# Flight distance and reaction to fawn handling are greater in high- than in low-ranked pampas deer (Ozotoceros bezoarticus) females

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## Abstract

*The flight distance from humans and the reaction of the mother to human handling of their offspring are measures that can be used to assess the quality of the human-animal relationship which could vary according to animals' position in a group. The objective was to determine if the flight distance and the mother's reaction to human handling of her fawn during the first 24 h after birth differ according to pampas deer (Ozotoceros bezoarticus) hinds' social rank. A complementary aim was to compare the mothers' reaction to their fawns being handled relative to its sex. Studies were carried out on a semi-captive population. Animals were classed as high- or low-ranking individuals according to agonistic interactions between hinds recorded during autumn (breeding season) while animals received rations. In the first part of the study, the flight distance was determined in high- and low-ranked hinds. In the second, the minimum distance that the mother stayed from her fawn was recorded while the fawn was weighed and sexed during the first 24 h after birth, and the latency period for the dam to return with her fawn was also recorded. High-ranked hinds presented greater flight distance than low-ranked hinds. High-ranked hinds kept a greater distance from their fawns compared to low-ranked hinds and more high- than low-ranked hinds remained at a farther distance. In summary, high-ranked hinds seem to perceive humans as a greater threat, and thus be more fearful of them. The sex of the fawn did not affect the hinds' reaction to human handling.*

**Keywords**: *animal-human relationship, animal welfare, cervid, dominance, hierarchy, maternal behaviour*

## Introduction

Animal welfare may be affected by the quality of human-animal relationship (Waiblinger *et al* 2006). It is therefore important to study how this relationship affects the captive management of each species according to its needs, especially in endangered species bred *ex situ*. Hence, an understanding of how animals in continuous contact with humans perceive them — the extent to which each animal considers human presence dangerous — is an important component of animals' individual welfare. How animals react to humans impacts upon their physiology and behaviour (cows [*Bos taurus*]: Hemsworth 2003; Indian Gaur [*Bos gaurus gaurus*]: Sekar *et al* 2008; antelopes [*Antelope cervicapra L*]: Rajagopal *et al* 2011); effects that are probably even more pronounced in wild compared to domestic animals (for a review, see Claxton 2011). For example, stressful human management induces behavioural reactions in red deer (*Cervus elaphus*) (Bartosova *et al* 2014). Moreover, the ability to adapt to the presence of people and frequent handling should be considered an important fitness-determining factor in wild animals managed in captivity (Price 1999).

Most ruminants, including deer, live in hierarchical groups. Hierarchies are maintained through agonistic interactions that imply threat and submission (Lynch *et al* 1992), resulting in a dominant individual (the winner) and a submissive individual (the loser) (Drews 1993). Dominance relationships determine unequal access to resources, such as food (Ceacero *et al* 2012), water (Andersson *et al* 1984), lying space (Andersen & Bøe 2007), or shade (Sherwin & Johnson 1987), and is positively related to mate acquisition (Willisch & Nehaus 2010) and, thus, to lifetime fitness (Wilson *et al* 2011). The differing access to resources also has direct consequences on animal physiology and metabolism (Turbill *et al* 2013). The consequences of hierarchical relationships may be even greater for captive compared to free animals, as the former are unable to control their social environments (Price 1999), which may also affect their relationship with humans. For example, even in domestic animals, such as cattle, social management may affect aggression toward humans (Price & Wallach 1990).

Flight distance from humans is a method of assessing the quality of the human-animal relationship in domestic ruminants (Waiblinger *et al* 2006). This is an objective test used to assess the animal reaction to handling and evaluate the animal in motion (Blache & Bickell 2010; Burdick *et al* 2011). However, there would appear not to have been any systematic

studies using the flight distance test in wild animals. In some domestic species, social rank influences how animals relate to humans, probably as a consequence of how different individuals perceive humans. In goats (*Capra hircus*), the relationship with the handler differs according to the social hierarchical status: high-ranked goats keep a greater distance from the handler than low-ranked animals (Miranda-de la Lama *et al* 2013). Similarly, in dairy cattle, high-ranked females react to humans, and avoid them more than low-ranked females (Beilharz & Mylrea 1963; Yunes 2001).

