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ARTICLE

Effects of initial handling practices on behavior and average daily gain of fed steers

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R. Woiwode, T. Grandin, B. Kirch and J. Paterson

Full Length Research Paper

Effects of initial handling practices on behavior and average daily gain of fed steers

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The objective of this study was to investigate the relationship between handling methods, cattle behavior during handling, and average daily gain (ADG) of feed yard cattle. Hereford steers ($n = 496$; initial body weight [BW] = 304 ± 35.6 kg) of similar genetic background were enrolled in this study after arrival at a commercial feed yard in Southwest Kansas. Two handling conditions prior to the working barn and two conditions of release from the squeeze chute were imposed. When cattle were moved from home pens to the working area, handlers were required to quietly walk all steers (SLOW); or handlers were permitted to bring steers to the processing area in the normal manner (FAST), which included handlers running, yelling, and cracking whips. Individual steers were randomly assigned to one of the two conditions of release from the squeeze chute. The first was a delay not longer than 30 s following the completion of procedures to allow cattle to stop struggling (DELAY); the second was release immediately following the completion of procedures (NORM). Vocalization and behavioral agitation (chute score) were measured in the squeeze chute and exit speed and exit behavior scores were assigned to all steers as they exited the squeeze chute the first time they were worked after entering the feed yard. Paired t-tests determined that cattle exiting the chute at a walk or trot vs. a run tended to have higher ($P=0.08$) ADG. Cattle vocalizing during restraint had lower ($P=0.04$) ADG than those that did not vocalize. The FAST group showed a tendency to vocalize more frequently than the SLOW group. There was a significant positive correlation between exit speed and vocalization ($P=0.0021$, $r=0.14256$) and a significant negative correlation between exit speed and ADG ($P=0.0036$, $r=-0.13542$). Handling was correlated with both behavior and ADG. Cattle that vocalize during handling and restraint may have reduced weight gains.

Key words: Average daily gain (ADG), cattle handling, feed yard, squeeze chute, weight gain.

INTRODUCTION

Cattle handling and practices used in the production of cattle have long been the focus of both discussion and

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investigation to better understand the impact of handling on the welfare and productivity of cattle in feed yards.

Animals that remain calm during handling and restraint in the squeeze chute are more productive (Petherick et al., 2002), and vocalization has been correlated with physical measures of stress (Hemsworth et al., 2013) and cattle that vocalize more (Dunn, 1990) or have higher temperament scores (King et al., 2006) have higher serum cortisol concentrations. Weight gain is reduced if cattle become behaviorally agitated, while restrained or if they exit the squeeze chute at a high speed (Vetters et al., 2013; Voisinet et al., 1997). When cattle are all raised and handled under the same conditions, differences in temperament scores are influenced by inherited differences in reactivity.

Conversely, if cattle with similar genetic backgrounds that were raised under the same conditions experience different handling methods during initial working in a new environment, behavioral reactions in this case may provide new insight on the impact of handling methods. Cattle with Brahman characteristics exit from a squeeze chute faster (Basczack et al., 2006). Studies also show that as cattle handled several times acclimate to handling, exit speed will become slower (Cooke et al., 2009). Temperament scores reflect both genetic influence and learned behaviors, and temperament scores are related to carcass quality, as cattle with higher temperament scores yield carcasses with higher shear force values (King, 2006). The purpose of this study was to determine if methods for handling cattle shortly after arrival at a feed yard had an effect on behavior and weight gain.

MATERIALS AND METHODS

All methods of handling applied to cattle in this project were approved by the Colorado State University Institutional Animal Care and Use Committee Protocol #12-3601A.

Animals

A total of 496 yearling horned Hereford steers (initial body weight [BW] = 304 ± 35.6 kg) were used to assess the influence of handling practices on behavior and average daily gain (ADG). Steers originated from a single herd with similar genetic background, from a single producer in the Northwestern U.S., and they were pastured in Kansas prior to entering the feed yard. Steers were enrolled in this study when they arrived for feeding at a commercial feed yard in Kansas. Each steer was uniquely identified with an electronic identification (EID) ear tag and all steers were eligible for the Certified Hereford Beef incentive program. Upon arrival at the feed yard, lot weights were recorded for each group of steers arriving by semi-trailer. They were mixed together into one common group and then sorted into four pens to achieve uniformity of pen weights. Steers were assigned to four adjacent home pens in the same alley to reduce variation due to location and management.

