Temperament assessment provides insight into future health and growth performance of beef cattle

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Introduction

Throughout the productive life of beef cattle many stressful events occur (e.g. branding, castration, vaccination and tagging) coupled with weaning, social mixing, and transportation. These stressful events have been reported to induce secretion of several of the prominent stress-related hormones: cortisol, epinephrine, and norepinephrine (Crookshank et al., 1979; Rulofson et al., 1988; Lay et al., 1992; Buckham Sporer et al., 2008). Acute stress is not necessarily detrimental to the health of an animal, and may even be beneficial (Galyean et al., 1999; Dhabhar, 2002; Duff and Galyean, 2007; Sorrells and Sapolsky, 2007). However, chronic stress can negatively impact growth, reproductive function, and immune function (Moberg, 1987; Dobson et al., 2001). Therefore minimizing adverse consequences of multiple stressful incidents as well as identification of animals that may react differently to multiple stressful events may be beneficial to health and growth of beef cattle.

The effect of animal temperament on health and performance is an area of increasing research interest. Specifically in cattle, temperament is defined as the reactivity, or fear response, to humans (Fordyce et al., 1988a). Correlations between temperament and concentrations of stress hormones in cattle have been reported in that more temperamental, or excitable, cattle have greater concentrations of cortisol and epinephrine (Schuehle et al., 2005; King et al., 2006; Curley et al., 2006a, b, 2008). In addition, temperament can have negative impacts on growth (average daily gain), carcass traits, and immune function in cattle with less desirable temperaments (Voisinet et al., 1997; Fell et al., 1999; Oliphint, 2006).

Multiple studies have provided valuable information on the relationships between cattle temperament, transportation, immune challenges, and production traits over the last six years. Temperament assessments of beef cattle can be comprised of several subjective and objective tests; however, our studies have primarily focused on the following three measurements: 1) chute score, 2) pen score, and 3) exit velocity. While chute and pen scores are subjective measures of temperament, exit velocity is an objective measurement that records the rate (m/s) at which cattle exit a working chute (Burrow et al., 1988; Curley et al., 2006a). Pen score (Hammond et al., 1996) is a subjective measurement in which cattle are separated into small groups of three to five and their reactivity to a human observer scored on a scale of 1 (calm, docile, and approachable) to 5 (aggressive, volatile, and crazy). Chute scores reflect the behavior of the animal while confined in a chute and scored on a scale of 1 (calm, no movement) to 5 (rearing, twisting of the body, or violent struggling; Grandin, 1993). Utilization of a temperament score which is the average of exit velocity and pen score provides a combined temperament measurement that encompasses both the subjective and the objective perspectives (Curley et al., 2006a; King et al., 2006). Additionally, temperament is a moderately heritable trait and improvements in overall herd temperament and production efficiency can be made relatively quickly in a practical production situation.

Results and Discussion

The two measurements used most often for the collaborative research at Texas AgriLife Research and Mississippi State-MAFES-Brown Loam Experiment Station are pen score and exit velocity. Whereas the various methodologies for temperament assessment may measure slightly different aspects of animal behavior, they do relate to one another and, in the case of exit velocity and pen score, to increased circulating glucocorticoids such as cortisol (Curley et al., 2006a, b). Calves that exhibit a greater exit velocity or leave the working chute at a greater speed are usually more temperamental than those calves that leave the working chute at a lesser speed. Additionally, secretion of the stress-related hormones epinephrine and cortisol is exaggerated in the more temperamental calves (Schuehle et al., 2005; Curley et al., 2006a, b, 2008; King et al. 2006). Exit velocity can be measured in cattle of all ages, from 3 weeks of age through maturity, although from a practical production standpoint, and to more accurately predict temperament in calves, it is best for producers to determine exit velocity closer to weaning time (Burdick et al., 2009; 2011a). Cattle can be ranked based on their exit velocity and this can help producers determine which animals are the "flightiest" and therefore provide an objective measurement to determine which animals should be culled due to temperament or assigned to different management groups (e.g. feeder versus retained as a replacement in the breeding herd). Additionally, temperament score is an average of exit velocity and pen score and is the primary measure of temperament assessment in our research group due to the fact that it provides a more accurate assessment of temperament in that it takes into account two aspects of behavior involved in the "flight" or "fight" syndrome.

