Factors Affecting Dominance and Aggressive Interactions Among Castrated Male Domestic Horses (*Equus caballus*)

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ABSTRACT

Dominance hierarchies and aggression in feral horse (*Equus caballus*) populations have been well studied. Though research has extended somewhat into the organization of domestic horse populations, no studies have been done on aggression and dominance in bands consisting almost entirely of castrated males. In this study, I investigated the effects of rank, height, weight, age, age at castration and group size on rates of aggression in a population of seventeen castrated male domestic horses organized into six groups. I found that weight was the most significant predictor of rank as well as rate of aggression, but that rank was not significantly correlated with rate of aggression. Height, age, age at castration and group size all had negligible effects on rank and rate of aggression.

INTRODUCTION

Horses in the wild live in groups of varying sizes, from two individuals up to groups of 20 or 30, and the structure of these groups varies widely (Linklater et al, 1999). Usually a herd consists of one stallion and one to ten mares and their offspring. All-male groups, called bachelor groups, are observed in most feral horse populations and zebras (*Equus zebra*) (Keiper, 1976). Bachelor groups are thought to be formed when juvenile males leave their maternal bands and group together for a number of years before forming their own herds. In addition, all-female bands will occasionally form for short periods of time, and some bands have more than one stallion, which are either co-dominant or show a dominance hierarchy (Keiper, 1976; Feh, 1999).

The position of the stallion in the overall dominance hierarchy has been debated. Initial studies placed the stallion as the dominant animal in the group but more recent studies indicate that the stallion is usually subordinate to at least one mare (Houpt & Keiper, 1982). Studies of dominance in feral mares reveal stable dominance hierarchies seemingly based on height and age (Rutberg & Greenberg, 1990). A 1982 study (Houpt & Keiper) on the position of the stallion in feral and domestic groups, some of which included geldings (castrated male horses), showed that in both the wild and captivity, the stallions almost always took up middle positions in the hierarchy. One feral group included a gelding that had previously been a domestic pony, which occupied the lowest rank in the hierarchy, while in the three domestic groups, a gelding was the dominant horse in each. This seems to indicate that dominance is not dependent on testosterone. Moreover some studies show that dominant horses are also the least aggressive (Rutberg & Greenberg, 1990; Feh, 1999). However in the 1982 study (Houpt & Keiper) dominance and number of aggressive acts were positively correlated.

There has been much discussion about the influence of testosterone in aggressive behavior, and for many male mammals, testosterone seems to increase aggressive behavior (Barfield, et al., 1972; Anisko, et al., 1973). It has also been documented that castration results in a reduction of aggressive behavior (Anisko, et al., 1973) or prevents the development of aggressive behavior when the castration is performed while the animal is young (Whitsett, 1975). Studies have been conducted on laboratory animals, including rats, mice, hamsters and gerbils, as well as in the field on mongooses (Creel, et al., 1993; Barfield et al, 1972; Whitsett, 1975; Ferris et al, 1998), and the results of these studies show that the influence of testosterone on aggression varies greatly among species. These studies demonstrated that aggression could be dependent on or completely independent of the presence of gonads.

The effects of castration on large domestic animals have been largely ignored. Castration is usually performed on domestic animals for the purpose of curbing reproduction, however it is also generally assumed that castrated males are less aggressive and easier to handle. Testosterone is primarily produced in the gonads, but is also produced in the adrenal gland (Bennett & Whitehead, 1983); therefore castration should sharply reduce the level of testosterone in the blood but may not remove it altogether.

This study aimed to investigate the interactions among age at castration, dominance, and physical factors, like height, age and weight, on aggressive behavior in gelded horses. Previous studies indicate that because horses are not territorial, their length of residence in a particular area should not influence the dominance hierarchy (Feh, 1999; Rutberg & Greenberg, 1990); therefore an individual's length of

residence at the stable should not influence its rank. It was unknown whether domestic geldings would display behaviors associated with the rituals of stallion-stallion confrontation, like arched neck threats and marking of fecal piles (Miller, 1981), but because these horses were not in a breeding situation, I did not expect to see these behaviors displayed. Studies have indicated that there is a significant positive correlation between height and dominance, and a non-significant positive correlation between age and dominance (Rutberg & Greenberg, 1990); therefore I expected to find that physical factors significantly influence dominance. I also expected to find that dominant horses would be more aggressive than subordinate horses, and that age of castration may play a role in determining dominance if previously bred horses retain stallion-like behaviors after castration.

METHODS

The study site is located at Hunter's Rein Stables in Otego, NY, in the middle of agricultural land. The horses boarded at the stable are turned out into enclosed pastures during the day, and then in the late afternoon are brought into their individual stalls to be fed and to spend the night. The pastures range in size from an acre to more than ten acres, and the number of horses turned out in a particular pasture depends on its size. The pastures are open fields, bordered by trees, with water provided in water troughs. During the winter, hay is spread on the snow for the horses to graze on without having to dig through the snow.

There were seventeen available gelding horses (*Equus caballus*) at Hunter's Rein Stables. Each was turned out during the day in groups of two to five in six pastures; groups were either all male or included one female. To analyze aggressive behavior, I recorded, using a small tape recorder, the following aggressive acts (Table 1): frontal assaults; active and passive displacement; bites to the head or neck, flank, or rear; the act of kicking with the front legs or rearing; and the act of kicking with the hind legs.

Table 1: Summary of aggressive acts, and their definitions. Threats of each act, and acts that did not make contact with their intended target were counted as aggressive acts.

Front Assault	Charging at a speed other than a walk; usually followed by biting or kicking
Head/Neck threat/bite	A bite, or threat to bite, the head, neck or chest
Flank threat/bite	A bite, or threat to bite, the flank region between the shoulder and hip
Rear threat/bite	A bite, or threat to bite, the region of the hips, buttocks, or tail
Front kick/Rearing	The act of kicking out with the front legs. Rearing includes bringing the front feet off the ground to any height, independent of kicking.
Hind kick	The act of kicking out with the hind legs
Active Displacement	Causing a horse to move away upon approach at a walk, accompanied by flattened ears, a threat of aggression, or an aggressive act
Passive Displacement	Causing a horse to move away upon approach at a walk without demonstrating any aggressive acts

Any of the above physical actions that did not make contact with the intended individual were counted as aggressive acts. Threats, which included baring the teeth and lunging toward the target animal as an attempt at biting, and turning the rear toward the target animal as a threat to kick with the hind legs, were also counted. Displacement occurs when one horse approaches another and the other moves out of its way without any confrontation (Rutberg & Greenberg, 1990). Each horse was easily recognizable, and I knew each by name. After the first day of observations, my presence did not noticeably disturb or affect the horses.

The height at the withers of each horse was measured using a meter stick, and a weight tape was used to gain an estimation of weight. In addition, the owners were questioned for the ages and age at castration of the horses. These measurements were taken after the period of observation to avoid influencing my account of what was observed.

Dominance hierarchies were established for each pasture by grading each horse on the number of interactions it "won" as well as the number of displacements it received and from which horse it received them (Feh, 1999; Rutberg & Greenberg, 1990). These hierarchies were then translated into ranks based on whether a horse was the alpha, beta, middle, or omega animal. The most dominant animal, the alpha, was ranked a 4; the second most dominant animal, the beta, was ranked a 3; any middle ranking horses that

were neither first, second nor last, were ranked a 2; and the most subordinate animal, the omega, was ranked a 1. In this way, a group of five has an alpha, beta, two middles, and an omega, while a group of three has an alpha, beta and omega, and a group of two has an alpha and omega. In this last case, the second animal is considered an omega instead of a beta because when there are only two animals, and one is clearly dominant, the subordinate one rarely wins in a confrontation and is therefore always subordinate. In the two pastures that contained females, the female was the most dominant animal in both cases, therefore the highest-ranking male was considered a beta and given a rank of 3. In one pasture the composition changed, so that the subordinate animal of the two horses was removed and replaced with a dominant animal. Therefore the animal that remained in the pasture was initially the alpha and after the change was the omega. Because of this, I counted the pasture before the change and after the change as two separate pastures. For the analyses, the horse that remained in the pasture was considered two separate horses, because his rates of aggression and modes of aggression changed when his place in the hierarchy changed.

The recordings of my observations were transcribed, and the number of each type of aggressive act initiated and received was then totaled. From this a rate of aggression initiated and a rate of aggression received were calculated. SPSS version 10 was used in the analyses of the data. Pearson's Correlation (1-tailed) was used to investigate the degree of correlation between the rate of aggression initiated by an individual and the following: rate of aggression received, weight, height, rank, age and size of the individual's group.

