changes in exit times during the 1st half, 2nd half, or overall during the entire experiment were analyzed with initial isolation behavior score and treatment (HANDLED vs. CONTROL) as main effects. The effects of facial hair whorl position and initial isolation behavior score were confounded, therefore, both variables could not be included in the model.

The analysis of changes in behavior scores and exit times for heifers in the four initial isolation behavior groups revealed heterogeneity in variances for change in isolation score and change in exit time. Therefore, changes in isolation behavior score and changes in exit times for animals in each of the four initial isolation behavior score

groups were analyzed with treatment (HANDLED vs. CONTROL) as the only main effect.

Overall changes in in-chute behavior scores of heifer in the HANDLED or CONTROL groups were not different among heifers in three of the four initial scoring groups (Treatment x Initial isolation score, $P < 0.75$). Heifers that were in the HANDLED group with an initial isolation score of 3 had an average decrease in in-chute behavior score of -0.39 ± 0.14 . The CONTROL heifers, with an initial isolation score of 3, had a slight increase (0.03 ± 0.17) in average in-chute scores over the 20 wks. The change in in-chute behavior due to handling was significant during the first half of the experiment ($P < 0.001$) but not during the second half ($P < 0.48$) (Figures 5.1, 5.2, 5.3).

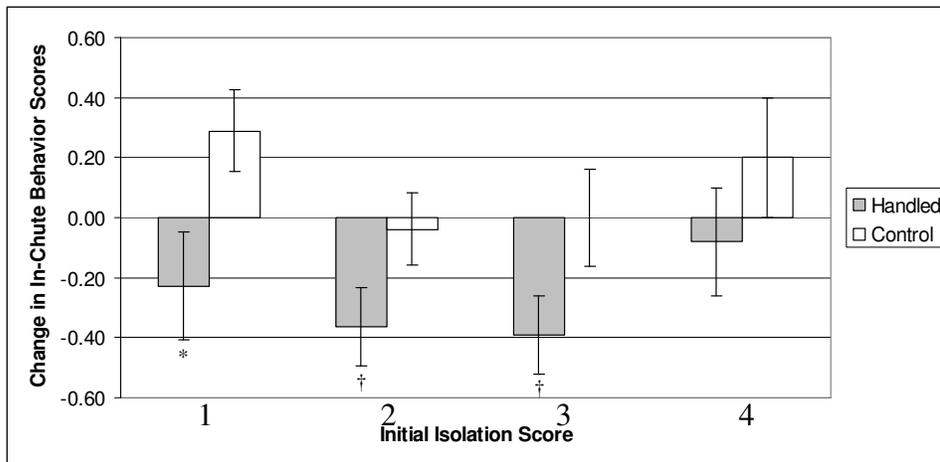


Figure 5.1. 1st Half Changes in In-Chute Behavior Scores by Initial Isolation Score Group.

* $P < 0.05$ means within isolation score differ

† $P < 0.10$ means within isolation score differ

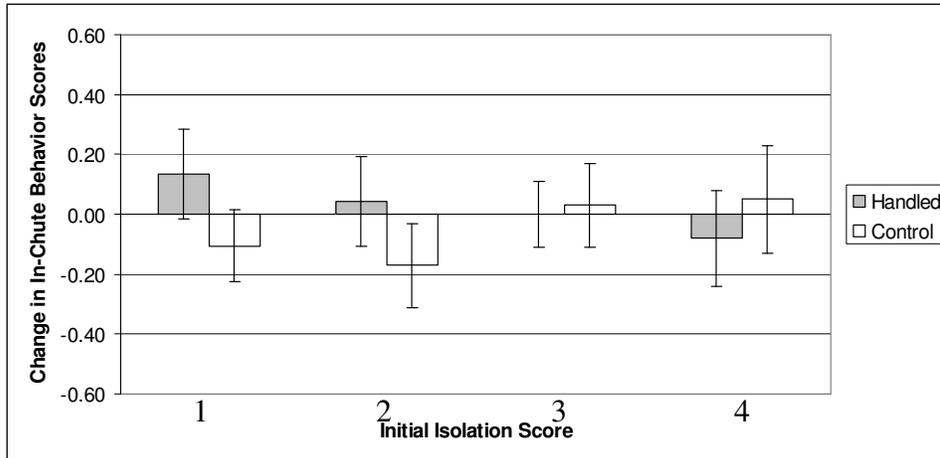


Figure 5.2. 2nd Half Changes in In-Chute Behavior Scores by Initial Isolation Score Group.