In small ruminants the reaction of the mother to offspring handling is used to evaluate maternal behaviour quality (Everett-Hincks *et al* 2005; Grovenburg *et al* 2009), as it reflects the investment that the mother is willing to make for her offspring. Similarly, the distance a ewe retreats from her lamb while it is tagged by a handler is used to categorise the intensity of the ewe-lamb bond (O'Connor *et al* 1985). Although this test considers the reaction of the ewe to handling of her lamb as maternal behaviour, the result may also be influenced by differences in how individual animals react to humans. High-ranked females have access to the best resources (Clutton-Brock *et al* 1982; Ceacero *et al* 2012; Turbill *et al* 2013), which may lead to them having a better physical condition than low-ranked females, and in white-tailed deer (*Odocoileus virginianus*), good physical condition in hinds favours an aggressive parental defence (Smith 1987). Therefore, hinds of differing social rank may react differently to human handling of their fawns. However, to the best of our knowledge there are no published studies relating social rank with maternal behaviour in ruminants.

The pampas deer (*Ozotoceros bezoarticus*) is a species of South American deer included in the most endangered category by CITES (CITES 2014). In Uruguay, there are two wild populations (González *et al* 2002) and one allocated at the Estación de Cría de Fauna Autóctona Cerro Pan de Azúcar (ECFA) (Ungerfeld *et al* 2008a). It is a species with hierarchical social relationships (Ungerfeld *et al* 2008b), that implies the existence of high and low social-ranked individuals (Drews 1993). As is observed in other ruminants, there are hierarchical structures whereby males dominate hinds (Freitas-de-Melo *et al* 2013), but there are also social hierarchies among hinds (Freitas-de-Melo *et al* 2013; Ungerfeld & Freitas-de-Melo 2014). Therefore, considering that the species is endangered, yet at the same time bred in captivity, it would be important to determine if individual social rank is related to the behavioural response to humans. As high-ranked females are usually assured of their social position, humans are probably perceived as dominant individuals and, thus, have greater consequence for them.

Many welfare problems, especially in wild animals, occur as a consequence of the lack of knowledge of the species' basic social behaviour (Galindo *et al* 2011). In this sense, understanding what determines individual differences in social behaviour and how animals react to humans may help to solve basic social welfare problems in captive animals. If these differences are related to social rank, keepers in close contact with these animals may readily estimate which animals are high and low ranked, and thus how close they can get to different individuals. Similarly, a knowledge of social rank can ensure hinds are disturbed less when examining hinds after birth. Overall, differences in individual behavioural responses to husbandry practices may reflect different emotional status, which may therefore imply differences in the animals' welfare as they interact with humans. Therefore, we hypothesised that high-ranked females would have a greater flight distance to humans and would stay further from humans while they manipulate their offspring than low-ranked females. Thus, the aim of this study was to determine if the flight distance and the mother's reaction to human handling of her fawn, during the first 24 h after birth, differs according to the pampas deer hinds' social rank. A complementary aim was to determine if the reaction of the hind to her fawn being handled differed according to its sex. Overall, this information may be useful to help improve the welfare of captive pampas deer females, as well as provoking similar studies in related species.

## Materials and methods

### Animals and location

Studies were carried out in the ECFA (34°3' S, 54° W). The ECFA comprises 86 ha and only native fauna are bred there. The pampas deer were maintained in breeding groups consisting of one adult male, five to seven adult hinds, and young animals, each in 0.5–1.0 ha paddocks, with abundant water, natural pasture, trees and shrubs. Each animal received approximately 600 g of ration (Molino San José, San José, Uruguay) (90% dry matter, 18% crude protein, and 30% acid detergent fibre) once a day. All animals were tagged and accustomed to the presence of humans as they had been fed and monitored daily since birth. Depending upon management and specific requirements, humans may be present in each breeding group for 10 to 40 min each day.

### Determination of social ranks

During the early breeding season (February) (Ungerfeld *et al* 2011) of each year (Study 1: 2009, Study 2: 2010–2012), all the female-female agonistic interactions resulting in displacement of an animal were recorded, in accordance with Freitas-de-Melo *et al* (2013). Focal recordings were performed on each group for 20 to 40 min (according to the observation of frequent interactions) in the morning (0800 to 1000h), and 20 to 40 min in the afternoon (1600 to 1800h), after ration was provided. Rations were provided in three containers of 100 × 45 cm (length × width) each, located in each paddock, separated approximately 2.5–3.0 m from each other, provided in three feeding stations. Recordings were performed from a minimum distance of 4–8 m from the animals. We observed — as in previous studies — that this does not disturb the normal behaviour in this species (Ungerfeld & Freitas-de-Melo 2014).

The success index (SI) for each female was calculated based on the dominance-subordinate relationships, according to Clutton-Brock *et al* (1979) as follows:

SI = number of individuals displaced/number of individuals displaced + number of individuals that displace it

For each study, the two hinds with the highest and lowest SI in each breeding group were considered as high- and low-ranked individuals.

## Study 1: Flight distance

The study was performed with 27 hinds allocated to five breeding groups (five to six hinds per breeding group). The agonistic behaviours used to calculate the SI were recorded during eight consecutive days (total = 53 h; 3,661 interactions). Therefore, flight distance was determined in ten high-ranked and ten low-ranked hinds (SI = 0.81 [± 0.06] and 0.18 [± 0.04], respectively).

The flight distance was measured once daily for eight days by the same observer between 1600 and 1800h. The observer always dressed in the same uniform, and began walking head-on to the female, once it was established that the hind was stationary, and paying attention to the observer. The observer began walking to within approximately 10 m of the hind, without looking at her, with hands kept close to the body, and with one moderate step taken per second. When the animal moved both forelimbs, the observer marked the spot she had set off from and measured the distance to the place she moved to. This was considered the flight distance. As the area was not uniform, and the distances relatively short, it was comparatively easy to identify the exact spot where the nearest point of the deer was located before moving.

## Study 2: Fawn handling

This study began the year following Study 1. Data were recorded during three consecutive years, including six breeding groups per year. As the composition of each group varied between years, the study comprised 18 different breeding groups. Social ranks were determined each year by recording all the spontaneous agonistic behaviours between hinds during ten consecutive days (total: 190 h; 7,251 interactions).

Births taking place from August to January of each year — the peak time for births (Ungerfeld *et al* 2008a) — were recorded (total: high-ranked hinds = 23; low-ranked hinds = 20). The tests were performed in 17 mother-fawn dyads, including six, five, and six in the first, second, and third year, respectively. From these, eleven were high-ranked hinds and their offspring (seven male and four female fawns) and six were low-ranked hinds and their offspring (three male and three female fawns) (SI = 0.84 [± 0.04] and 0.11 [± 0.05], respectively). Maternal reaction to human handling of the fawn was recorded in the first 24 h after birth. The minimum distance the mother stayed from her fawn while it was weighed and sexed (during approximately 1 min) was recorded by one observer using a tape measure. After the fawn was released, the latency period within which the mother returned to her fawn (maximum time of observation = 15 min) was also recorded.

## Statistical analysis

The normal distribution of the flight distance was determined with the Shapiro-Wilk test. Data recorded in high- and low-ranked hinds were compared with an ANOVA for repeated measurements, including the social rank, the number of test, the breeding group, and the interaction between social rank and number of test as main effects. The individual hind into each social rank was considered as a random effect.

