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Sex-Dependent Interactions between Humans and Dogs

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Summary

The domesticated dog (*Canis familiaris*) has undergone a vast number of genetic and environmental changes since its divergence from the wolf (*Canis lupus*) approximately 100,000 years ago (Call et al., 2003). However, the basic pack social structure of wolves has remained unchanged throughout evolutionary time; it can still be observed in the domesticated dog. What *has* changed is that humans have become integrated into the pack structure. The goal of this study was to assess the exact position humans have acquired within the dominance hierarchy that modulates dog social interactions. This was done by observing dogs at a local dog park and recording the following behavioral traits related to dominance: latency to leaving an owner's side, the total time spent away from an owner, and the number of glances directed at an owner. The data from these observations suggest that the establishment of dominance roles between dog and owner is dependent on the sex of both dog and owner. Male dogs exhibit more behaviors characteristic of dominant individuals than female dogs, and dogs appear to treat male owners in a more dominant manner than they do female owners. These findings have practical applications, as a better understanding of dog behavior in relation to humans may be useful when training dogs or when treating a dog that exhibits behavioral problems including over-aggressiveness. Furthermore, through an understanding of sex-dependent dog behavior, a prospective dog owner can make a more educated choice when picking a pet.

Introduction

Canis familiaris, better known as the domesticated dog, was one of the first animals domesticated by humans. This domestication occurred approximately 100,000 years ago, and from that point on, many behavioral changes have occurred within the species; these changes have been modulated by both genetic and environmental effects (Scott 1964). For example, many of the behavioral differences between dogs and their recent "cousin," the gray wolf (*Canis lupus*), have been attributed to differences in gene expression. Specifically, Saetre et al. (2004), who have extensively studied the patterns of gene expression in both the dog and wolf brain, concluded that substantial differences in hypothalamic gene expression between wolves and dogs are responsible for the obvious behavioral divergences between the two species. This is not unreasonable, considering that the hypothalamus controls emotion and behavior. Interestingly, Saetre et al. (2004) further suggest that these genetic changes were mediated by the *act* of domestication itself. They demonstrated that this was indeed the case, showing that gray wolves and coyotes, two *wild* species that diverged *millions* of years ago, share a highly conserved pattern of hypothalamic gene expression. In contrast, the *domesticated* dog, despite diverging from the gray wolf only *thousands* of years ago, shows a unique pattern of gene expression in this region of the brain.

Not only have shifts in gene expression occurred since canine domestication, but environmental factors correlating with the shift from a wild to a domesticated lifestyle have also influenced the evolution of dog behavior. The most obvious environmental change was the new-found interdependent relationship between humans and dogs (Scott, 1964). Specifically, once dogs were domesticated, their survival and reproduction became controlled by their owners, food and shelter were provided to them, and mating was most often restricted to fixed interactions orchestrated by owners (Scott & Fuller, 1965). This is probably most evident when one looks at the vast array of highly specialized dog breeds that currently exist as a result of human intervention. These breeds surely would not have evolved through natural selection pressures, as most of them express maladaptive traits that would hinder survival. For example, the long snout bred into the collie often correlates with blindness. At the other extreme, the severely flattened face bred into the English bulldog hinders this breed's ability to breathe. Clearly, only through drastic human interference have these "abnormally" structured dogs been able to flourish in the modern-day world (Kubyn, 1998).

Despite the obvious changes, both genetic and environmental, that have led to the evolution of the modern companion dog, this species has retained some of the characteristics of its ancestors. For example, the social structure of domesticated dogs is very similar to that of wolves; dogs are still "pack" animals by nature, preferring to live and function as a member of a social group (Scott & Fuller, 1965). Characteristic pack behavior is highly *allelomimetic*, in that members of the pack function as a single entity. This includes running, lying down, and barking with other pack members as well as maintaining constant eye contact with other members of the pack (Scott & Fuller, 1965). Dominance and subordination are key indicators in pack social structure as well. Although males in the pack are typically dominant to females, both an alpha male and alpha female exist. The alpha female, though subordinate to the males in the pack, is dominant to all other females. This intrasexual hierarchy fluctuates—less dominant males may try to overtake the alpha male's position through direct aggressive interactions, while the females subordinate to the alpha female attempt to move up in rank through vocalization and aggressive threats (Scott & Fuller, 1965).

