Correlations between behavior in corrals and the bullring in Lidia breed bulls

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Abstract:

The value of fighting bulls (Lidia breed) is quantified based on their behavior in the bullring. Predicting this behavior is challenging because the heritability of behavior patterns is unknown and their interpretation subjective. An analysis was done of the possible relationship between bull behavior during pre-bullfight handling (unloading, first and second veterinary examinations) and during the bullfight. Behavioral parameter data was recorded for 200 adult bulls during pre-bullfight handling and the bullfight. Among the six genetic lines in the sample, the Santa Coloma and Albaserrada lines exhibited the highest values for mobility, aggressiveness, respiratory rate, and fight rate. Correlations were identified between some behaviors in pre-bullfight handling and others during the bullfight. Mobility during unloading and the first examination was positively correlated with Exit speed in the opening, Focus on *banderillero* (lancer on foot) in the second period of the bullfight and Determination in the third period. In contrast, aggressiveness

during unloading was negatively correlated with mobility parameters during the second and third periods. No differences between animals were observed during the second examination, indicating that bulls quickly adapted to the corrals. The results suggest that some aspects of bull behavior prior to the bullfight can provide valuable information to bullfighters and breeders.

Introduction

The breed of cattle bred for bullfighting is known as Lidia. It is the only breed exploited for its ethological performance. Since the 18th Century, individuals have been selected based on behavioral traits observed during what is known as a *tienta*, a test of aggressiveness[1]. Because it has been a genetic improvement process carried out at the herd level, it has produced multiple genetic lines characterized by phenotypic[2] and ethological[3] traits that are both stable and defined[4]. The resulting bulls are raised for four to five years to fight in the bullring for approximately fifteen minutes[5]. The goal of selection is to produce bulls deemed apt for bullfights, which exhibit behavior broadly termed *bravura* (implying both ferocity and bravery). However, defining ideal behavior for a fighting bull is extremely difficult and highly subjective[6-7].

To produce bulls with the desired *bravura*, breeders keep exhaustive records of behavior in breeding animals during the *tienta*, and of bulls during bullfights[8]. This is a complex task that does not necessarily produce high heritability of the desired traits[9]. One challenge in attaining trait heritability is defining what the desired behavioral traits are. Many authors have tried to objectively describe the desired behavioral traits in fighting bulls by defining the ethological patterns, positive or negative, defining the opposing qualities of *bravura* and meekness[10-14]. Some have devised ethological assessment methods based on the frequency of behavioral patterns. For example, there is a fighting bull rating table[15], a bull aptitude test[16], and bull evaluation sheets[17,18]. In addition, a computer program and ethological assessment methodology[19] have been implemented[20-22]. These studies focus on quantifying or evaluating bull behavior, be it during the *tienta* or a bullfight. The intent is to select breeding animals or verify bull performance during bullfights.

A bull's behavior during pre-bullfight handling (transport, unloading and stabling) may reflect the ethological traits it will exhibit during the bullfight. If this hypothesis holds true, observing bull behavior prior to a bullfight could provide valuable information on its potential behavior in the ring. This would be merely predictive since the performance of the bullfighters and the variables in each bullfight also strongly influence on a bull's behavior. This connection has been suggested previously[16], but without scientific analysis to support the argument. The present study objective was to analyze bull behavior during pre-bullfight handling in an effort to begin defining ethological guidelines that could predict bull behavior in the bullring.

Material and methods

Data were collected for two hundred animals which fought at bullrings in the cities of Valencia and Madrid, Spain. All animals were between three and five years of age. They came from 17 herds, and belonged to 6 different lines of the Lidia breed.

Pre-bullfight handling did not differ, following a standard procedure. This begins with transport to the bullring three days before the bullfight where the bulls are unloaded individually into a small pen (approx. 150 m²), and cooled with water until they have calmed down. They are then moved through a narrow corridor to a scale, where they are weighed individually, and into a larger corral (approx. 300 m²). Here they have an initial veterinary examination. The bulls remain together in the corral for 48 h. On the day of the bullfight, they are moved individually into another (approx. 300 m²) corral where they have a second, and final, veterinary examination.

Bull behavior during the pre-bullfight handling process was documented on a form by three veterinarians who agreed on the evaluation before recording it. Behavior was assessed at four stages in the process: unloading (1); first veterinary examination (2); second veterinary examination (3); and during time in corrals (4).

At stages 1, 2 and 3, mobility, aggressiveness and respiratory rate were assessed using a three-point scale (1= low, 2= intermediate, and 3= high). At stage 4, once all the animals were in the same corral, two types of collective behavior were assessed: nervousness, (1-calm, 2-vigilant, 3-nervous) and fight rate (1-infrequent, 2-moderate, 3-frequent).

Video recordings were taken of each animal's bullfight and later evaluated by the same person, with experience in ethological assessment. The software and methodology described by Sánchez et al[19], and validated by Alonso et al[23-25], were used. This allows evaluation of an animal's behavior during each of the bullfight's three periods (known as *tercios*). During each *tercio*, a total of 21 behavioral variables (see below) were graded

on a five-point scale and recorded in an independent spreadsheet file, along with the duration of each *tercio*.

1. Exit speed (rapisal). The speed at which the bull runs through the door into the ring. 0= animal exits walking and stops in corridor. 5= animal exits at a run.

2. Stops at door (parapu). If the bull stops when it steps onto the sand. 0= animal maintains exit speed when stepping onto sand. 5 = animal stops.

3. Ring circuit (recorre). If the bull moves around the ring before being stopped by the first flourishes of a cape. 0= animal remains standing at some point in the bullring. 5= animal makes one or more circuits.

4. Distance at start of charge (acudlar). Distance at which the bull begins to charge when first provoked. 0= animal only charges when a bullfighter is very close. 5= animal charges at any distance, no matter distance to the bullfighter.

5. Attacks shields (remata). If bull gores or hits shield behind which bullfighter shelters. 0= under no circumstances does animal attack shield. 5= animal attacks shields every time it gets near them during initial lancing.

6. Head height vis-a-vis horse (humillacab). Estimated height at which bull places horns on horse's body. 0= animal raises horns towards lancer. 5= animal places horns on lower portion of protective armor or on horse's abdomen.

7. Push. Extent to which, once it has made contact, the bull uses its dorsal muscles and hind quarters to push the horse. 0= animal does not push at all, remains static or leans slightly into horse. 5= animal uses dorsals and hind legs in attempt to displace horse.

8. Goring. If bull gores horse's protective armor and to what extent. 0= animal firmly pushes against armor, without changing from point of initial contact. 5= animal insistently gores armor, and even tries to detach the lance.

9. Release (suelto). If animal releases or disengages from horse after feeling pain from the lance, and runs away from horse without bullfighters challenging it. 0= animal remains with horse and does not escape, requires challenge. 5= animal disengages and quickly runs away after feeling pain from lance.

10. Response to pain (crecedol). Extent to which the bull, upon feeling pain, increases its force and aggressivity against the horse. 0= animal decreases aggressivity in response to pain. 5= animal attacks more decisively after lancer's aggression.

11. Distance to *banderillero* (largoban). The distance from which the bull charges the *banderillero* (lancer on foot) when called. 0= animal waits until *banderillero* is very close. 5= animal charges before being called on all three attempts.

12. Focus on *banderillero* (fijoban). Extent to which animal focuses on *banderillero* or is distracted. 0= animal is constantly distracted by the crowd and other bullfighters. 5= animal focuses on *banderillero* from the first call until the lancing ends.

13. Follows *banderillero* (sigueban). The tenacity with which the bull follows the *banderillero* once the darts have been anchored in its back. 0= animal stands still after encounter. 5= animal insistently follows *banderillero*, normally until he takes cover behind a shield.

14. Gallop. Frequency with which bull gallops. 0= animal never gallops. 5= animal is constantly galloping.

15. Distance of charge at *muleta* (largomu). Distance from which bull begins charge at *muleta* (cape supported with stave). 0= animal does not charge until *muleta* is very close. 5= animal begins charge from large distance when given the option.

16. Head height vis-a-vis *muleta* (humillamu). Head height of bull when charging *muleta*. 0= animal keeps head high from beginning to end of charge. 5= animal lowers head when beginning charge and keeps it low until finishing.

17. Determination (codicia). The passes in each "set" of charges at the *muleta* can continue without pause after each one. This is frequently the case at the beginning of the third *tercio*, but can decrease as it progresses. 0= animal stops after each set. 5= animal does not pause between passes in all sets.

18. Delay (tardea). Number of calls or challenges required for bull to charge. 0= animal charges the moment cape is shown. 5= animal requires repeated calls, on each pass, before charging.

19. Charge area (embiste). The third *tercio* occurs in an area chosen by the bullfighter or one preferred by the bull. 0= encounters must happen in area preferred by animal, usually near the shields or the exit to the corrals. 5= animal exhibits no preference.

20. Focus on *muleta* (fijomul). Extent to which bull remains focused on *muleta*. 0= animal looks at the bullfighter or the crowd, is constantly distracted. 5= animal remains focused on *muleta* at all times.

21. Runs away from *muleta* (huyemul). Extent to which bull runs away from muleta, in search of an exit, after first charges. 0= animal exhibits no intent to avoid muleta. 5= animal constantly runs away, making it impossible to complete passes.

Results for all the variables described above were expressed as a mean with standard deviation. A one-way ANOVA was applied to identify any effect of genetic line or moment of observation (unloading, first examination, second examination) on the ethological variables documented pre-bullfight. If a factor of variation had two levels and was statistically significant ($P \leq 0.05$), a Student-Newman-Keuls test ($P \leq 0.05$) was run *a posteriori* to compare groups of homogeneous means. Any possible linear relationships between the ethological variables documented in the corrals and those documented during the bullfight were identified with a Pearson's linear correlation test. All statistical analyses were run with the IBM® SPSS® ver. 19.0 software program[26].

Results

Analysis (ANOVA, Student-Newman-Keuls) of the ethological values collected during pre-bullfight handling indicated that animal attitude, represented by mobility, aggressiveness and respiratory rate, exhibited no changes during unloading and the first examination, which take place on the same day and consecutively. Aggressiveness and respiratory rate decreased significantly in the second examination (Figure 1).

Figure 1: Ethological values (means) during unloading and two veterinary examinations
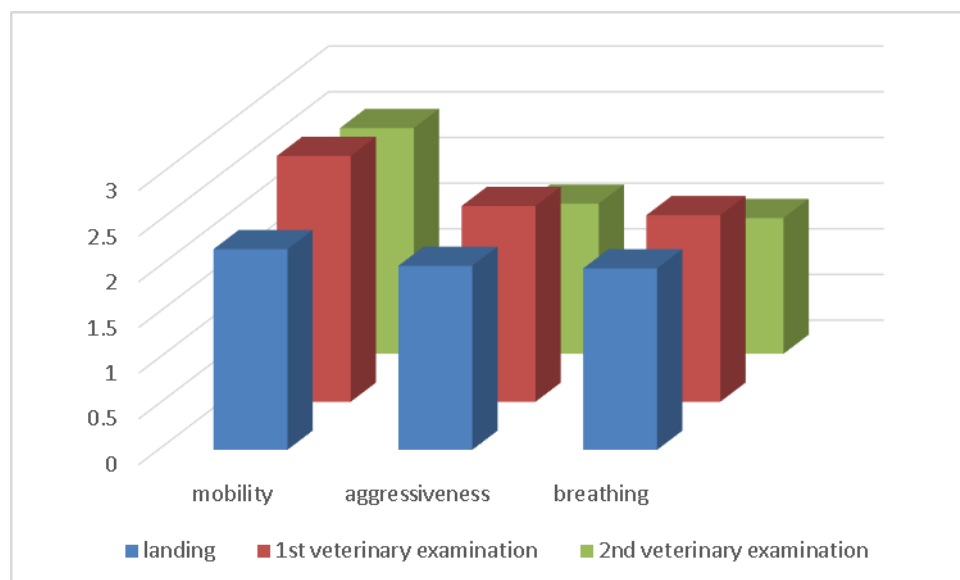
ab Different letters over columns in the same stages indicate significant difference ($P<0.05$).

Analysis of bull behavior by genetic origin (line) identified differences between them during pre-bullfight handling (Table 1), but not during the bullfight. In the corrals, the Santa Coloma and Albaserrada lines exhibited the highest values for mobility,

aggressiveness and respiratory rate, especially at unloading and first examination. Values for the nervousness variable were highest in Santa Coloma in the corrals, and highest in Albaserrada and Santa Coloma animals during the bullfight ($P<0.05$).

The Pearson's linear correlation analysis identified multiple significant correlations (Tables 2, 3, 4, 5 and 6). Results have been simplified by grouping the results from the unloading and first examination stages since their means did not differ (Figure 1).

Table 1: Ethological parameter values (mean) by genetic line during pre-bullfight handling

Line	n	Unloading			1st Exam			2nd Exam			Corrals	
		Mobi	Agre	Resp	Mobi	Agre	Resp	Mobi	Agre	Resp	Nerv	Fight
Murube	18	1.55[a]	1.13[a]	1.23[a]	1.76[a]	1.02[a]	1.21[a]	1.46[a]	1.09[a]	1.24[a]	1.24[a]	1.08[a]
Núñez	24	2.27[b]	1.26[a]	1.58[a]	2.17[a]	1.41[a]	1.59[ab]	2.25[b]	1.53[a]	1.01[a]	1.27[a]	1.02[a]
Domecq	100	2.35[b]	1.44[a]	1.30[a]	1.96[a]	2.02[a]	1.80[b]	1.84[ab]	1.48[a]	1.53[a]	1.28[a]	1.35[a]
Atanasio	22	1.92[ab]	1.87[a]	1.83[a]	1.55[a]	1.70[a]	1.83[b]	2.20[b]	1.23[a]	1.25[a]	1.22[a]	1.38[a]
Albaserrada	18	2.64[c]	2.91[b]	2.83[b]	2.52[b]	2.53[b]	2.58[c]	2.3[b]	2.88[b]	1.53[a]	1.51[a]	2.20[b]
Santa Coloma	18	2.55[c]	2.88[b]	2.54[b]	2.53[b]	2.01[a]	2.77[c]	2.74[c]	2.29[ab]	1.81[a]	2.43[b]	2.76[b]
Total	200	2.20	2.01	1.82	2.41	2.14	1.94	2.34	1.74	1.39	1.59	1.79

Mobi= mobility; Agre= aggressiveness; Resp= respiration rate; Nerv= nervousness; Fight= fight rate.

[ab] Different letter superscripts in the same column indicate significant difference ($P<0.05$).

Table 2: Pearson's linear correlation analysis between bull ethological parameters recorded during pre-bullfight handling and during the opening of the bullfight

| | | OPENING | | | | |
		Rapisal	**Parapu**	**Recorre**	**Acudlar**	**Remata**
Unloading	Mobi	0.34*	0.12	0.09	0.12	-0.03
	Agre	0.13	-0.07	0.15	0.01	0.27*
	Resp	0.08	0.04	-0.07	-0.02	0.12
Examination	Mobi	0.03	0.03	-0.06	0.11	0.05
	Agre	0.11	0.02	0.09	0.06	0.00
	Resp	0.17	0.08	0.03	0.11	0.05
Corrals	Nerv	0.14	-0.07	0.12	0.19	0.04
	Fight	0.04	0.08	0.03	-0.18	0.03

Rapisal= Exit speed; Parapu= Stops at door; Recorre= Ring circuit; Acudlar= Distance start of charge; Remata= Attacks shield; Mobi= Mobility; Agre= Aggressiveness; Resp= Respiration Rate; Nerv= Nervousness; Figh = Fight rate.
* ($P<0.05$).

Table 3: Pearson's linear correlation analysis between bull ethological parameters recorded during pre-bullfight handling and during the first *tercio* (*varas*) of the bullfight

| | | VARAS | | | | |
		Humillacab	**Empuja**	**Cabecea**	**Suelto**	**Crecedol**
Unloading	Mobi	0.14	0.05	-0.09	0.06	0.00
	Agre	0.12	-0.04	0.03	-0.16	0.10
	Resp	-0.07	0.16	0.10	0.08	0.01
Examination	Mobi	0.08	0.12	-0.05	0.12	0.07
	Agre	0.03	-0.06	0.15	0.08	0.12
	Resp	0.09	0.19	0.01	0.16	0.18
Corrals	Nerv	0.17	0.13	0.06	0.11	-0.11
	Fight	0.08	-0.17	0.12	-0.03	-0.18

Humillacab= Head height vis-a-vis horse; Empuja= Push; Cabecea= Goring; Suelto= Release; Crecedol= Response to pain; Mobi= Mobility; Agre= Aggressiveness; Resp= Respiration Rate; Nerv= Nervousness; Fight= Fight rate.
* ($P<0.05$).

Table 4: Pearson's linear correlation analysis between bull ethological parameters recorded during pre-bullfight handling and during the second *tercio* (*banderillas*) of the bullfight

| | | BANDERILLAS | | | |
		Largoban	Fijoban	Sigueban	Galopa
Unloading	Mobi	0.58*	0.05	0.12	0.09
	Agre	-0.22*	0.01	-0.21*	-0.41*
	Resp	0.12	0.06	0.17	0.10
Examination	Mobi	0.18	0.02	-0.01	0.21*
	Agre	-0.03	0.11	0.11	0.05
	Resp	0.1	-0.07	-0.02	0.01
Corrals	Nerv	0.17	-0.11	0.16	0.17
	Fight	-0.05	0.05	0.09	-0.07

Largoban = Distance to *banderillero*; Fijoban = Focus on *banderillero*; Sigueban = Follows *banderillero*; Galopa = Gallops; Mobi = Mobility; Agre = Aggressiveness; Resp = Respiration Rate; Nerv = Nervousness; Fight = Fight rate.

* ($P<0.05$).

Table 5: Pearson's linear correlation analysis between bull ethological parameters recorded during pre-bullfight handling and during the third *tercio* (*muleta*) of the bullfight

| | | MULETA | | | | | | |
		Largomu	Humillamul	Codicia	Tardea	Embiste	Fijomul	Huyemul
UL	Mobi	0.11	0.19	0.11	-0.19	**0.29***	-0.04	-0.15
	Agre	**-0.31***	0.08	0.17	-0.13	0.16	0.13	0.02
	Resp	-0.03	0.06	-0.08	0.14	0.07	0.17	0.19
EX	Mobi	0.03	-0.07	0.16	-0.17	0.12	-0.00	-0.11
	Agre	0.07	0.11	-0.10	**0.45***	0.08	0.16	0.02
	Resp	0.00	-0.19	-0.18	0.07	0.18	0.04	0.17
COR	Nerv	0.11	0.14	**-0.27***	0.04	0.07	0.13	-0.12
	Fight	0.08	-0.14	-0.12	0.01	-0.09	0.15	0.04

Largomu = Distance of charge at *muleta*; Humillamul = Head height vis-à-vis *muleta*; Codicia = Determination; Tardea = Delay; Embiste = Charge area; Fijomul = Focus on *muleta*; Huyemul = Runs from *muleta*; UL = Unloading; EX = Examination; COR = Corrals; Mobility; Agre = Aggressiveness; Resp = Respiration Rate; Nerv = Nervousness; Fight = Fight rate.

* ($P<0.05$).