To examine the effect of different factors on distance, a Bayesian approach was performed with the procedure GENMOD in the SAS statistical package. The effect of hierarchical ranks (high- or low-ranked) year (2010–2013), breeding group and sex were included as fixed effects. For the Bayesian analysis, it was decided to run a single chain of 1,100,000 iterations. The first 100,000 iterations were discarded and the sampling interval was 20, so that a total of 50.000 samples were kept to estimate features of posterior distributions. To study the effect of rank and sex on distance, the probability of the differences between the levels of these two effects being relevant were calculated. A relevant value is a quantity under which differences between treatments have no biological meaning (Blasco 2007). The amounts established as relevant for the purposes of this study were distances from 0.5 m to 3 m by 0.5 m interval for hierarchical ranks and sex effects.

A survival analysis was used to compare the time at which the mother returned with her fawn after handling, and the number of hinds that effectively returned after the 15-min period according to social rank and sex of the fawn. Where appropriate, data are expressed as means (± SEM).

## Results

### Flight distance

High-ranked hinds presented greater flight distance than low-ranked hinds (2.49 [± 0.13] vs 1.87 [± 0.14] m; $P = 0.006$) (Figure 1). Flight distance also decreased with the number of tests ($P < 0.0001$); from the third to the last test flight distances were smaller than in the first two tests (Figure 1). There was a significant interaction between social rank and number of test ($P = 0.028$) explained by greater values of high- than low-ranked hinds on the first ($P = 0.0001$), second ($P = 0.044$), and fifth ($P = 0.001$) tests (Figure 1).

### Fawn handling

High-ranked females kept a greater distance from their fawns while they were handled compared to low-ranked females (3.6 [± 0.9] vs 1.0 [± 0.2] m), since the probability that there were differences between high- and low-ranked females at 1.5 or less metres was greater than 0.77 (Table 1). The sex of the fawn had no influence on the probability of maintaining different distances (Table 1).

There were no differences in the proportion of high and low hinds that returned with their fawn during the recorded period and the time at which those that returned did it (survival analysis: 8/11 vs 6/6 and 3.5 [± 1.9] vs 2.8 [± 1.9] min for high- and low-ranked hinds, respectively; ns). Similarly, there

**Figure 1**



Flight distance recorded over 8 days in high- (−◆−) and low- (−○−) ranked pampas deer females.
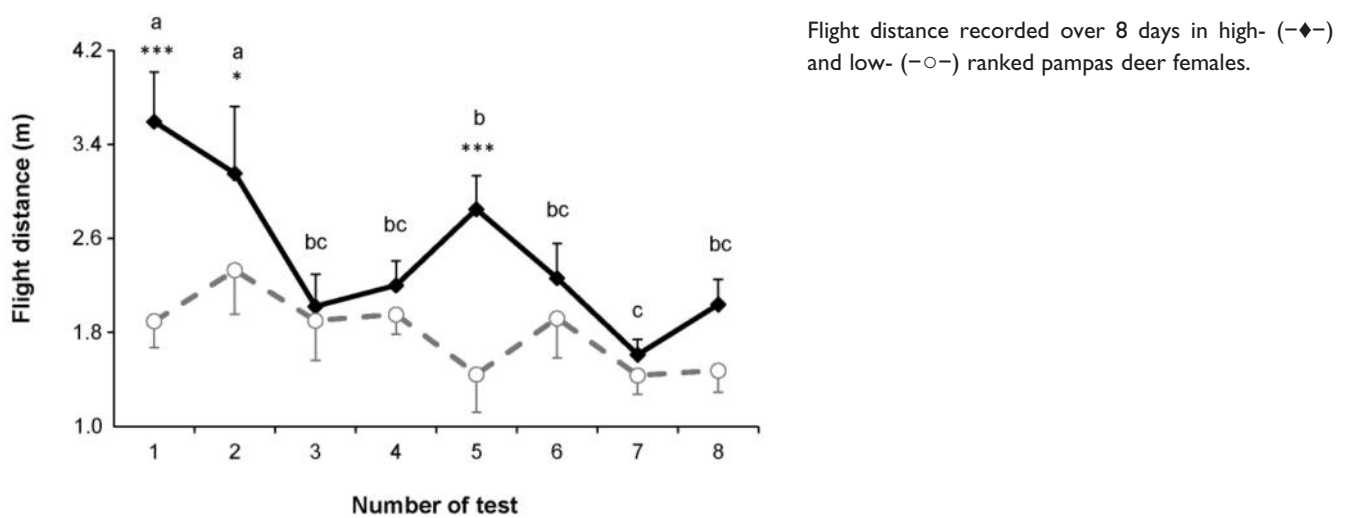
**Table 1** The probability of pampas deer females remaining at different distances while their fawns were handled, according to their social rank (high-ranked [HR] or low-ranked [LR]) or the sex of the fawn.