Experimental design

Both individual and group handling practices were studied to determine the effects of handling practices on the behavior and ADG of feed yard cattle. The group handling factor was the method by which steers were moved from home pens in the feed yard to the working area for vaccination, weighing, and other procedures. The first group treatment consisted of feed yard employees bringing cattle from home pens to the working area using their normal procedures that included running, yelling, and cracking whips (FAST). In the second treatment, the first author and one feed yard employee moved steers from their respective home pens to the working area without moving faster than a walk, and without yelling or cracking whips (SLOW).

The individual handling factor included two conditions. Individual cattle were randomly assigned to one of the two conditions of release from the squeeze chute. In the first condition, the handler operating the squeeze chute released each steer at his discretion after all procedures were completed (NORM). In the second condition, the handler operating the squeeze chute released cattle upon a signal from the observer. The observer signaled for the release of steers after they stopped struggling and stood still (DELAY); the maximum length of time in the DELAY condition was 30 s. Visual assessments by a single observer (the first author) were performed during routine handling events to reduce variation associated with different observers.

Routine handling after arrival

Cattle in this study were observed within 48 h following their arrival at a Kansas feed yard. Routine intake protocol procedures were performed by feed yard employees and these procedures included placement of individual identification tags by pen, two vaccinations, a vitamin drench, dewormer, and the placement of a subcutaneous growth promotant (Revalor XS, Merck Animal Health) in the pinna. These procedures were determined as part of the protocol administered by the consulting veterinarian retained by the feed yard and procedures were performed by feed yard employees. Institutional approval obtained for this study permitted the observer to watch these procedures that were part of the normal activities of this commercial feed yard. The normal sequence of events for working cattle was: (1) removing cattle from the home pen; (2) moving through a 5 m wide alley to the working area; (3) placing pens of cattle in a small holding area adjacent to the next working facility; (4) moving cattle through a round crowd pen and curved single-file alley to the squeeze chute; (5) restraint in the squeeze chute for vaccinations and other procedures.

Handling conditions prior to routine working

During routine handling (as defined earlier) data were collected in the main cattle handling (working) facility at a Kansas feed yard. Final individual weights were collected in a separate event prior to shipping for slaughter, but no other data were collected at this time. Pens of steers assigned to the FAST treatment were brought to the processing area as the investigator observed. Two handlers (feed yard employees) entered the pen along the fence line and worked toward the back of the pen, at times moving at a jog. One handler stopped approximately a third of the distance from the gate to the back of the pen and paused long enough for the second handler to near the back of the pen. The second handler would then make a right angle turn away from the far corner of the pen and begin to work the cattle away from the back of the pen towards the gate, working back and forth behind the cattle, while the first handler

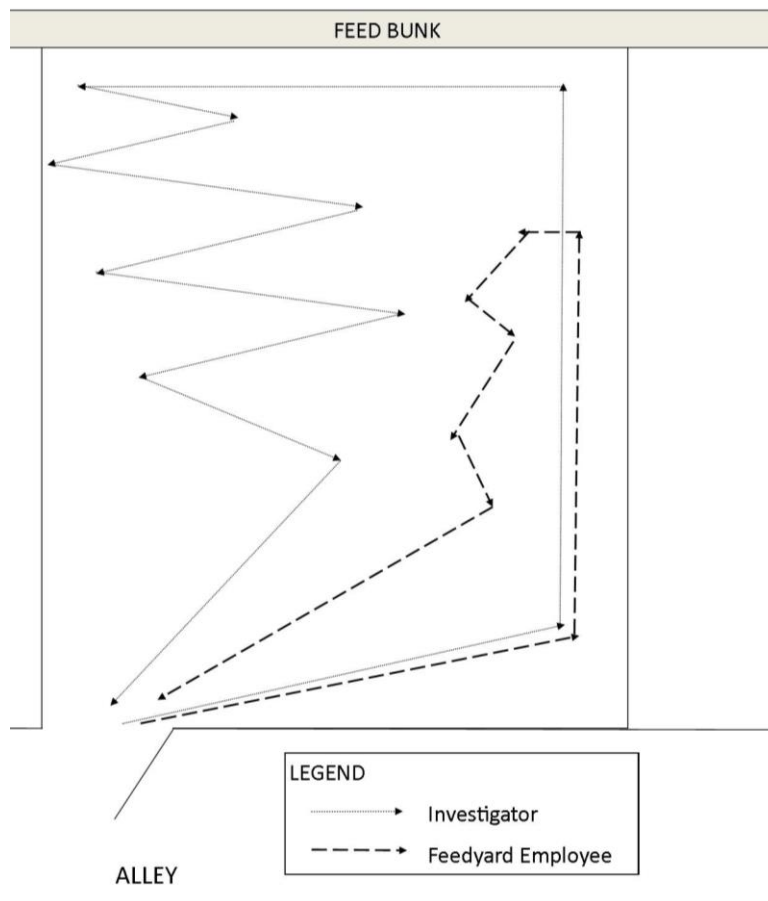


Figure 1. Movement patterns of handlers when gathering cattle: SLOW handling condition.

worked parallel to the cattle, working them towards the gate.

The handlers used loud whistles and snapped whips that they carried to encourage the steers to move. This prompted the steers to run and the handlers ran with them. As the cattle moved out of the gate and into the alley, the handlers trailed the cattle together, using the whips and their voices and whistles to keep the cattle moving down the alley at a trot or run. Under the conditions of the SLOW treatment, handlers were instructed to bring steers to the working area quietly, without yelling, cracking whips, or exceeding a walk. The investigator assisted a single employee in bringing the pens of steers to the processing area, to ensure that the SLOW condition was met. The first author entered the pen along the fence line and worked towards the back of the pen, moving at a walk (Figure 1).

The second handler stopped approximately two thirds of the distance from the gate to the back of the pen and waited for the researcher to reach the back of the pen and sweep the cattle towards the gate at a walk, in the manner described for low-stress handling of cattle (Williams, 2015; Grandin and Deesing, 1998). The first author worked toward the far corner and turned to move parallel with the steers as they moved towards the gate. Some of the steers trotted, but neither the feedlot employee nor the investigator moved faster than a walk. This resulted in the steers returning to a walk as they proceeded down the alley to the

working area. Feed yard employees herded steers from the holding pens adjacent to the working facility, through the round crowd pen and single file chute system, using their normal procedures. Cattle were moved through the circular crowd pen and the single file alley with no electric prod use. An electric prod was used on less than 1% of the cattle that balked at the entrance of the squeeze chute.

Chute entry and capture

When steers entered the squeeze chute, an entry force score (ENT) was assigned, that described the amount of handler effort required to encourage steers to enter the squeeze chute. Steers that entered the squeeze chute without any physical touch from the handler or driving aids received a score of 1. Steers that required a light touch or tap to enter the chute received a score of 2. Steers that required a single impulse from an electric prod to enter the chute received a score of 3, and steers requiring more than 1 electrical impulse to enter the chute received a score of 4.

How steers entered the squeeze chute was scored as entry speed: 1 = walk, 2 = trot, 3 = run or gallop under this method (Baszczak et al., 2006). Improper squeeze chute capture was not deliberately applied as an experimental treatment.

Table 1. Chute temperament Score.

Score	Description
1	Calm – no movement
2	Restless shifting
3	Squirming, occasional shaking of weigh box or chute
4	Continuous vigorous movement and shaking of weigh box or chute
5	Behaviors included in level 4 plus rearing, twisting, or violently struggling

Behavior scores used to describe behavior of steers while restrained in squeeze chute after head gate capture and restraint. Temperament scores collapsed into two categories for comparison. Low denoted steers scored 1 or 2 on original scale; High denoted steers scored ≥ 3 on original scale.

However, it was observed to occur at such a great frequency that it warranted collection of data and inclusion in the analysis. Squeeze chute capture (CAP) was scored for each steer on a 2 point scale (0 = correct capture; 1 = incorrect capture). Incorrect capture was scored if the head gate was accidentally closed against the eyes or jaws of steers.