Human-animal interactions in cattle production commonly occur through handling coupled with various management practices. Animal temperament has been shown to have negative impacts on aspects of both dairy and beef production. Cattle with more excitable temperaments exhibit lower body weight gains (Burrow, 1997; Voisinet et al., 1997), produce tougher meat (King et al., 2006; Voisinet et al., 1997), have inhibited milk production (Drugociu et al., 1977; Breuer et al., 2000), and yield increased amounts of bruise trim due to injuries acquired during transportation (Fordyce et al., 1988). Coupled with the negative effects on growth and carcass traits, temperament can also have negative effects on immune function (Fell et al., 1999; Oliphint, 2006). More specifically, temperamental animals have decreased carcass weight and tenderness, as well as increased carcass pH, and abnormal meat flavor or color (Fordyce et al., 1988b; King et al., 2006). This also renders cattle more susceptible to disease-causing pathogens (Oliphint, 2006). Mississippi cattle producers consigned steers (n=186) and heifers (n=24) to the Farm to Feedlot program in which cattle were evaluated for temperament using chute score, pen score and exit velocity prior to shipment to the feedlot (Vann et al., 2008a). Cattle were evaluated for ADG, treatment costs, net returns and carcass quality. Individual treatment costs increased as pen score and exit velocity increased. As exit velocity increased, final body weight, total gain, and ADG decreased ($P < 0.05$). In addition, as exit velocity increased, net returns decreased along with an increase in the number of days cattle were treated for sickness ($P < 0.07$; Vann et al., 2008a). We concluded that cattle that possess more excitable temperaments have increased treatment costs and lower net profits compared to cattle with calmer temperaments (Vann et al., 2008a). Researchers at Iowa State University reported that not only does cattle disposition influence convenience traits, but disposition also influences feedlot performance and carcass quality (Busby, 2005). All of these factors can lead to an increase in cost to the producer and decreased profitability.

Other stressors that cattle will encounter throughout the different management practices during their lifetime are transportation and commingling. Transportation has been purported to be a stressor in the livestock industry, yet interestingly there have been limited studies in cattle that have demonstrated increases in rectal temperature due to transportation. Tarrant et al. (1992) did not find a change in rectal temperature measured before and after a 24-h transport of Friesian steers. In addition, a shorter 9-h transport of beef bulls did not find a transport-induced difference in rectal temperature, measured using a hand-held digital thermometer (Buckham Sporer et al., 2008). Furthermore, rectal temperatures of bulls in that study were lower 48 h after the initiation of transportation. In contrast, rectal temperature increased in heifers that were transported for 4 h on two consecutive days compared to non-transported controls (Behrends et al., 2009). A recent study reported relationships between temperament and transportation with rectal temperature and serum concentrations of cortisol and epinephrine in bulls with rectal temperature recording devices for continual collection of rectal temperature during transport (Burdick et al., 2010). In this study, temperamental bulls had greater rectal temperature than calm or intermediate bulls ($P < 0.05$). Rectal temperature peaked within 30 min after the onset of transportation with temperamental bulls having greater peak rectal temperatures than calm or intermediate bulls ($P < 0.05$). The lowest mean rectal temperature was reached 400 min after the onset of transportation with calm bulls having lower mean rectal temperatures than intermediate or temperamental bulls ($P < 0.05$). Prior to transportation, temperamental bulls had greater cortisol concentrations than calm bulls ($P < 0.05$) as well as greater concentrations of epinephrine than calm or intermediate bulls ($P < 0.05$). Temperamental bulls also had greater concentrations of cortisol and epinephrine post-transportation than calm bulls ($P < 0.05$; Burdick et al., 2010). Additionally, a subsequent study by Burdick et al. (2011b), suggests that the most stressful part of transportation actually occurred prior to the transport event, and was more closely associated with the sorting and loading process. This study utilized automatic sampling devices (IceSampler™) which provided "real-time" endocrine indices of stress responsiveness during a 4-h transport and these hormonal changes were related to temperament. These studies indicate that temperamental cattle react very differently to varying aspects of management practices and thus that actual human-animal interactions are probably the most stressful events that these animals encounter.