The ability and predisposition for individuals to organize themselves into a pack was imperative for the survival of wolves. Not only was a group less vulnerable to predation, but group structure allowed for efficient mate access and the hunting of large prey that a single wolf could not kill. However, the direct benefits of such a structure are not as obvious in domesticated dogs. In spite of this, studies have shown that dogs still possess the innate tendency to form social groups. For example, Fogle and colleagues (1990) demonstrated that if left with other dogs and in the absence of humans, dogs will indeed structure themselves into a pack and that pack-like behavioral traits begin to emerge within such dogs at a very young age. Similarly, Scott and Fuller (1965), in their analysis of social relationships among puppies, concluded that puppies develop relationships based on dominance and subordination. Not only did the "pecking order" in which the

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puppies arranged themselves affect which pups obtained the first access to food, but it also affected the spatial relationship between the pups. Specifically, the most dominant pups were often seen roaming independently of their littermates, while the more subordinate pups often clustered together or attempted to follow the dominant individuals. Furthermore, the behavioral traits established early on in the pups' lives persisted through development; their "personalities" as youngsters were maintained through adulthood.

Despite the innate predisposition to organize themselves in social groups, dogs face a great impediment. Not only is it difficult for them to interact with other members of their species because they often live in single-dog households, but their dog-dog interactions are highly controlled by their owners. Many researchers argue that this challenge has led to the inclusion of a dog's owner into its pack in the absence of any other dogs (Scott and Marston, 1950). However, the exact position in which humans fit into the pack social structure has yet to be fully elucidated.

This question is of great significance. Unlike most instances in which dominance relationships between different species are not of great concern due to the fairly minimal between-species interaction, the interdependent and intimate human-dog relationship creates dominance issues between the two species of particular interest. Furthermore, effective communication with one's dog is a goal shared by a large majority of individuals, considering the fact that dogs are an integral part of approximately 38 million U.S. households (Sutter & Ostrander, 2004).

The goal of this study was to examine more closely human-dog interactions in relation to dog social behavior. Although it is known that dog behavior is modulated by the behavior of their human owners, it is not yet known whether dogs actually submit to humans and allow their owners to maintain a dominant status over them. Previous research has shown that the situation may be much more complex due to the numerous, multi-layered components of dog social interactions (Fogel & Wilson, 1990).

In light of recent studies, which have shown that the sex of a particular dog influences the behavior the dog exhibits toward its human family members (Lund et al., 1996), it was hypothesized that the dominance hierarchy established between a dog and its owner is sex-dependent, both in respect to the dog as well as the owner. Under this hypothesis, dominance interactions should differ between male and female dogs, as well as between male and female owners. To test this prediction, dogs were observed at a local dog park over a period of one month and assessed the differences in dominance-related behaviors exhibited by dogs with their respective owners. The parameters assessed for each focal dog included variation in latency to leaving an owner's side, the time spent away from an owner, and the degree of eye contact between dog and owner. All of these factors have been shown to be strongly correlated with a social structure arranged by dominant-subordinate relationships. Specifically, one of the main ways a dog establishes a dominant position in its pack is to control the motion of others (Scott & Fuller, 1965). Therefore, it was predicted that a more dominant dog would leave its owner's side more quickly, spend greater time away from its owner than a more submissive dog. Similarly, the more subordinate a dog, the greater the frequency in which it will initiate eye contact with other, more dominant pack members (McConnell, 2002). Therefore, it was also predicted that the more dominant a dog, the less it will tend to glance at its owner, if it indeed views its owner as a pack member.

The results of this study supported the hypothesis that the exact position achieved by an owner in the dominance hierarchy relating to dog social structure depended on the sex of both owner and dog. More exactly, males of both species took on a more dominant status in the human-dog relationship overall in comparison to the more subordinate behavior of females. These findings will serve many practical purposes, such as helping individuals to better match the dog they decide to adopt with the traits they desire. It may also prove beneficial for shelters, which aim to determine the temperament, aggressive tendencies, and adoptability of their dogs (Kroll et al. 2004).

Methods

Over a one month period (February 21 through March 21, 2005), a total of 57 dogs were observed at the Prairie Wolf Dog Exercise Area in the Lake County Forest Preserve. The sex of the observed focal dog, each of which was chosen randomly to avoid observer bias, as well as the sex of each dog's owner was recorded. The general appearance of each dog (breed and markings) was also noted to ensure that no dog was observed more than once. Then, each focal dog was observed individually for five minutes, starting from the time they were let off the leash. Using a stopwatch and the check-list technique (as described by Martin & Bateson 1993), the latency to leaving the owner's side (defined as the length of time it took each dog to venture out of a five-meter radius from its owner), the total amount of time each dog spent out of this five-meter radius, and the total number of glances each dog directed at its owner during the five-minute observational period was recorded. In an effort to limit the effects of confounding variables, dogs were observed on days that were relatively consistent in terms of temperature and weather. All observations were made on sunny days in which the temperature was between 35-45^{o}C. All data were taken between twelve and two in the afternoon to further minimize variance in the time of day observations were made. Microsoft Excel was used to perform T-tests and assess the statistical significance of the data collected.

Results

There was no significant difference between male and female dog latency to leaving owners once let off the leash (Figure 1). Trends in the data suggest that overall, this latency is greater for female dogs ($t = 1.79$, $df = 41$, $p = 0.08$). It appears that female dogs were more reluctant to leave a male owner than a female owner ($t = -1.56$, $df = 16$, $p = 0.15$). In terms of the total time spent away from the owner, male dogs spent a significantly greater time away than did female dogs (Figure 2, $t = -2.98$, $df = 54$, $p = 0.002$). For both male and female dogs, the sex of the owner was not a determinant in the amount of time spent away ($t = 0.44$, $df = 50$, $p = 0.33$).

Female dogs glanced at their owners significantly more often than male dogs (Figure 3, $t = 1.94$, $df = 56$, $p = 0.04$). Despite trends in the data that suggest female dogs glanced more at male owners than female owners, this difference was not statistically significant ($t = -1.32$, $df = 25$, $p = 0.20$). In contrast, male dogs showed owner-dependent glancing behavior—they glanced significantly more often at male owners than at female owners ($t = 3.5$, $df = 23$, $p = 0.002$). Overall, male owners received significantly more glances than female owners ($t = -2.73$, $df = 50$, $p = 0.009$).

Discussion

The results of this study suggest that the dominance hierarchy established between dog and owner is sex-dependent. Specifically, the data indicates that dogs "perceive" male owners as more dominant than female

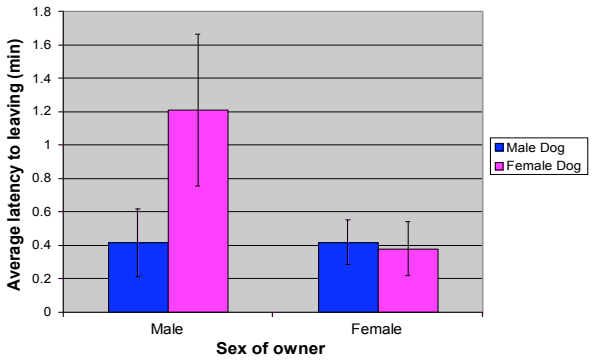

Figure 1. Latency to leaving an owner.
There was no significant difference in the latency to leaving an owner between male and female dogs. However, trends in the data suggest that female dogs remained by their owners for a longer time than male dogs, and that latency of female dogs was greater for male owners. Error bars represent standard error.

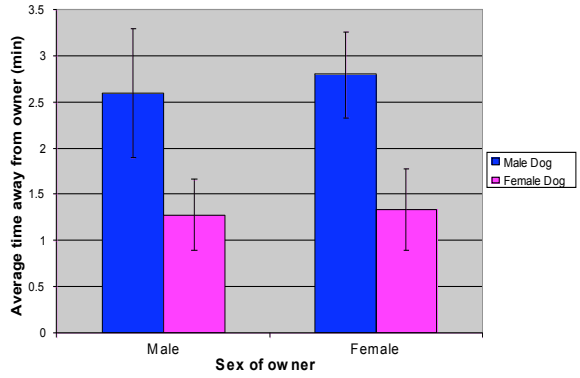

Figure 2. Amount of time a dog spent away from its owner.
Male dogs spent a significantly greater time away from their owner than than did female dogs (Figure 2, t = -2.98, df = 54, p = 0.002). For both male and female dogs, the sex of the owner was not a determinant in the amount of time spent away (t = 0.44, df = 50, p = 0.33). Error bars represent standard error.

owners, leading both male and female dogs to act in a more submissive manner toward male owners. For example, male owners received significantly more glances from their dogs than female owners (Figure 3). Because glancing at their owners seemed to be used by dogs as a way to ensure that they were following the desired path of their owners, it may be viewed as directly correlated with subordination. To explain, one way in which a dog submits to a pack leader is by following the leader's direction, and the subordinate can make sure it is doing so by visually "checking in" with the leader (Kubyn, 1998). This finding fits with the well-established fact that male dogs have a more dominant status within a dog pack than female dogs (Dehasse, 1994). If an owner is actually established as a member of his/her dog's pack, then it is expected that the more dominantly-viewed male owner would receive more glances than the less

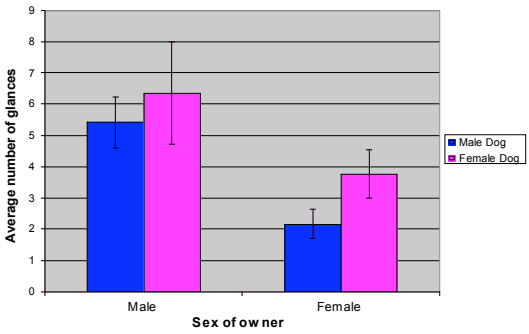

Figure 3. Average number of glances directed at an owner.
Female dogs glanced at their owners significantly more than male dogs (t=1.94, df = 56, p = 0.04). Male dogs glanced significantly more often at male owners than at female owners (t = 3.5, df = 23, p = 0.002). Overall, male owners received significantly more glances than female owners (t = -2.73, df = 50, p = 0.009). Error bars represent standard erro

dominantly-viewed female owner.

The results also show that male dogs were more dominant in nature than female dogs overall. They seemed to be less willing to fully submit to their owners, demonstrating a lower frequency of glancing compared to that of female dogs. Furthermore, male dogs took less time to initially leave their owners' sides, and they spent a longer total time away from their owners than female dogs (Figures 1 & 2). These differences in dog-owner spatial relationships suggest differing degrees of independence. Male dogs were quicker to move independently of their owners and define their own directions of motion, while females were less willing to do so. Because the degree of independence of a dog is directly correlated with its dominance status (dominant individuals are more independent than subordinates), these findings also suggest that male dogs behaved in a more dominant manner than females. This conclusion is in agreement with other studies on dog-human interactions. Previous research focused on assessing the differences in male and female dogs as potential guide dogs found that female dogs were more conscious of the distance between them and humans and that they would regulate this distance to a greater extent than male dogs (Koda & Shimoja, 1999).

