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Review

Dominance in domestic dogs revisited: Useful habit and useful construct?



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ABSTRACT

In the last decade, the validity and relevance of the dominance model was regularly put into question regarding relationships between canids like dogs and wolves, and consequently, human–dog relationships as well. The concept underlying this model, scientifically defined as an intervening variable reflecting status difference between individuals, is applicable when formal status signals symbolize the long-term relationship between individuals, resulting in a formalized dominance hierarchy. This article reviews the basics underlying the concept of dominance and reflects on the value and importance of some new quantitative studies on the applicability of the concept of dominance in domestic dogs. The conclusions are, first, that *formal dominance* is present in the domestic dog, expressed by context-independent unidirectional formal status signals. Consequently, formal dominance (e.g., submission) plays an important role in assessing status in dog–dog relationships. Second, that nonverbal status-related communication in humans resembles that in dogs to a considerable degree, and hence dogs may be well able to interpret this human status-related nonverbal communication from their perspective. Dominance is therefore also likely to play a role in human–dog relationships. Hence, the dominance concept might be useful to explain the development of certain problems in dog–dog and dog–human relationships. However, enforcing a dominant status by a human may entail considerable risks and should therefore be avoided.

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Introduction

The last decade saw a discussion on the validity and relevance of the dominance model regarding relationships between canids like dogs and wolves, and consequently, also concerning the human–dog relationship. The reasons for this were summarized in a much discussed article by Bradshaw et al. (2009), which denounces the concept of dominance in dogs and wolves on several grounds, to be mentioned in *Dominance in dogs: considering the pro and contra arguments in more detail* section. Recently, however, 3 new independent quantitative studies confirm the concept of dominance to be applicable in domestic dogs (Cafazzo et al., 2010; Trisko, 2011; van der Borg et al., 2012). Moreover, these studies also mention

and confirm the existence of the so-called *formal dominance* in dogs. This aspect of dominance was ignored in previous discussions on dogs, whereas this is well known in primates as a most important expression of submission or dominance. One exception is the study of Bauer and Smuts (2007), who recognize formal dominance in dogs, partly on the basis of a quantitative analysis of play behavior. These 3 recent quantitative studies used the research model developed at Utrecht University in the years 1970–1980 (de Waal, 1977; van Hooff and Wensing, 1987). Therefore, it is time to reconsider the arguments, data, and methods leading to such opposing conclusions and also to clarify whether the recent confirmations of dominance in domestic dogs could be a result of a bias in the methodology.

In this article, we first establish the theoretical backgrounds for dominance and its counterpart submission. In doing so, we follow the logic of the Utrecht School of former professor Jan van Hooff and his former pupil Frans de Waal, who have significantly contributed to the development of the concept of dominance and to the methodology to investigate what role dominance might play as an organizing principle in species, and to what degree. Subsequently,

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we will discuss the validity and power of the argumentations and data from authors opposing the idea of dominance playing a role in dogs and wolves and contrast these with the results from the recent studies using the Utrecht dominance model. Finally, we will discuss possible implications for the human–dog relationship. We do not discuss in depth the mechanisms of formation of dominance relationships and the connection between dominance and leadership. The former has been modeled in the studies by Hemelrijk (2002), Beacham (2003), Forkman and Haskell (2004), and Dugatkin and Dugatkin (2007), and the latter is discussed in the studies by Peterson et al. (2002), Bonanni et al. (2010), and Akos et al. (2014).

Some basics of dominance

Members of a social group may differ in many aspects. Differences may include asymmetries regarding physical power, stamina, lineage, personality, weight, weaponry, age, and so on (Maynard Smith and Parker, 1976; Chase and Seitz, 2011). These differences in personal properties of individuals may influence the dominance relationships (Bernstein, 1981) and may be stable over some time and to a certain degree. Stable asymmetries between individuals may lead to more or less predictable differences in behavioral outputs and outcomes of conflicts over resources. This predictability is not 100% because other factors (e.g., motivation) may interfere.

Dominance is regarded as an *intervening variable* that summarizes a set of behavioral differences between individuals (cf, Hinde, 1974; Hinde and Datta, 1981). This first means that a number of relevant behavioral exchanges within each dyad should show identical main directions: animal A shows several relevant behaviors more frequently toward animal B than vice versa. This first aspect can be investigated by correlation analysis and subsequent cluster or principal component analysis. This analysis may reveal groups of behavioral elements that are performed with the same main directions within the dyads. Behaviors in such a cluster may be lumped for further analysis. Typically, when main directions of submissive behaviors are reversed, these should correlate well with the behavioral measures reflecting dominance.