Vocalization

Vocalization (VOC) was recorded for each steer (on a yes/no basis), from the time they entered the chute, until procedures began, using methods previously described (BQA, 2009; Grandin, 1998). This was in an effort to separate vocalization as a commentary on handling (Watts and Stookey, 2000), or aversive methods of restraint (Grandin, 2003) from vocalization related to aversive or distressful procedures (Schwartzkopf-Genswein et al., 1997).

Chute temperament

Weights were recorded for each steer while they were restrained in a silencer (Moly Manufacturing; Lorraine, KS) hydraulic squeeze chute. During restraint, a chute score (TEMP) was assigned, using a 5 point scale (Grandin, 1993) to categorize temperament of cattle during restraint (Tulloh, 1961) (Table 1). Under this system, cattle were categorized as follows: 1 = calm – no movement; 2 = restless shifting; 3 = squirming, occasional shaking of weigh box or chute; 4 = continuous vigorous movement and shaking of weigh box or chute; 5 = behaviors included in level 4 plus rearing, twisting, or violently struggling. These temperament scores were then collapsed into two categories for analysis; scores of 3 and above on the original scale were ranked as high (HIGH) and scores of 1 or 2 were ranked as low (LOW).

Squeeze chute release

After vaccinations and other routine procedures were completed by feed yard employees; steers were released from the squeeze chute under one of two randomized conditions. Under the first condition (NORM), the handler operating the squeeze chute released each steer at his discretion in the normal fashion.

Under the second condition, a delay was imposed for the purpose of allowing cattle to stop struggling before release. This procedure was based on the hypothesis that if steers were released after they stopped struggling, they would exit the squeeze chute more slowly and be less likely to slip and fall (Stookey and Watts,

2014). Within pen, individual steers were randomly assigned to one of the two conditions of release from the squeeze chute. The first condition was a delay that lasted a maximum of 30 s following the completion of procedures (DELAY). The second condition was released immediately following the completion of procedures (NORM).

Exit speed and behavior

When steers were released from the chute, exit speed (EXS) was recorded as: 1 = walk; 2 = trot; and 3 = run or gallop (Vetters et al., 2013). The observer documented gait and additional behaviors (stumble, rear, jump, fall) for 7 to 8 m past the squeeze chute. Exit behavior (EXB) was scored on a 5-point scale (Table 3). These behaviors were collapsed into two categories with cattle classified as high or low on a reactivity scale (LOW = no behaviors other than exit speed, [EXBL]; HIGH = stumble, rear, jump [EXBH]).

The handlers were assisted by a single researcher when they returned the steers to their home pens. The same single person assigned all behavior and temperament scores for the duration of this study in order to eliminate one potential source of variation that might arise from more than one individual assigning scores.

Statistical analysis

A two-way analysis of variance was performed using the MIXED procedure in SAS (SAS Inst. Inc., Cary, NC, 2014). An interaction was observed between the group factor (TRT1) and the individual factor (TRT2). However, TRT2 was not significant ($P = 0.41$, $\alpha = 0.05$) and was removed from the model, and effects of TRT1 were evaluated. Paired t-tests were then performed to further investigate the effect of TRT1 on behavior and ADG by comparing mean behavior scores and mean ADG of the two groups.

Paired t-tests were used to compare mean behavior scores (TEMP, VOC, EXS, and EXB), CAP, and ADG for cattle by group for the TRT1 conditions (FAST, SLOW) and for the TRT2 conditions (NORM, DELAY). Also, mean behavior scores were compared for cattle by group for the CAP conditions.

Exit speed (EXS) in the form of gait scores obtained during routine handling were collapsed into two categories (SLOW = walk and trot; FAST = run) to create a simple discrete variable for exit speed analysis (Table 2). Likewise, chute temperament scores (TEMP) were collapsed into two categories for analysis (HIGH denotes steers that scored 3 and above on the original scale; LOW denotes steers that scored 1 or 2 on the original scale).

Paired t-tests were used to compare mean ADG for cattle in the SLOW vs. FAST groups and to compare mean ADG for cattle that

Table 2. Exit gait scores.

Score	Description
1	Walk
2	Trot
3	Run or Gallop

Exit gait scores were assigned to each steer based on the gait at which they exited the squeeze chute.

Table 3. Description of behaviors displayed on exit from the squeeze chute.