In the pre-bullfight handling results, the most valuable information in terms of predicting animal behavior during the bullfight is that for unloading and first examination. At this time, the animal is in a state of stress after transport, which brings out its intrinsic characteristics of mobility and aggressiveness. In the opening of the bullfight, mobility during unloading and first examination positively correlated to the parameter "Exit speed", as well as to "Distance to *banderillero*" in the second *tercio* (*banderillas*) and "Charge area" during the third *tercio* (*muleta*). In contrast, the ethological parameter values for the second examination were not strongly predictive of animal behavior during

the bullfight. However, the mobility parameter in this stage positively correlated with the "Gallops" parameter in the second *tercio*, a reflection of good physical condition in the corrals and the bullring. Also, the aggressiveness parameter in the second examination positively correlated with the "Delay" parameter in the third *tercio*.

Discussion

Research done in production animal management facilities to assess animal stress in response to transport to the slaughterhouse indicates that animals adapt to their new surroundings within a few hours[27-29]. This agrees with the present results in which bull aggressiveness and respiratory rate values were significantly lower at the second examination after they had adapted to the corrals for two days, which coincides with previous reports[30].

In the pre-bullfight stages, bulls of the Santa Coloma and Albaserrada lines exhibited the highest mobility, aggressiveness and respiratory rate values during unloading and first examination. This coincides with genetic studies of the Lidia breed which state that this difference in behavior has resulted from selection focused on more temperamental or fierce behavior[17,31], which has raised consanguinity rates in these lines[32]. The literature addressing the characteristics of the Lidia lines also indicates that the Santa Coloma and Albaserrada lines have a different capacity to adapt to the stress of transport and corralling[12,33]. Bulls from these lines also exhibit distinct behavior during the bullfight[27].

Aggressive behavior during unloading and the first veterinary examination is common in domestic animals, and even more so in those raised in extensive systems. In the Lidia breed, the lack of space in the corrals generates greater aggressiveness between individuals[34]. The present results showed a positive correlation between aggressiveness in the pre-bullfight stages and the ethological parameter "Attacks shield" during the bullfight. However, it exhibited a negative correlation with the parameters "Distance to *banderillero*", "Follows *banderillero*" and "Gallops" in the second *tercio* (*banderillas*), and with "Distance of charge at *muleta*" in the third *tercio* (*muleta*). A bull's aggressiveness in the corrals was apparently linked to its entrance into the ring and goring of the shields, which, in principle, would result from breed line and *bravura*. But the multiple negative correlations suggest that the most aggressive individuals during pre-bullfight handling did not perform well in the bullfight; indeed, they tended to be meeker as shown in their lack of mobility and zeal during both the second and third *tercios*.

As suggested in a previous study, bulls exhibiting greater aggressiveness during pre-bullfight handling may be experiencing greater stress, preventing them from resting adequately and resulting in their being less aggressive during the bullfight[35]. Perhaps the animals included in the present study that were more aggressive in the corrals were more stressed. They expended energy during pre-bullfight handling and were therefore more tired during the bullfight itself. This is supported by the negative correlation between nervousness in the corrals and lower "Determination" values during the third *tercio*. Animals exhibiting nervousness and aggressiveness in the corrals may be badly adapted to handling, undermining their physical condition and causing them to perform below expectations during the bullfight. Considering this, a bull's pre-bullfight behavior may affect its physical performance, pushing any correlation between ethologies into the background.

Respiratory frequency showed no correlation with the analyzed ethological parameters, although its relationship to animal physical condition during the bullfight, indicated by time in motion in the ring[35-36], is worth further study.

Conclusions and implications

No previous data, be it published or personal testimony from breeders, is available on bull behavior in the field or during pre-bullfight handling[37-38]. The present results suggest some correlation between certain ethological patterns during pre-bullfight handling and behavior during the bullfight. Broader studies including analyses of bull behavior in the field and prior to the bullfight could continue to improve predictability of behavior in the ring.

Acknowledgements

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