Interestingly, this study provides insight into the differing effects of the intersexual and intrasexual dominance hierarchies within a dog pack. Specifically, although not statistically significant, trends in the data suggest that female dogs took longer than male dogs to leave a *male* owner's side, whereas their latency to leaving a *female* owner's side is similar to that of a male dog's latency (Figure 2). This finding can be explained in terms of a strict intersexual hierarchy, where a female would not stand a chance of overthrowing a male and obtaining a dominant status over him, and a more fluctuating intrasexual hierarchy, where a female might attempt to overtake the dominant status of an alpha female. The fact that male dogs did not display the same behavior (their latency to leaving was independent of the sex of their owners) suggests that perhaps the male dominance hierarchy is more rigid than that of the female hierarchy.

Other studies have drawn similar conclusions based on parallel findings. For example, Koda and Shimoju

(1999), while assessing human-dog interactions in a guide-dog training program, observed that all dogs, independent of sex, would initiate contact with women more frequently than with men. The fact that alpha dogs are more "comfortable" approaching other pack members supports the researchers' speculation that willingness to initiate contact was directly correlated with dominance. Therefore, this study also suggests that both male and female dogs act in a more dominant fashion when interacting with women. Interestingly, Koda and Shimoju (1999) also found that men made contact with dogs more frequently than women. If willingness to initiate contact works in the same manner in humans, then this raises an important question: do dogs have an innate predisposition for asserting dominance over women, or are dogs merely responding to the fact that women act less dominantly than men?

The findings of this study have useful and practical applications. For instance, a better understanding of human-dog relationships and how these relationships are dependent on both owner and dog sex should be considered when one decides to include a dog as a family member. For example, an individual who seeks a more aggressive dog for protection might decide to adopt a male dog. In contrast, an individual who has young children and therefore desires an extremely safe and subordinate dog might choose a female dog. However, it is important to realize that while generalizations may be true, on average, breeds and individuals may differ due to the complexity of dog behavior. The choice of whether a male or female will be the best choice for a prospective owner may not necessarily be clear-cut. A female owner may very well experience dominant-related problems with a female dog, as the data from this study suggest that female dogs are less willing to submit to female owners than they are to male owners.

Similarly, other research has made it obvious that additional factors besides dog and owner sex play a crucial role in modulating dog-owner interactions. The personality traits of an owner also affect the behavior of his/her dog. Dodman et al. (2003) studied the effects of human personality disorders on dog behavior and found that owner personality and canine problems are intimately related. Emotionally unstable, shy, and less-confident owners have more aggressive dogs than stable, outgoing, and confident owners. Furthermore, it must be noted that dogs are much more aware of their owners' actions than most people realize. Call et al. (2003) have shown that dogs have highly developed cognitive skills that allow them to detect and process visible behaviors of humans. More specifically, the degree of eye contact between owner and dog as well as the spatial orientation of an owner with respect to his/her dog are both determinants of how a dog behaves in different situations (Gácsi et al. 2004).

Clearly, future studies are needed before we can gain all the knowledge necessary to successfully explain the dominance tendencies of domesticated dogs. Although this study did not focus on how the choices owners make in terms of interacting with their dogs influence the social bonds that develop between them, other researchers have begun to examine this important question. Rooney and Bradshaw (2003) addressed the effects that play (specifically tug-of-war between owner and dog) and the outcome of play (whether the dog "wins" or "loses") has on human-dog relationships. The results of this study suggest that although *how* dogs play correlates with their general temperament and relationship with owners, the *type* of play itself has no observable effect on the establishment of dominance or aggression between dogs and owners. In other words, the notion that it is "bad" to play tug with one's dog does not appear to be true. Finally, one of the major limitations of this study was that dog breed was not taken into account. Because gene expression is a crucial component that contributes to behavioral manifestations, genetic factors may have contributed to the variation in the results of this study and should obviously be assessed in future research.

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