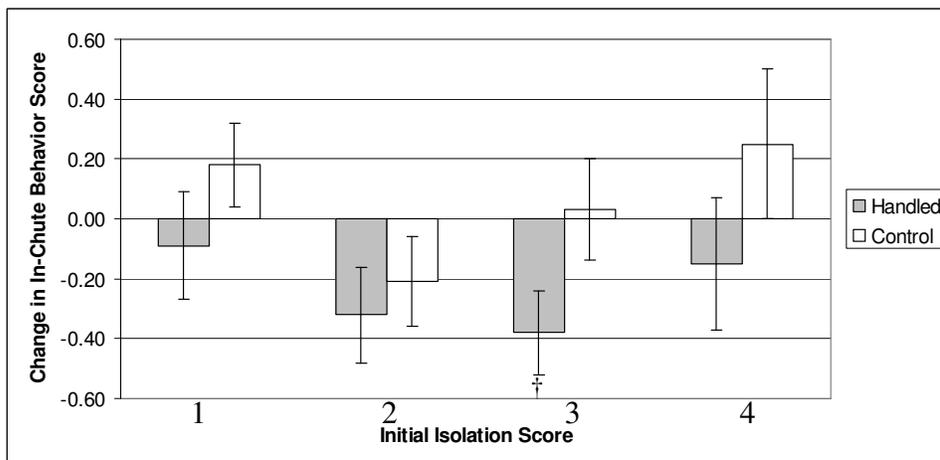


Figure 5.3. Overall Changes in In-Chute Behavior Scores by Initial Isolation Score Group.
 † $P < 0.10$ means within isolation score differ

If heifers had an initial isolation score of 2 or 3, weekly handling decreased ($P < 0.01$) the overall mean isolation behavior scores over those of heifers in the control group. There was no difference in the overall change in isolation behavior score of the heifers that were regarded as calmest (classified as 1), or most nervous (classified as 4) at the beginning of the experiment. For heifers classified as 3, the change in isolation behavior score was greater in the handled group during both the first ($P < 0.01$) and the second halves ($P < 0.07$) of the experiment. The difference in the change in isolation score

between HANDLED and CONTROL heifers classified as 2, was only significant during the first half of the experiment ($P < 0.03$) (Figures 5.4, 5.5, 5.6).

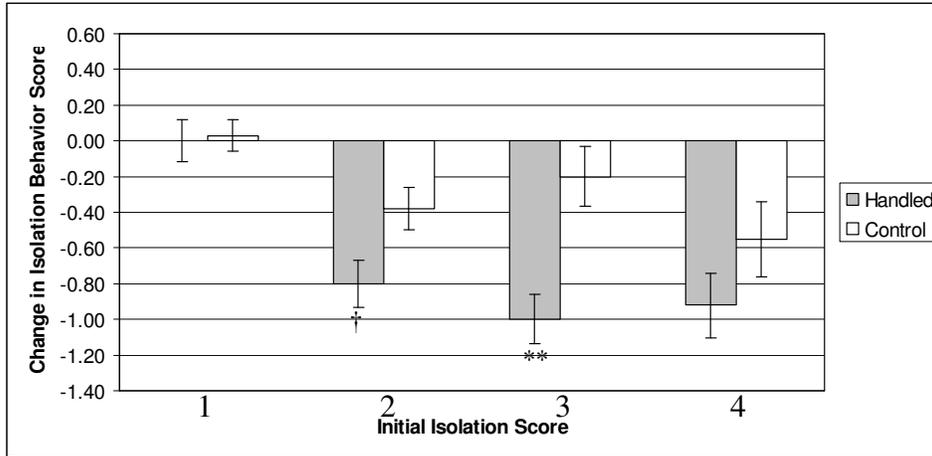


Figure 5.4. 1st Half Changes in Isolation Behavior Scores by Initial Isolation Score Group.