Score	Behavior	Description
N	Normal	Walk, trot, or run only
S	Stumble	Lower leg contacts ground
R	Rear	Front end elevated, both front feet leave ground
J	Jump	Rearing, and both hind feet leave ground
F	Fall	Body (belly, torso, etc.) contacts ground

vocalized vs. those that did not. Pearson's correlations were calculated for TEMP, VOC, EXS, EXB, NORM, DELAY, SLOW, and FAST using the CORR procedure of SAS (SAS Inst. Inc., Cary, NC, 2014) to determine the relationships between handling, behavior, and ADG. Unless otherwise stated, all p-values were reported at a significance level of $\alpha=0.05$.

RESULTS AND DISCUSSION

Cattle exiting in the chute at a walk or trot vs. a run tended to have higher ($P=0.08$) ADG. Cattle that vocalized during restraint had lower ($P=0.04$) ADG than those that did not vocalize. A higher rate of vocalization occurred in the FAST group when compared with the SLOW group. There was a significant, positive correlation between exit speed and vocalization ($P=0.0021$, $r=0.14256$), and a significant, negative correlation between exit speed and ADG ($P=0.0036$, $r=-0.13542$). Using this approach, handling was correlated with behavior and ADG.

Squeeze chute capture

A high rate of accidental improper capture (where the head gate closed on the jaw or eyes of the steer) was observed during routine handling. This improper capture (CAPP) was observed to occur 39.9% of the time during working cattle. In some cases, the head gate was closed improperly on a steer as many as 4 times, and 15.2% of steers experienced forceful closure of the head gate on their head 2 or more times.

Steers that experienced improper CAP had numerically

lighter body weights (mean weight 324.4 kg vs. 327.9 kg) than steers that experienced proper CAP. The speed at which cattle enter the squeeze chute can influence a handler's ability to capture and restrain them properly, and this entry speed may be determined by temperament as well as body weight. Improper CAP was significantly correlated ($P<0.01$) with lower ADG, faster EXS, and increased VOC; but was not correlated with TEMP ($P=0.34$).

Improper capture (either where the head gate is closed on the body or the head) may be related to the speed and force at which the steer enters the chute, or to the experience or training level of the handler operating the chute. A possible explanation for the high rate of improper CAP observed in this study may be the amount of squeeze that the handler operating the squeeze chute used.

The handler used the squeeze to SLOW the cattle down when entering the squeeze chute, in a reported effort to reduce injuries to the shoulders. During the observation period, it was difficult for many cattle to fully advance in the squeeze chute, because of the amount of squeeze and because they could not advance freely, the head gate was closed on their heads.

Vocalization

Vocalization scores were compared by CAP method and steers with correct CAP vocalized less than steers with incorrect CAP (23.4% vs. 33.5%; $P<0.01$). Cattle may vocalize for a number of reasons, which include painful experiences, such as hot iron branding (Watts and Stookey, 1999; Schwartzgopf-Genswein et al., 1997),

isolation (Watts and Stookey, 2001), excessive pressure from a neck restraint (Bourguet et al., 2011; Schwartzkopf-Genswein et al., 1997), or fear. The higher rate of vocalization observed among steers with incorrect CAP supports earlier findings that vocalization is associated with a painful event (Grandin, 1998; Watts and Stookey, 1999). Handlers operating the squeeze chute should receive additional training to reduce the percentage of improper captures.

Chute temperament scores

Chute temperament scores were assigned to each steer and these scores were collapsed into HIGH and LOW categories. Under this ranking system, 21.6% were ranked as HIGH and 78.4% of steers were ranked as LOW. A majority of cattle observed had LOW temperament ratings, which may be partly due to producers selecting for cattle with calmer temperament. Differences in temperament between different cattle breeds also exist (Baszczak et al., 2006). The cattle in this study were a single breed with similar genetics, which reduced variability in temperament. A greater rate of correct CAP was observed for the LOW group when compared with the HIGH group (79.6% vs. 20.4%, respectively).

Calmer cattle may enter the squeeze chute more slowly, which may make it easier for the handler to achieve proper CAP. However, in this study, TEMP was not correlated with CAP. A possible explanation for this result is that CAP occurred before TEMP scores were assigned, and improper catches, if painful in nature, could have exaggerated TEMP scores.

Another explanation might be that the hydraulic squeeze used in this study held the cattle tightly enough to prevent full expression of agitated behavior. When a hydraulic chute is used, exit speed scoring is more effective for determining differences in cattle temperament (Baszczak et al., 2006). In studies where chute was effective in determining behavioral differences, the animals were held more loosely in either a manually squeeze chute or a single animal scale (Benhajali-et al., 2010; Voisinet et al., 1997).

Squeeze chute release

Release method had no significant effect on behavior as the exit of the squeeze chute. A possible reason that there were no significant differences in the number of steers that slipped and fell is that a large, customized woven rubber tire mat (Double D Family Mat Shop, Park, KS) was installed at the exit of the squeeze chute. This mat extended roughly 5 m from the exit of the squeeze chute into the alley. The length of the mat provided enough space for each foot to make contact with the mat

a minimum of one time. It is likely that the presence of this rubber mat greatly reduced the number of slips and falls.

Exit speed

All the factors that affected the speed at which cattle exited the squeeze chute remained largely unexplained, though temperament and previous experiences with handling affected exit speed.

Aversive procedures that occur during restraint may also affect this behavior. When exit speed (EXS) of steers was compared by capture method, fewer steers ($P \leq 0.01$) ran from the squeeze chute after correct CAP compared with incorrect CAP (53.9% vs. 65.4%), which further suggests that improper CAP is an aversive event that may heighten the flight response. Cattle exiting the chute faster have lower ADG (Vetters et al., 2013), and this emphasizes the importance of proper handling during routine events.

Exit behavior

Scores from the original 5 point exit behavior scale were collapsed into two categories for analysis, with HIGH used to denote steers that performed any behavior or combination of the behaviors on the original scale (stumble, rear, jump, fall), and LOW used to denote steers that did not perform any of the behaviors listed earlier.

During routine handling, steers were ranked as having LOW (58.7%) or HIGH (41.3%) behavior scores (EXB) when they exited the squeeze chute. More HIGH scores were recorded for steers with incorrect CAP when compared with those with correct CAP ($P \leq 0.01$). When comparing the EXS and EXB of cattle, it may be useful to consider these behaviors in a cumulative effect. There is a lack of published research about EXB of feed yard cattle, though Vetters et al. (2013) reported that jump is not continuous with walk, trot, and run for EXS. It is likely that cattle that exhibit behaviors in addition to EXS may be signaling greater agitation, and are exhibiting a heightened flight response.

High EXS has been negatively correlated to ADG. Running while exiting may be a display of greater agitation, and this shows the importance of proper handling. The addition of EXB to EXS may have potential for modeling cumulative effects of agitation on ADG.

Conclusions

Cattle that vocalized during restraint in the squeeze chute had lower ADG than those that did not vocalize. When

steers were brought from home pens to the processing area by handlers who moved at a walk, there was a trend towards less vocalization. Steers that exited more quickly from the squeeze chute were also more likely to vocalize during restraint. This shows that vocalization may be a possible indicator of handling problems in the squeeze chute.

Steers captured incorrectly vocalized more; exited the chute faster; and displayed more behaviors of agitation such as rearing or jumping when exiting the squeeze chute. Agitated behavior during restraint has been shown to have lower both weight gain and beef quality, including an increased instance of dark cutters. Collectively or as additive factors, it is reasonable to consider that there is an additive negative effect on cattle performance as well. The reductions in ADG that resulted from a single aversive handling event in this study demonstrated the importance of correct capture method (CAP).

The potential exists that there may be a long-term cumulative impact due to aversive events, such as improper capture. Both proper and improper CAP needs to be investigated using both quantitative (serum glucose and cortisol; feed intake) and qualitative measures (TEMP, EXS, EXB). This may show the impact of handling practices on performance of feed yard cattle. Finally, the addition of EXB to EXS may have the potential for modeling cumulative effects of agitation on ADG. This may warrant further investigation under more controlled conditions, such as a feed intake unit. Because reductions in ADG have been demonstrated to occur as the result of a single aversive event, this emphasizes the importance of focusing even greater care and attention on each and every handling event to ensure optimal performance and welfare for cattle throughout the duration of the finishing period.

Conflict of Interests

The authors have not declared any conflict of interests.

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