| Distance (m) | HR < LR probability | Females > males probability |
|---|---|---|
| 0 | 0.95888 | 0.528 |
| 0.5 | 0.92274 | 0.365 |
| 1.0 | 0.86136 | 0.227 |
| 1.5 | 0.77202 | 0.126 |
| 2.0 | 0.65398 | 0.064 |
| 2.5 | 0.5138 | 0.031 |
| 3.0 | 0.37416 | 0.014 |

were no differences in the proportion of hinds that returned with their fawns according to their sex during the recorded period and the time at which those that returned did it (survival analysis: 8/10 vs 6/7 and 3.3 [± 1.9] vs 3.0 [± 1.8] min for male and female fawns, respectively; ns).

## Discussion

Overall, the human-animal relationship in female pampas deer differed according to the hinds' social rank. High-ranked hinds avoided humans at greater distances or stayed at greater distances from humans while their fawns were handled, demonstrating that their perception of humans differed. This expands previous observations from domestic (dairy cows: Beilharz & Mylrea 1963; Yunes 2001, goats: Miranda-de la Lama *et al* 2013) to non-domestic ruminants. It would be interesting to determine if similar results can be obtained in domestic deer species; although these animals would be used to humans and their degree of domestication differs from that of other domestic ruminant species (Price 1999). Thus, their overall relationship with humans would seem to differ.

The differences with which high- and low-ranked hinds react may reflect different emotional status provoked by their perception of humans. Some researchers consider that social animals habituated to humans may consider them as part of their group (Price 1984) and, thus, perceive them as dominant individuals (Lott & Hart 1979). For example, human attitudes towards cattle play heavily on their fear responses (Hemsworth *et al* 2000, 2011). Considering that, at least in deer, individuals tend to be more aggressive toward closer ranked individuals (Jennings *et al* 2006; Freitas-de-Melo *et al* 2013), high-ranked hinds might expect a greater aggressiveness from humans (greater but closest rank) than low-ranked hinds. As loser individuals generally avoid confrontation (Bartos *et al* 2007), and stay at greater distances from winners (Ungerfeld & Freitas-de-Melo 2014), high-ranked hinds may maintain greater distances from humans. Therefore, the perception of what different ranked animals may expect from an individual that is dominant to all of them, may explain the differences in the distances maintained by them from humans.

High-ranked hinds stayed at greater distances than low-ranked hinds while their fawns were handled. Although, in this period after birth, pampas deer hinds tend not to remain close to their fawns (Olazábal *et al* 2013), all of the tested hinds reacted when their fawns were handled, reflecting a high level of interest. This test explores the strength of the mother-fawn relationship and the extent to which the hind invests in the fawns' defence, however it also considers how humans are perceived by different hinds. In this sense, an inverse relationship exists between aggressiveness of white-tailed deer hinds while humans handled their fawns and offspring mortality (Smith 1987), and also between the anti-predatory behaviour of mule deer hinds and the survival of their fawns (Lingle *et al* 2005). However, if the continuous presence of humans leads them to be perceived as highly ranked individuals, and there is a negative relationship between dominance rank difference and fight rate (Jennings *et al* 2006) the lowest aggressiveness of high-ranked females can be understood.