RESULTS

The number of aggressive acts initiated by an individual ranged from 1 to 136, likewise the number of aggressive acts received by an individual ranged from 1 to 107. The highest rate of initiated aggression was 13.27 acts/hr, and the lowest rate was 0.1 acts/hr. Likewise the highest rate of received aggression was 12.78 acts/hr, and the lowest rate was 0.1 acts/hr. Generally, an individual horse's rates of initiated and received aggression were similar, except in cases of very dominant or very subordinate horses (Figure 1). For example, the omega horse in the group of five males had a rate of initiated aggression of 0.68 acts/hr but a rate of aggression received of 4.88 acts/hr. The average rate of aggression initiated of the entire group of 17 horses was 4.457 acts/hr, and the average rate of aggression received was 4.434 acts/hr.

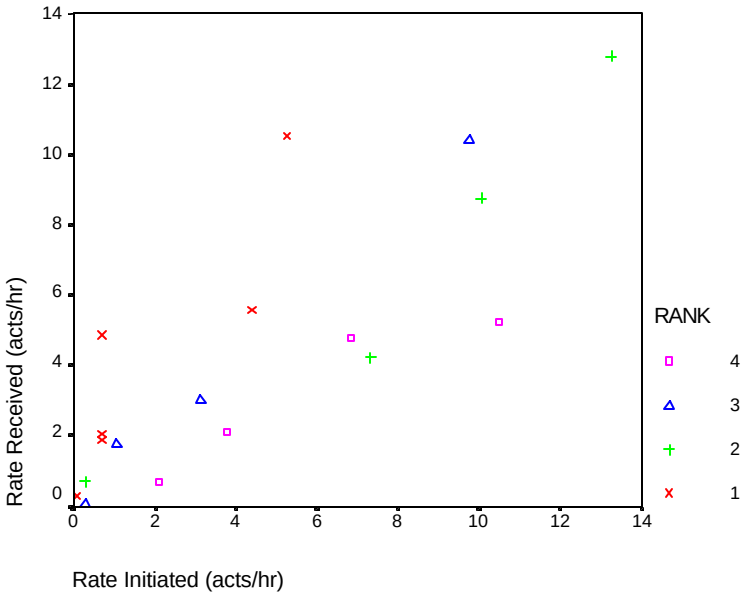

Figure 1: The correlation between rate of aggression initiated (acts/hr) and rate of aggression received (acts/hr), labeled by rank. This demonstrates that only the lower ranking animals did not retaliate as often as the higher-ranking animals.

The most frequently seen aggressive act was a bite to the head or neck, and the least frequently seen was a bite to the flank. Stallion behaviors like arched neck threats and marking of fecal piles (Miller,

1981) were not observed. The type of aggressive behavior initiated depended on the rank of the horse. Bites to the flank or rear were most often initiated by dominant animals, while kicks with the rear legs were most often used by subordinate animals, often in response to a bite by a dominant animal.

Some aggression was observed across the fences separating the pastures, but this accounted for only ten of the 707 observed aggressive acts. In addition, in both of the two pastures that contained one female, the female was the most dominant animal.

The ages of the horses varied from 3 to 24. However, thirteen of the seventeen total horses were between the ages of 10 and 20, and of those thirteen, eleven were between the ages of 10 and 15. Therefore this group showed little range in ages. The effects of age at castration could not be investigated in this study because only one of the seventeen horses had been used for breeding before being castrated at the age of eight. The remaining horses were castrated around the age of one or two. This one particular horse, though the dominant animal of his group, did not stand out in any way as unusual in his behavior. He had a high rate of aggression, but was not the most aggressive horse of the study, and did not display any stallion-like behavior.

Rate initiated and rate received were significantly positively correlated ($p<0.01$), as were rate initiated and weight ($p<0.05$) (Table 2, Figure 2). Rate initiated and height were positively correlated, though not significantly ($p=0.089$) (Table 2). Rate initiated and rank were not significantly correlated, though the correlation was slightly positive (Table 2). Rate initiated and group size, and rate initiated and age had no significant correlations. Correlations were also investigated between rank and the following: weight, height, rate received and group size. Rank and weight were significantly positively correlated ($p<0.01$) (Figure 3), and rank and height were positively correlated, though not significantly ($p=0.056$) (Table 2). Rank and rate received, rank and age, and rank and group size were not significantly correlated.

Univariate analysis of variance was used to determine whether the pasture a given horse was assigned to and rank have significant effects on rate initiated, and it was found that pasture ($N=18$; $F= 5.068$; $df=5$; $p=0.017$) had a significant effect, and rank ($N=18$; $F= 4.096$; $df= 3$; $p= 0.043$) also had a significant effect.