** $P < 0.01$ means within isolation score differ

† $P < 0.10$ means within isolation score differ

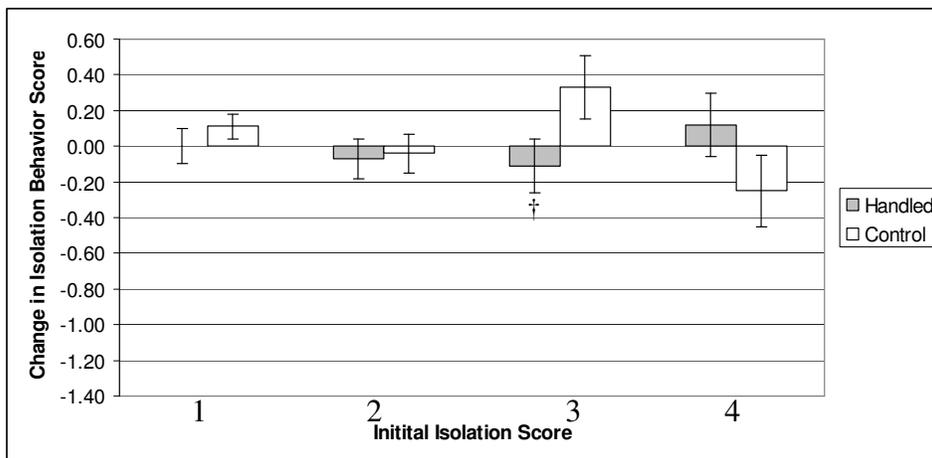


Figure 5.5. 2nd Half Changes in Isolation Behavior Scores by Initial Isolation Score Group.

† $P < 0.10$ means within isolation score differ

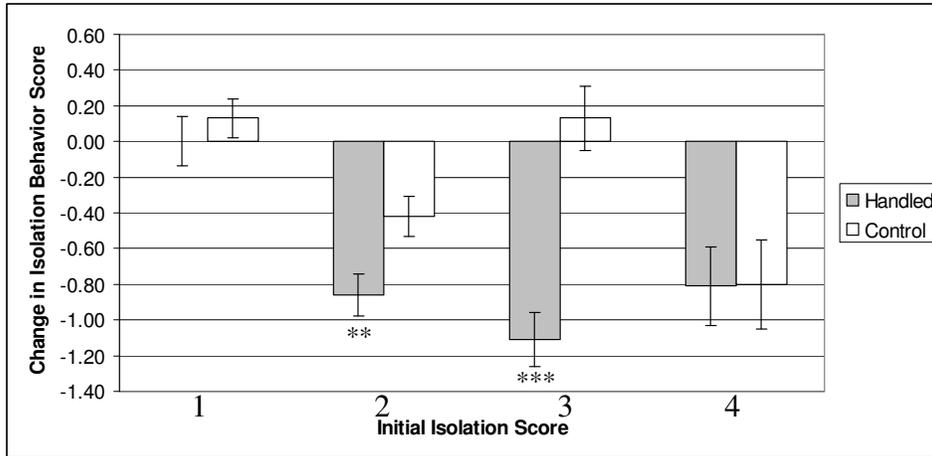


Figure 5.6. Overall Changes in Isolation Behavior Scores by Initial Isolation Score Group.
 *** $P < 0.0001$ means within isolation score differ
 ** $P < 0.01$ means within isolation score differ

The overall changes in exit time for heifers in the HANDLED group were greater ($P < 0.07$) than those for heifers in the CONTROL group in all cases, except when heifers received an initial isolation score of 4 (most nervous). Handling did not cause differences in the change in exit times during the first half of the experiment, regardless of initial isolation score classification. However, during the second half of the experiment changes in exit times were greater ($P < 0.04$) for heifers in the HANDLED group if they received an initial isolation behavior score of 1 or 2.

For the first half of the experiment (0 to 10 wk) there were no significant differences in exit times in each of the four initial isolation score groups between the two treatments. Over the second half of the experiment there was a difference between the treatment groups for the heifers that had an initial isolation score of 1 ($P < 0.05$) or 2 ($P < 0.01$). The heifers in isolation group 1 that had been handled exhibited an increase in average exit time of 11.7 ± 5.3 s, while heifers in the control group, on average, took 2.6 ± 4.0 s less to exit the isolation pen. This same trend was also observed in the heifers that received an initial isolation score of 2. Those heifers that were handled had an

increase in exit time of 4.3 ± 1.7 s, and heifers in the control group had an average decrease of -2.7 ± 1.6 s. Among the animals that had initial isolation scores of 3 or 4, there were no significant differences between the two treatment groups (Figures 5.7, 5.8, 5.9).

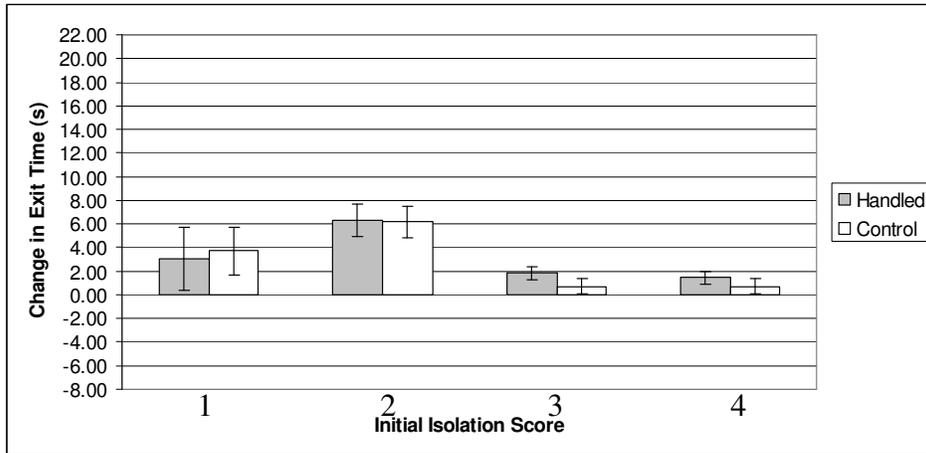


Figure 5.7. 1st Half Changes in Exit Time by Initial Isolation Score

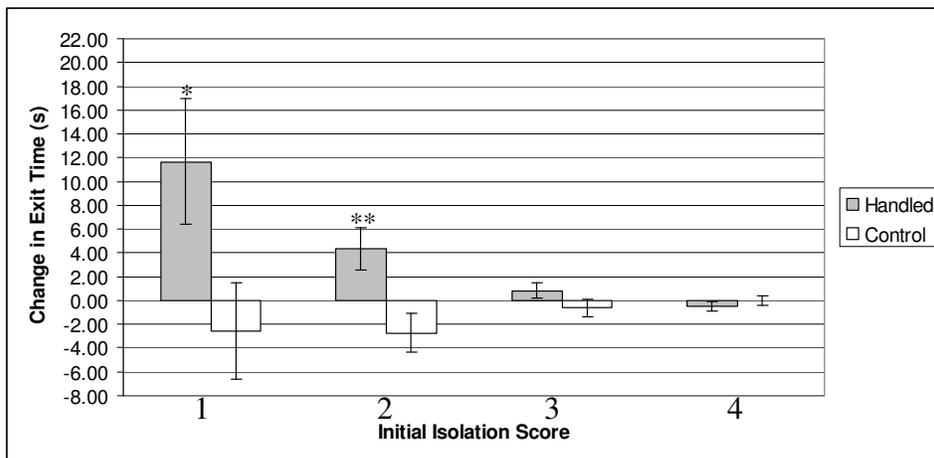


Figure 5.8. 2nd Half Changes in Exit Times by Initial Isolation Score Group.

** $P < 0.01$ means within isolation score differ

* $P < 0.05$ means within isolation score differ

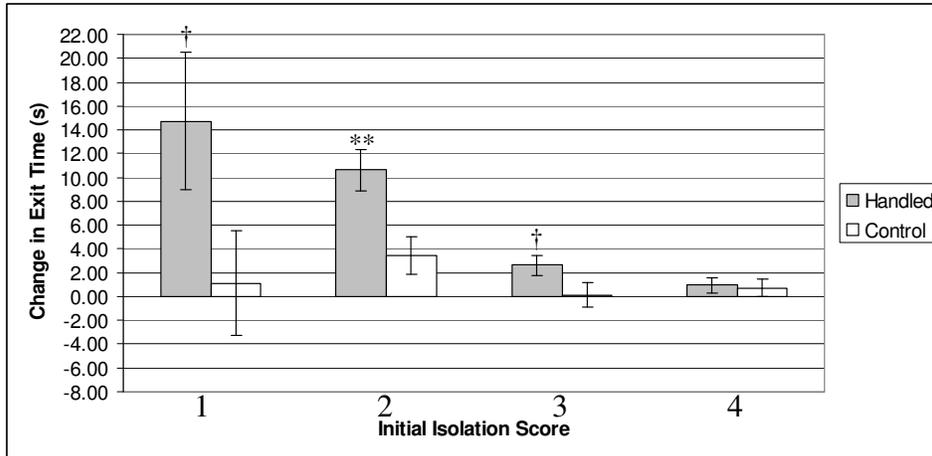


Figure 5.9. Overall Changes in Exit Times by Initial Isolation Score Group.

** $P < 0.01$ means within isolation score differ

† $P < 0.10$ means within isolation score differ

For the entire experiment (0 to 20 wk) the heifers that were handled, and had an initial isolation score of 1 ($P < 0.08$), 2 ($P < 0.01$), or 3 ($P < 0.07$), recorded longer exit times from the isolation pen when compared to the heifers in the respective control groups. There was no difference in the change in exit times between the heifers in the two treatment groups when those heifers received an initial isolation behavior score of 4 ($P < 0.84$).

Heifer Weights

The heifers in this experiment weighed an average of 234 ± 22 kg at the start of the experiment (0 wk). At the end of the 20 wk experimental period all heifers weighed an average of 331 ± 33 kg. The average daily gain over the entire experiment was 0.56 ± 0.12 kg/head/d.

Serum Progesterone Concentrations

Eight heifers had serum progesterone concentrations of less than 1 ng/ml in both blood samples collected at the end of the experimental period and were considered as

non-cycling (HANDLED, n = 2; CONTROL, n = 6). The heifers that were not cycling had an average final weight of 305 ± 47 kg.

Social Dominance

Social dominance ranking was determined at the end of the experiment only for the heifers that had been HANDLED for 20 wk. Time in the controlling position at the feed source was recorded for pairs of heifers to determine the predicted time advantage or disadvantage of each animal relative to the group mean time. The relative predicted time advantage was used as the social dominance order with the group. The relative predicted time advantage was regressed on in-chute behavior scores, isolation scores, and exit times at the final scoring session (20 wk); as well as the overall change in in-chute behavior and isolation scores, and exit times over the entire experiment. Social dominance order based on predicted time advantage was also correlated to each heifer's final weight. Analysis revealed that the final in-chute behavior score was positively related with the social dominance ranking ($P < 0.10$). Each heifer's final weight at the time of the social dominance testing was not related to the outcome of the pairings for control over the feed source ($P < 0.25$).

The mean social dominance ranking was different between the three facial hair whorl groups ($P < 0.05$). Heifers with a hair whorl located in the middle of their forehead were ranked higher in the social dominance order than either those with high or low hair whorls.