Second, these main directions within dyads should be identical over different competitive contexts. That is to say that the main directions of behaviors within each pair of individuals in context A should be identical to those in contexts B and C. For example, the main directions of behavioral exchanges in mate competition should be identical to those in food competition. An example of this type of consistency in dogs is given by the study of Cafazzo et al. (2010).

Third, these behavioral asymmetries should be stable over a considerable period to be measured over weeks, months, and even several years.

Fourth, if a certain relevant behavior is found to be exchanged exclusively in one direction (animal A performs behavior X toward animal B, but [almost] never vice versa), it is said that such a behavior functions as a *formal dominance signal* or even a meta-communicative signal (cf, van Hooff and Wensing, 1987), conveying either dominance or submission. Such formal dominance signals have been described in several species including wolves and several primates (see, e.g., van Hooff and Wensing (1987) for wolves and de Waal (1977) for Java monkeys). Formal dominance signals should be shown exclusively in the same direction, independent of the type of context. There are formal signals that express dominance and formal signals that express subordination (Preuschoft, 1999). In the latter case, these signals may also function to inhibit further aggressive or dominant behavior by dominants. For example, the silent *bared teeth display* in Java and Barbary macaques is exclusively shown by submissive individuals toward dominants, independent of the context (de Waal and Luttrell, 1985; Preuschoft and

van Schaik, 2000). In wolves, a high posture is shown by dominants toward subordinates, whereas a low posture is exclusively shown by subordinates toward higher ranking animals, again independent of the context (van Hooff and Wensing, 1987).

We will use the term status signals (cf, Flack and de Waal, 2004) as a shortcut, indicating signals that are involved in either signaling dominance or submission.

In some articles (e.g., de Waal, 1989), an additional criterion to recognize formal status signals is added, namely that such a 1-sided signal should be shown not only during competitive conflicts but also *outside* conflicts, for example, during greeting. This has been shown to occur in free-ranging domestic dogs also (Bonanni et al., 2010). The detection of formal status signals in a species is taken as proof that dominance relationships are important in structuring a given social organization. However, if formal status signals cannot be demonstrated, this does not exclude the possibility that dominance does play some role. Rather it suggests that its role might be far more limited (see, e.g., Schilder, 1988).

The degree of one sidedness by which a certain behavior is shown can be expressed in an index, called the direction (in)consistency index (van Hooff and Wensing, 1987). For example, a direction consistency index of 90% means that an average of 90% of all occurrences of that particular behavior in all dyads were shown by animal A toward animal B and only 10% by animal B toward animal A. For dogs, formal status signals were suggested by Bauer and Smuts (2007) in their article on play in dogs. They observed that “role reversals” occurred during play and involved chasing and tackles but never included mounts, muzzle bites, and muzzle licks, suggesting that these behaviors *were invariant indicators of formal dominance* during play in domestic dogs (*italics ours*).

For a human observer, the usefulness of a formal status signal to identify the rank of individuals may sometimes be hampered by the rarity of its performance; preferably, it should be shown in most dyads. This aspect is called the *coverage*. It may occur that a rare signal of formal dominance, because of its one-sidedness, could in principle very well be used as a dominance indicator but that its rarity prevents its use to clarify rank relationships between a large number of individuals in a group. When it is shown, however, it can be extremely meaningful. An example is the behavior head-on-hindquarters in plains zebra stallions. This is very much a 1-sided behavior, and its main directions were stable over years, but it occurred in only a few dyads and was therefore not suited to be used as a criterion to rank all stallions in a herd (Schilder, 1988).

A last characteristic of dominance in a social group is that stable relationships often lead to a ranking of individuals, which is completely or nearly *linear*. However, triangles may exist, meaning that animal A dominates animal B, that animal B dominates C, whereas animal C dominates A. The degree of linearity is dependent on the number of blank relationships (no behavioral exchanges for that particular behavior in a dyad), the number of ties (both A and B perform a behavior to one another with the same frequency), and the number of triangles. Several procedures to construct rank order and test their linearity and steepness have been published (de Vries and Appleby, 2000; de Vries et al., 2000; Gammell et al., 2001; Bayly et al., 2006). Ranking individuals in a group may be useful to describe behavioral patterns in that group but may not (necessarily) reflect an important variable in social organization (Bernstein, 1981).