Evaluation of ultrasound body composition traits as affected by temperament, transportation and an immune challenge has also been a focus of our research team. The objective of one research project was to evaluate the combined effects of transportation and animal temperament on real-time ultrasound body composition traits (primarily percentage of intramuscular fat) in Angus crossbred (n=68) and Brahman (n=60) steers (Vann et al., 2008b). Cattle were assigned temperament scores at weaning, as yearlings, and prior to departure to the feedlot and three sets of steers were hauled three distances (644, 809 and 1,236 km) to a feedlot. Breed and distance cattle were hauled affected percentage of intramuscular fat ($P = 0.053$) and rib fat ($P = 0.02$) at feedlot arrival. Angus crossbred steers hauled shorter distances had smaller changes in percent intramuscular fat than Brahman steers ($P < 0.002$). As the distance cattle were hauled increased, the percentage change in intramuscular fat increased (Figure. 1). These results suggest that transportation has negative impacts on body composition traits, specifically intramuscular fat and rib fat. Furthermore, in another study Brahman bulls were evaluated to determine the influence of temperament on ultrasound body composition traits in response to transportation and an endotoxin challenge (Vann et al., 2008b). Based on their temperament score (combination of exit velocity and pen score) the calmest (n=8), intermediate (n=8), and most temperamental bulls (n=8) were transported (770 km) and underwent an endotoxin challenge. Prior to departure and post-endotoxin challenge, ultrasound measurements were collected on the bulls for percent intramuscular fat, ribeye area and rib fat. Rib fat was reduced (average 0.03 ± 0.03 cm) due to transportation for bulls in all temperament classifications ($P < 0.03$). There was a numerical trend for bulls classified as temperamental (-0.15 ± 0.11) to have the smallest decrease in percentage of intramuscular fat compared with calm (-0.41 ±0.11) or intermediate (-0.43 ± 0.11) bulls due to either transportation or post-endotoxin challenge. Although many of these changes in ultrasound body composition traits are minimal, there are some trends; however, more research needs to be done to further elucidate these changes in body composition traits. Transportation does have negative impacts on body composition traits, especially intramuscular fat in young steers transported to the feedlot or bulls undergoing transport and an immune challenge, however, there is some inference which can be applied to fat cattle that are transported long distances to a harvest facility as they could undergo similar changes in percent intramuscular fat and this could impact carcass quality grade for cattle marketed on a grid system.

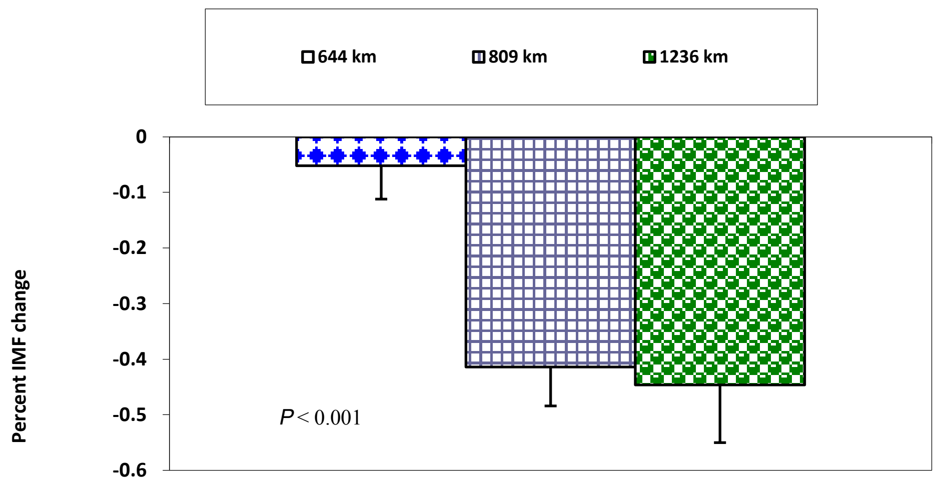

Figure 1. Loss of intramuscular fat (%IMF) was related to travel distance of Angus crossbred and Brahman steers (Vann et al., 2008b).

In summary, there are many methodologies that can be utilized to measure cattle temperament, however; these data suggest that objective measures of temperament assessment may be more useful than subjective methodologies alone. Furthermore, a combined temperament score (an average of subjective and objective measures) provides a more complete assessment due to the fact that it accounts for more than one aspect of cattle behavior. All measures of temperament indicate some adaptation of animals to interactions with humans and management practices. Truly excitable cattle seem to need longer periods of adaptation and are at greater risk for injury to themselves, personnel and equipment in interactions occurring in routine management practices. Not to mention, these more excitable animals have elevated concentrations of stress hormones and catecholamine's throughout their lifetime which negatively impacts growth performance, carcass traits (e.g. quality grade, tenderness, and marbling), and response to vaccination, and immune challenges. In a feedlot atmosphere, these excitable cattle tend to have lower ADG, lower carcass weights, and increased treatment costs due to sickness resulting in lower net profits. Cattle temperament is a moderately heritable trait; thus, identification of these animals in a herd can be utilized to a producer's advantage in that these animals can be marketed or assigned to different management groups (e.g. feeder versus retained as replacements in the breeding herd) which better fits their overall production potential. Future research focus for our team involves more in depth exploration of the interactions of temperament, transportation and immune function as well as cattle feeding behavior and its relationship to overall animal health, productivity, and profitability.

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