Table 5.3. Correlations and p-values comparing social dominance ranking and final scoring session results (in-chute, isolation, and exit time); overall changes (0 to 20 wks) (in-chute, isolation, exit time); and final weights for the heifers in the HANDLED treatment group.

		Correlation	p-value
Final Scoring Session (20 wk)			
	In-chute	0.47	0.09
	Isolation	0.03	0.91
	Exit Time	-0.01	0.67
Overall Change in Scores/Times (0-20 wk)			
	In-chute	0.32	0.32
	Isolation	0.09	0.77
	Exit Time	-0.02	0.39
Final Weight		-0.01	0.24

Chapter 6 Discussion

The purpose of this experiment was to determine if weekly handling of crossbred replacement beef heifers would change their behavior measures in three testing situations (in-chute behavior, isolation, and exit time). We hypothesized that weekly handling sessions would decrease the severity of the response to stressful situations. Based upon published literature regarding the relationship between facial hair whorl position and behavior, we hypothesized that the heifers with the hair whorl located above the eyes would be the most agitated.

Testing method

There are many different methods used to test the behavior and describe the temperament of cattle. The methods used in this experiment were chosen based on the short time needed to score temperament and the simplicity of the scoring systems. For in-chute behavior testing we allowed 20 s for testing and used the 4-point scale first described by Grandin et al. (1995) because it is well accepted and has an adequate range in behavior scores to characterize variation in behavior of heifers in a chute.

We chose to perform a behavior test on isolation heifers free to move in 8' X 36" pen in order to observe each animal's behavior when it was alone and away from herd mates. This test allowed a greater variety in the expression of temperament differences because heifers were not confined. This procedure also mimicked practical situations in which individual animals are penned to provide assistance (e.g., during calving). This testing method also allowed us to measure aggressive behavior of heifers toward a handler.

The final procedure performed during each testing session was the recording of the time it took each heifer to exit from the isolation pen. In previous studies (Burrow

and Dillon, 1997) many heifers refused to leave the chute and had to be prodded. In our experiment all of the heifers were willing to leave the isolation area and did not need to be pushed.

In-Chute Behavior Score

Both groups of heifers (HANDLED, CONTROL) started the experiment with the same mean in-chute behavior score and after the 20 wk of handling ended with the same mean behavior score. During the first ten weeks the HANDLED heifers had a slight decrease in mean in-chute scores while the CONTROL heifers had a slight increase in scores. This trend was reversed over the second half of the handling period.

Grandin (1993) reported that behavior of beef bulls and steers restrained in a squeeze chute was very persistent over a series of five restraint sessions 30 d apart. That experiment was not designed to test whether handling calmed animals over time; it was to determine if nervousness was evident at each session. Similar to Grandin's findings, we observed the animals that were the most nervous remained so throughout the entire experiment. The lack of change in behavior scores could be due to many different factors. One possibility could be the limitations of the 4-point scoring system, where even slight changes in behavior could still give the animal the same behavior score. Another possibility is that the most agitated animals remain agitated regardless of prior handling experience.

Isolation Behavior Score

Observers in this study agreed that the isolation behavior test was the most conclusive in determining each animal's temperament. Aggression behavior was either absent or difficult to observe when the animal was in the chute. However, when the

animal was isolated, aggression or escape behaviors were readily visible and easy to describe. While there was not a significant difference in the mean isolation score between the two experimental groups at each of the three scoring sessions, the heifers in the HANDLED group had a greater change in overall scores because that group started with a slightly higher mean score. This change in isolation score occurred during the first ten weeks of the experiment.

Other work has been done to determine docility of cattle isolated from herd mates (Grignard et al., 2000). A pen isolated from other animals was used to observe the behavior animal alone and then with a handler. Each heifer was evaluated twice, three months apart. The heifer's docility scores increased from the first to the second testing sessions. In that study, eight heifers were evaluated as being aggressive during the first test, and five of those heifers were also described as aggressive at the second session.

During each isolation behavior testing session in our experiment the animals that received a behavior score of 3 or 4 (most agitated) also received a temperament rating describing their behavior as evasive or aggressive toward the handler. During the first session 40% (60 / 146 heifers; HANDLED, n=36; CONTROL, n=24) were scored 3 or 4 by both of the observers. The majority of the animals displayed evasive behavior, with only 14 showing signs of aggression (HANDLED, n=6, CONTROL, n=8). By the final session, 28% of the heifers received either a 3 or 4 isolation score from both observers, with 11 animals showing signs of aggression (HANDLED, n=2; CONTROL, n=9).

While the numbers are small, handling tended to decrease the number of heifers that were aggressive toward the handler. Handling these heifers helped to decrease the nervousness of the animals during isolation and to reduce the animals' aggression towards a handler.

Without the handling sessions the CONTROL heifers remained more nervous and aggressive toward the handlers.

Exit Time Recordings

The time it took for each heifer to leave the isolation pen was recorded at each of the three scoring sessions. Those heifers that took longer to leave the isolation pen area were calmer and walked out of the testing area, while the faster animals were the more agitated animals. The two experimental groups began the experiment with the same mean exit times. However, after the 20 weekly handling sessions the heifers in the HANDLED group took longer to exit the isolation pen and had a greater change in their exit times throughout the experiment as compared to the animals in the CONTROL group. No changes in exit times were recorded during the first half of the experiment in either group, the increased mean exit time for heifers in the HANDLED group occurred during the second half of the trial. Similar to the isolation pen behavior test, the heifers with the low facial hair whorls were more agitated and took a shorter amount of time to exit the pen.

Handling Effects on Heifers with Different Initial Isolation Behavior Scores

We chose to analyze the data from CONTROL and HANDLED heifers within each of four groups based upon their mean initial (0 wk) isolation score. The mean changes in behavior scores or exit times during the 1st half, 2nd half, or entire experiment were calculated for each treatment and were reported for each initial isolation classification group.

During the first half of the behavior trial in-chute behavior scores of the heifers in the HANDLED group, within each isolation score group, had mean a decrease in scores.

However, of the heifers in the CONTROL group only those with an initial isolation score of 2 had a lower in-chute score. CONTROL heifers with initial isolation scores of 1 and 4 had an increase in in-chute scores, while no change was seen in those animals that received an initial isolation score of 3. In the first 10 wks handling had the greatest affect on in-chute scores for the animals with initial isolation scores of 1, 2, and 3. The heifers that were the most nervous (isolation score 4) did not decrease in the severity of their response to being caught in the squeeze chute. During the second half (10 to 20 wks), there were no significant differences in the changes in in-chute behavior scores between the two treatment groups. Therefore, handling had the most impact on in-chute behavior scores during the first 10 wks of handling. Overall handling only had a significant impact on those animals that received an initial isolation score of 3 when compared to the CONTROL animals with the same initial isolation score. The trend of handling having the greatest impact on behavior during the first 10 wk period also occurred in the isolation behavior scores. The opposite trend, with the majority of the change occurring during the 2nd 10 wk period was observed in the exit time recordings. While the time period when the greatest change took place varied among the testing method used, it remains uncertain whether there is a certain time frame when the majority of the changes would occur.

Overall, for the entire twenty week period, after analyzing the data for HANDLED and CONTROL heifers within the initial isolation score groups it became evident which groups of heifers benefited the most with the handling sessions. The largest difference in change of isolation behavior score was seen in the heifers that had an original isolation score of 2 and 3. Minimal changes of the isolation scores were seen in

group 1, the calmest animals which could not become any calmer due to the 4-point scoring system, and group 4, the most agitated animals. Therefore, we have concluded that this decrease in isolation scores were due to either calming of the animals as they aged or them becoming accustomed to being isolated and not due to the handling sessions. All 4 groups in both treatment groups reported slower exit times over the 20 wk handling period. The heifers in the HANDLED group had longer exit times in all 4 groups based on initial isolation scores; however similar to the isolation scores, the most agitated heifers in both treatment groups had comparable means for both changes in isolation scores and exit times. These results indicate that handling the most nervous heifers had no effect on isolation score or exit times, and was no better at helping behavior than leaving the animal out on pasture.

Facial Hair Whorl Location and Behavior

In the first scoring session (0 wk) the heifers with hair whorls low on their forehead had the highest mean isolation score, as compared to the heifers with hair whorls classified as medium and high. The cattle with facial hair whorls classified as medium and low had a greater decrease in isolation behavior score over the entire experiment (0 to 20 wks) when compared to their counterparts with hair whorls high on the forehead. The relationship of handling and the location of facial hair whorl has not been explored. Previous research investigating the link between hair whorl position and behavior had evaluated cattle in an auction ring setting (Lanier et al., 2001). Results of that study indicated that cattle with high hair whorls were more nervous and had higher behavior scores. While their results are in direct contrast to our findings, it should be noted that they observed 1636 animals from a variety of locations, breeds, and ages. The

150 animals used in our study all had the same background and breeding, and were approximately the same age.

Social Dominance

Social dominance is extremely difficult and time consuming to determine in a large group of grazing animals. Due to time constraints we only determined social dominance rank in the heifers that were in the HANDLED treatment group. The time that each heifer controlled a feed source was collected for select pairings over a 2 min time period. The social dominance ranking was correlated with in-chute behavior scores, isolation scores, and exit times at the final scoring session (20 wk); the change in in-chute behavior and isolation scores, and exit times over the entire experiment; and with the heifer's final weight. Final (20 wk) in-chute behavior score for each heifer was positively correlated with the social dominance ranking (0.47; $P < 0.10$). This indicated that those heifers that were more fractious in the chute were higher in the social dominance ordering of the group.

The heifer's weight at the time of testing did not influence the outcome of the of the social dominance testing. These results are in agreement with others who report that several factors in addition to weight contribute to dominance, including age, breed, temperament, and the presence or absence of horns (Ewing et al., 1999)

Anecdotal Observations

Throughout the trial informal notes were made on the behavior of both groups of heifers as they were worked through the facilities for routine de-worming or vaccinations. Handlers noticed that the heifers that had been handled weekly were easier to move into corrals and much easier to sort. It was also observed that the two groups of heifers had

very different flight zones. The CONTROL heifers were much more wary of people on foot during feeding times, and would remain at a greater distance until the humans left the feeding area.

Chapter 7 Implications

In summary, handling replacement heifers decreased the severity of the response to novel situations. Handling had the greatest impact on the cattle that were in the middle of the temperament spectrum. Weekly handling for 20 wks did not have any significant impact on the animals that were initially classified in the calmest or most agitated groups. Social dominance was only related to the final in-chute behavior scores in our experiment.

Temperament evaluations are quick and easy to perform and provided invaluable information about an animal's behavior. Cattle that show aggressive tendencies should not be purchased as a safety concern for both the animals and handlers. However, as long as facilities are sturdy enough to handle nervous cattle, if the animal has superior genetics, cattle displaying nervous/evasive behavior can be integrated into the herd. Weekly handling of cattle was not effective in decreasing the nervousness in the most agitated animals. However, the type of handling, running through chutes or working in a pen, was not addressed in this experiment and therefore needs to be researched to see if different exercises work better at calming the animals down. Also, it was revealed that for both in-chute and isolation behavior scoring, the change that occurred in the heifers that had been handled occurred in the first 10 wks. Exit times, however, had the largest change in the second 10 wk handling period. In practical situations producers are not going to make culling decisions based on a heifer having a high or low hair whorl. However, the hair whorl could indicate which animals should be watched for nervous behavior. Overall, the results of this experiment indicate that behavior testing can reveal differences in the temperament of heifers and that, other than the most nervous and agitated heifers, repeated handling could serve to improve the temperament of the animals.

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