Table 2: Correlation coefficients between rate initiated, rate received, weight, height, and rank. The marked numbers are significant ($p<0.05$).

	Rate Received	Weight	Height	Rank
Rate Initiated	0.826*	0.419*	0.332	0.260
Rank	-0.137	0.718*	0.388	

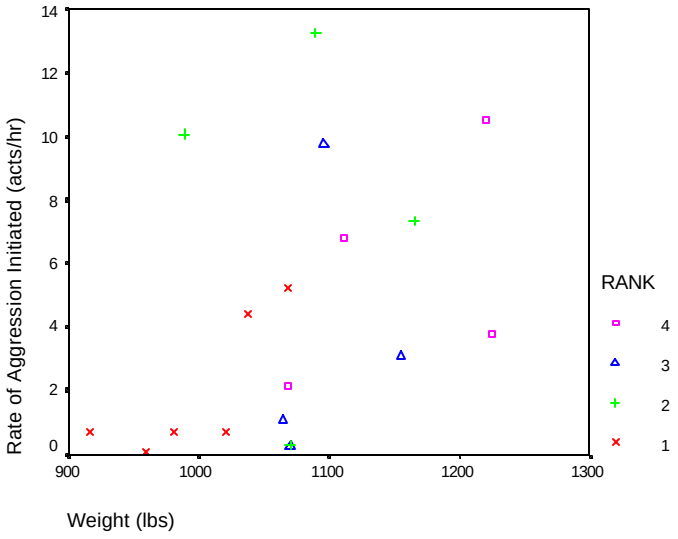

Figure 2: Correlation between weight and rate of aggression initiated, organized by rank.

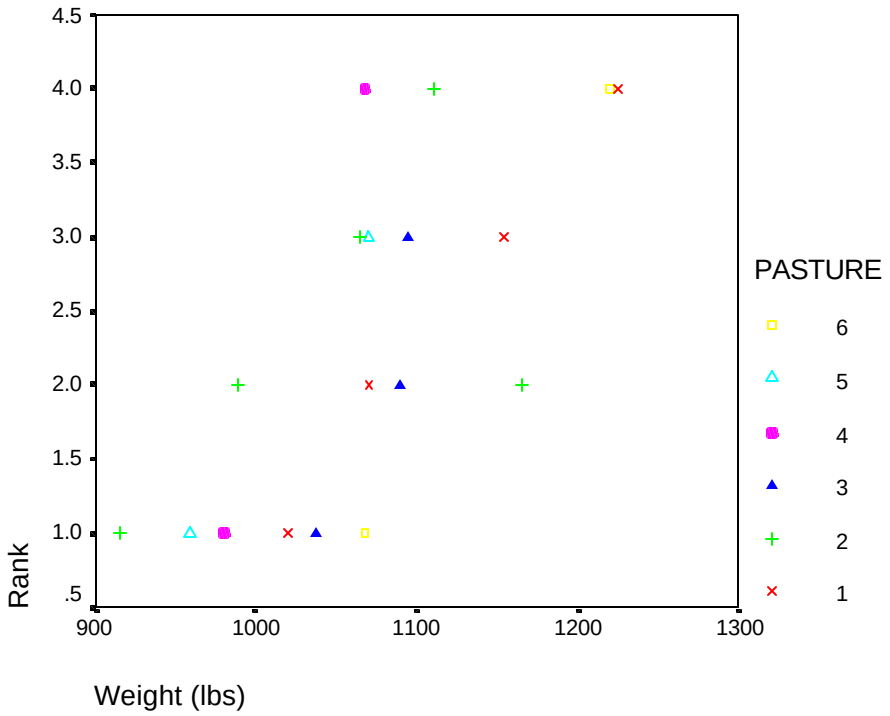

Figure 3: The correlation between weight (lbs.) and rank, divided by pasture. The highest-ranking animals for pastures 3 and 5 are not displayed because they were female.

DISCUSSION

Comparative studies of feral and domestic rates of aggression indicate that domestic horses have higher rates of aggression than feral horses. A study on feral mares indicated that individuals were involved in aggressive interactions between 1.9 and 1.2 times per hour (Rutberg & Greenberg, 1990). A study on domestic mixed bands in a situation of forced competition in a paired feeding situation found a rate of 47 aggressive acts per hour (Houpt & Keiper, 1982). The same study found that the same individuals in a grazing situation had rates of 13 aggressive acts per hour. The average rate of aggression I found in the present study was 4.46 aggressive acts per hour, but the highest rate (13.27 acts/hr) is comparable to the previously observed rate.

Stallion behaviors (Miller, 1981) were not observed during this study, even by the one animal who was used to breed and then castrated later in life. This indicates that stallion behaviors are linked to breeding behavior and therefore testosterone levels, and are not learned and retained. It also indicates that the levels of testosterone are negligible in these particular horses, and should not be affecting their behavior. Further study could determine the situations in which stallions exhibit these behaviors, and whether they are only related to breeding activities. In addition, studies could measure the comparative levels of testosterone in both stallions and geldings and investigate whether a correlation exists between levels of testosterone and type or rate of aggression.

The types of aggressive acts and the situations in which they were used were consistent with previous studies on feral horses (Houpt & Keiper, 1982; Rutberg & Greenberg, 1990) in which biting was primarily an offensive act toward either a less dominant animal or one of similar rank, kicking with the hind legs was generally used by subordinate animals as a defensive act, and front kicking and rearing were generally only seen between animals of similar rank. This is consistent with my observation that dominant horses usually bit the rear or flank of subordinate horses, which would then retaliate with a hind kick.

Rates of initiated and received aggression correlated strongly because most aggressive encounters were between animals of similar rank, and therefore the receiving horse would most often retaliate. Only the most subordinate horses would not retaliate when attacked, and this was demonstrated in the differences between an individual's rate of aggression initiated versus rate of aggression received. Based on the statistically significant data, weight plays an important role in rank of an animal, and also affects the rate of

aggression initiated. In this situation, rank does not determine weight because the horses are not in competition for resources; they are fed separately at night and therefore rank does not control access to food. The heaviest horses were both the highest ranking, and the most aggressive. It would seem then, that the most aggressive horses were also the highest ranking, but despite a slight positive correlation, the data do not support this. It was also surprising that though height and weight were significantly positively correlated ($p<0.01$), as would be expected, neither height and rank, nor height and rate initiated were significantly correlated.

Previous studies have found that age is an important factor in aggression in mares (Rutberg & Greenberg, 1990), but in this study, age was correlated with neither rank nor rate initiated, which may be because the vast majority of the horses were in their early teens. In a population of animals with a more wide distribution of ages, age may play a role in determining rank and rate of aggression. However, for this population, it seems that the most reliable predictor of rank is weight.

Rank did not significantly correlate with rate of aggression initiated, however the lack of significance may be because two of the six pastures had only two individuals, and so had no mid-ranking animals. It generally held true that mid-ranking animals initiated more aggression than individuals of other ranks, which may indicate repeated attempts to increase their rank and the need to maintain their rank against horses with similar weights.

It is possible that though stallion-like behavior may be dependent on hormones, aggression in general may be learned (Houpt & Wolski, 1980). In addition, it is generally accepted that mares remaining in their natal bands achieve their rank through their mothers (Rutberg & Greenberg, 1990). Though the males in this study are not in their natal bands, studies have shown that higher-ranking females in feral populations produce more robust offspring because of better access to resources (Monard & Duncan, 1996), which may then confer a high rank to the offspring through superior strength and health. This may hold true for domestic bands as well, but because the dominance of the mother of the males in this study could not be determined, this aspect of dominance could not be studied.

The data also support the observation that members of certain pastures were involved in more aggressive acts than members of other pastures independent of the number of individuals in each group. This may be because of the presence of a particularly aggressive animal, which then causes the aggression rate of the entire group to increase because of retaliation, but there was little evidence for this. Conversely, this could be because of the distribution of weight in the group. A group of horses with a variety of weights among its members may also have a strictly defined hierarchy. This may then prevent subordinate horses from being aggressive. Groups of horses with similar weights may have a more loosely defined hierarchy, which then may lead to more aggressive interactions. In mares, attempts to increase rank are accompanied by higher rates of aggression (Rutberg & Greenberg, 1990). In addition, it is possible that the hierarchies I observed are not stable over long periods of time, because the horses' weights fluctuate with the season and how often they are being exercised. Further study could track the hierarchies as the horses weights change through seasons or years.

This study has implications for barn managers who wish to reduce aggression in their fields. This particular stable routinely has horses inflicting wounds severe enough for medical attention. It would seem that the best way to organize the members of a pasture would be to include horses of varying weights so that a stable hierarchy can form, and therefore curb aggression. This study also demonstrates that in horses, aggression is not dependent on testosterone, though further study is needed to determine whether modes and rates of aggression change before and after castration.

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