In general, protective behaviour of fawns may be linked to reproductive fitness. Therefore, it may be expected that high-ranked females have greater reproductive success (Clutton-Brock *et al* 1986; Cassinello 1996), but on the other hand, low-ranked females may be willing to invest more than high-ranked females against a threat to defend their fawns. Therefore, the closer distance at which low-ranked females remained from humans suggests a greater protective attitude towards their fawns, and thus explains the lack of survival differences of offspring of high- or low-ranked hinds (Morales-Piñeyrúa 2014). However, as Grovenburg *et al* (2009) observed that aggressiveness of white-tailed deer hinds while humans handle their offspring increases some days after parturition, it remains to be tested if the differences observed in pampas deer hinds continue. However, considering that at least under the conditions of the ECFA, the reproductive success of high- and low-ranked pampas deer hinds does not differ (Morales-Piñeyrúa *et al* 2014), it seems that as with flight distance, the greater distance maintained by high-ranked hinds may also be related to avoidance of humans. Moreover, this interpretation is reinforced by the lack of difference regarding latency periods needed by hinds to return with their fawns when the human stops interfering.

There were no statistical differences regarding the distance the hind remained back according to the sex of her fawn. In contrast to what has been reported in other deer species (Clutton-Brock *et al* 1981), at least for pampas deer allocated at the ECFA the cost of rearing both sexes is similar. In this sense, previous studies showed neither sex-related differences between fawns' weight at birth (Ungerfeld *et al* 2008a; Morales-Piñeyrúa 2014) nor suckling time during the first months (Villagrán *et al* 2012). Therefore, this result is in accordance with Morales-Piñeyrúa *et al* (2014), who observed no differences in offspring sex ratio of high- or low-ranked females.

To summarise, in pampas deer hinds the relationship with humans differs according to social status. High- and low-ranked hinds develop different strategies in relation to humans. It is possible that high-ranked individuals perceive humans as a greater threat, and are thus more fearful of them, or also have a better survival or fitness strategy. Sex of the fawn did not affect the hinds' reaction to human handling. This knowledge should be taken into consideration by those working with this species in order to avoid affecting animals' welfare while working on breeding groups or handling newborn fawns.

### Animal welfare implications

When handling wild animals it is important to consider how individual animals may react toward humans. As pointed out by Galindo *et al* (2011), many welfare problems occur as a consequence of the lack of knowledge of the basic social behaviours of the species. These authors stated that social behaviour, including individual differences, should be understood to solve basic social welfare problems in captive animals. Obviously, the need for knowledge is even greater for conservation of endangered species. In this

sense, these studies provide basic information on individual differences as to how pampas deer hinds react to humans. When these animals are managed in small groups, as was the case in our study, it is easy for keepers to estimate which animals are high- and which are low-ranked without needing to record agonistic interactions. Therefore, being aware of the differences in flight distance, they can readily estimate how close they can get from different individuals and, thus, use different strategies to manage them. An awareness of these distances can make examination of low-ranked animals possible without capturing them, but the same logic cannot be applied to high-ranked individuals. Their behaviour would have been altered, thereby making it more difficult to examine them without the administration of an anaesthetic. One other important point emerging from our study relates to the examination of fawns after birth, as this is highly stressful for the mother. Many ungulate fawns from low-ranked animals tend to have reduced survival rates, so it is especially important to examine and check their health status more frequently than fawns from high-ranked females. In this sense, the stress induced in their mothers provoked by invasive management technique would probably be outweighed in those individuals in need of a greater frequency of examinations.

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