A quantitative analysis as described previously may lead to a variety of results: nonconcordant distributions of behaviors over dyads leading to nonidentical rank orders, or behaviors that are exchanged reciprocally, show an insufficient coverage, or a nonsignificant degree of linearity. An example of such an analysis leading to a limited applicability of the dominance concept as sketched can be found in the study by Schilder (1988) for plains

zebra stallions. Therefore, the methodology is *not* bound to produce biased results but is precise and sensitive. The fact that 3 recent independent studies on dominance in dogs using this methodology found formal dominance to be present in the dog cannot therefore, with any likelihood, be attributed to a bias inherent to the methodology.

Finally, the validation of the concept of dominance must be found in its ultimate biological consequence, namely reproductive success. Indeed, the relationship between dominance status and reproductive success has been found in many species (see Ellis, 1995 for a review; African wild dogs: Creel et al., 2007). Most, but not all these studies, confirm the biological importance of being high ranking, and therefore they point at the important role of dominance relationships. Especially in primatology, the study of dominance, its causes, and its biological implications has been developed to great depth. Many of these studies took many years, enabling assessment of (sometimes lifelong) reproductive output in relation to rank position. One such study has been performed on free-ranging dogs. The authors found that, although the pack comprised multiple breeding individuals, both male copulation success and female reproductive success were positively influenced by a linear combination of dominance rank, age, and leadership (Cafazzo, personal communication). Spotte (2012), on the other hand, summarizes that neither rank nor body size are important factors influencing reproductive success in the dog. Doubt is cast concerning this conclusion as, according to many articles, rank orders are not based on formal status signals.

It has become clear that dominance relationships become established not because higher ranking individuals *reinforce* their status by being aggressive or showing formal dominance signals but because lower ranking individuals *recognize supremacy* by showing formal submissive signals (e.g., Rowell, 1974; Syme, 1974; van Hooff and Wensing, 1987). This statement also makes sense from a logical point of view: if acceptance is lacking, conflicts are bound to remain or individuals avoid each other and may leave their group (see Mech and Cluff, 2010 for wolves). A state of repeated conflicts may occur when perceived asymmetries between 2 individuals are too small. In turn, this explains why conflicts between some dogs in the same household may be more frequent, persistent, and fierce than between other combinations. The probability of conflicts should be increased when dogs of the same sex, same age, and same breed are involved, leading to minimal asymmetry and hence, to more uncertainty with regard to their relationship. With this point, we now arrive at the assumed short-term function of dominance, namely to restrain the number and severity of physical conflicts. In canids, we know of just 2 studies that show that a stable hierarchy decreases and an instable situation increases the occurrence of aggressive encounters in semicaptive wolves (Zimen, 1975; Moran 1982). Nevertheless, it may occur that either the submissive animal does not recognize its status or the dominant animal will still reinforce its status, in spite of the submissive animal showing submissive behavior (Forkman and Haskell, 2004; Mech and Cluff, 2010).

In principle, conflicts are costly because they consume energy and time, may lead to wounds and other risks, such as an increased vulnerability to predation as a consequence of a decreased attention toward predators. These are the reasons why individuals have to make an *a priori* assessment before entering into a conflict. This assessment would include processing information on whether the resource at stake is worth the risk, the chances of losing and winning, and the possible costs of entering into a conflict. The outcome of such a weighing should lead to a decision to fight or to refrain and retreat. Uncertainty concerning the resource holding potential (RHP) could lead to agonistic interactions. These provide individuals with opportunities to gain information on the strength of

opponents, which consequently can result into avoiding fights with animals that could defeat them. In this way, physical harm or worse may be reduced (de Waal, 1989).

To form dominance relationships resulting in a rank order, animals do not need to have a concept of dominance, which is suggested by Casey (2009). It suffices that dogs know who is superior and who is subordinate, and a self-organized rank order emerges (Beacham, 2003). Moreover, unpublished data from Utrecht University showed that dogs also have insight into the relationships between third parties. If this were not true, interventions in ongoing interactions would be randomly directed. However, the data showed that they are clearly consistent with the rank order! