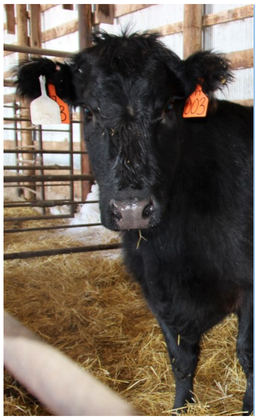

Evaluation of Methods to Measure Temperament in Cattle and Their Impacts on Predictions of Genetic Merit

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Introduction

Measuring temperament, defined as the reaction of the animal to human handling (Burrow and Dillon, 1997; Fordyce et al., 1982), in beef cattle has been of industry-wide interest. Calmer cattle result in less stress and safer work environments for the handler as well as that animal and its contemporaries (Grandin, 1989). The reduction of stress on both animals and humans can result in more efficient production of beef and reduced costs due to health reasons (e.g., King et al., 2006; Cooke et al., 2009a, 2009b, 2011). This is particularly true as wilder, more excitable temperaments alter immune responses in cattle (reviewed by Burdick et al., 2011).

Temperament, among other similar traits of production importance, is challenging to measure. Using an objective scale or collecting data in an objective manner can be cost prohibitive for a producer. For example, flight speed (Burrow et al., 1988), which is based on the premise that calmer animals leave the chute at a slower rate than their unruly contemporaries, requires specific equipment and skills to measure the characteristic. It has been shown that there is only moderate persistence of flight speed over a day (Vetters et al., 2012). Additionally, there are questions about what aspects of temperament (e.g., nervousness, flightiness, gregariousness, aggressiveness, etc.) flight speed really accounts for, but little research has been conducted to understand this. Furthermore, purely objective methods often lack the ability to capture the various aspects of temperament.

Subjective methods are more cost efficient for the producer and can be utilized to capture various attributes of a complex trait. Subjective methods, however, rely on the evaluator's perception of that trait. In the case of temperament, several subjective methods have been identified, including flight distance (Fordyce et al., 1982), crush score (also called temperament score; Hearnshaw and Morris, 1984), movement score (Fordyce et al., 1982; 1988; adapted by Grandin, 1993), docility score (Beef Improvement Federation, 2018), as well as a method based around behavioral attributes (Sant'Anna and Paranhos da Costa, 2013). A purely research-based scoring method also has been described (Boldt, 2008; Hulsman Hanna et al., 2014). Due to the impact of temperament on production characteristics, breed associations have implemented docility score into their genetic evaluation programs (e.g., Hyde, 2010; Northcutt and Bowman, 2010).

Subjective methods rely on the evaluator's perception of the animal's reaction to human handling. Due to this, there is potential for evaluator bias either between evaluators or across days of evaluation (Vetters et al., 2012). Very little is known of the actual impact of evaluators on these subjective scoring methods. Rather, a limited number of studies have reported repeatability of scores on animals (Vetters et al., 2012; Jones, 2013), which provides an indication of usefulness in the production setting, but not necessarily an indication of what variation could be expected between evaluators for any given method. Even fewer actually compare these repeatability measures across methods.

Because temperament is a complex trait and often highly influenced by environmental cues, it is important to assess current and new methods for their effectiveness in capturing this trait of interest, especially if these methods are used for selection purposes. Findings related to temperament scoring methods have further-reaching implications as they also could be translated to other difficult-to-collect traits, such as fertility and reproductive performance. Therefore, a long-term objective of this project is to identify a practical measure of temperament to use in genetic evaluation programs. Current short-term objectives of this study are to: 1) characterize subjective and objective measurements of temperament, 2) identify evaluator impact on subjective measurements relative to genetic predictions, and 3) determine the feasibility and practicality of objective methods being characterized. This report describes the approach and current status of the project.

Materials & Methods

Animals. Calves at weaning age from Central Grasslands Research Extension Center (CGREC) were evaluated for temperament using subjective and objective scoring systems. Weaning age is recommended to reduce influences on temperament evaluation due to past experiences (BIF, 2018). The cow herd producing these calves was comprised of approximately 425 females (mature cows and heifers) with primarily Angus and/ or Hereford influence that were bred to Angus or Hereford bulls. Each calf had blood drawn via jugular venipuncture for white blood cell extraction. White blood cell pellets have been stored long-term in an ultralow freezer until funding becomes available for DNA extraction and genotyping. Data was collected on weaning-age calves from 2014 to 2017 resulting in approximately 1,542 calves with records available.

Data Collection and Traits. During weaning time, temperament was evaluated by randomly assigning evaluators (n = 6) to two of three subjective scoring methods (n = 4 evaluators per method). This was constructed to determine the level of differences between evaluator perceptions of temperament (i.e., evaluator bias) without introducing bias due to stress of scoring three scales. Efforts were taken to keep evaluators consistent across years. Many evaluators were involved during all four years and kept the same two scoring systems over those years; however, a subset was only involved in specific years. Replacements typically had similar backgrounds or experiences, where this difference also is being investigated as part of the long-term objective. Furthermore, novel objective methods of measuring temperament also were investigated to determine usefulness in measuring temperament.

Subjective evaluation methods include:

1) Qualitative Behavior Assessment (QBA; Sant'Anna and Paranhos da Costa, 2013). The QBA method uses 12 behavioral attributes: active, relaxed, fearful, agitated, calm, attentive, positively occupied, curious, irritated, apathetic, happy and distressed. Evaluation occurs as the animal leaves the chute and enters a working pen. Evaluators interpret the body language of the animal and score each attribute independently on a 136-mm line, where the far left of the line is no expression and the far right of the line is full expression. The score is the distance (in mm) of the mark from the left side.

2) Temperament score (Sant'Anna and Paranhos da Costa, 2013). Like QBA, temperament score is used to evaluate the animal as it leaves the chute and enters a working pen. It is a 1 to 5 scale with whole numbers, where a score of 1 is a calm animal and a score of 5 is a wild animal. The middle value (3) is not included to avoid having evaluators choose an intermediate score.

3) Docility score (Beef Improvement Federation, 2018). Docility score is evaluated when the animal is in the squeeze chute with its head restrained, but body movement is not restricted. Each calf is scored on a 1 to 6 scale, where 1 indicates a docile, easily handled animal, and 6 indicates a very aggressive, wild animal.

Objective evaluation methods include:

1) Video image analysis (VIA). Video was captured on each calf from the top as it entered the silencer chute in 2016 and 2017. Prior to entering the chute, the calf had a red marker placed on its tail head. A second red marker was present at a designated location within the chute. The video clip was reduced to a 10-second window for each calf in the same time frame of being in the chute for consistency. Deviations of the calf's red marker from the permanent red marker was captured to understand movement as a possible measure of temperament.

2) Pupil Dilation and Thermal Imaging. After the head of the calf was caught in the silencer chute, but before blood draw, an infrared picture of the calf's left eye was taken for pupil dilation and a thermal image reading of the calf's face was recorded as two additional measures of temperament. These records were only recorded in 2016 and 2017.3) Four-platform standing scale (Pacific Industrial Scale, British Columbia, Canada). Immediately after being evaluated in the squeeze cute for docility score, the animal was placed on a custom four-platform standing scale for a minimum of 45 seconds to record weight borne on each quadrant over time (records multiple times per second). Measures used from this data included the standard deviation of a set number of records and the coefficient of variation of this standard deviation (Yu, 2016). Additional measures using the scale data are being investigated.

Temperament Index (TI). In their study, Sant'Anna and Paranhos da Costa (2013) took those behavior measurements and, through principle component analysis, transformed them into a single score for each animal termed the Temperament Index (TI). Although measuring the behavior attributes for the QBA requires subjective assessment, the use of principal component analysis converts these measurements, which may have correlation, to a set of values that are linearly uncorrelated (i.e., the principal components). The TI is the first principal component, meaning that it accounts for the largest amount of variation in the data, and each following component is uncorrelated to the TI. Attributes of QBA across the four years per evaluator were run through the PRINCOMP procedure of SAS to produce the TI.

Statistical Analysis. Phenotypes (scores and attributes) were evaluated using a mixed model procedure in SAS (SAS Institute Inc., Cary, NC) for the appropriate fixed effect model. Fixed effects being considered include: evaluation day (n = 2 per year), birth year (n = 4), evaluator (n = 11 total), breed composition or type (n = 8 or 2) and other environmental effects (e.g., sequence of evaluation). The average score for each method on each calf will be used for an aggregate value to compare against evaluators and across methods, particularly for project objective 3.

Genetic Predictions. Predictions of genetic merit will be produced using an animal model ASReml software (Gilmour et al., 2017). This approach uses the fixed effects identified, random effect of calf with relationship based on pedigree for additive genetic merit, and random effect of calf without pedigree relationship to account for maternal permanent environmental effects. Analysis will be conducted as single traits and in pairs to identify heritability and genetic correlations. Predictions will be generated and used for comparison of method efficacy and evaluator impacts on animal rankings.

Results & Discussion

Initially, concern existed that drawing blood prior to temperament scores in the four-platform scale and evaluation pen would cause issues with comparisons. In the first year (2014), this was investigated by randomly assigning sets of five calves as they came through the working facilities to either have blood draw conducted before or after evaluation. The effect of blood draw was found to be unimportant (Hulsman Hanna et al., 2017). A full -length publication is pending submission this year on this topic.

Using four years of data, the evaluator effect was again found to be significant for subjective methods (Celestino Jr. et al., 2019), where investigation of evaluator effect showed that some scales had minor differences (i.e., less than 15% of the scale) and others had major differences (i.e., more than 60% of the scale). Estimates of heritability and other genetic parameters have been produced (Celestino Jr. et al., 2019). Heritability (h^2) ranged from 0.00 ± 0.00 (TI) to 0.29 ± 0.05 (QBA calm). Maternal permanent environmental effects (c^2) ranged from 0.00 ± 0.00 (TI) to 0.36 ± 0.05 (TS), where several traits were found to have moderately high values (e.g., over 0.25 and included DS, agitated, calm, distressed, and irritated). The impact of evaluator on these estimates and ranking of genetic merit as well as the relationship of these scales to each other genetically is ongoing.

Outcomes from QBA analysis in SAS indicate that very different outcomes can occur across populations (*Bos indicus* vs. *Bos taurus* breeds) and evaluators (Hieber, 2016; Yu, 2016). Due to this, additional methods to characterize the QBA attributes is warranted. This currently is being done by pursuing a factor analytic model using multivariate approaches (Henderson and Quaas, 1976).

Lastly, the relationship of infrared thermography has been investigated with DS, TS, QBA attributes, and four-platform standing scale measures (Ogdahl et al., 2019). Low relationships of methods were found with thermal eye temperature values, indicating that prediction of temperament using infrared thermography may not be useful. Additional investigations of thermal images and VIA data are ongoing.

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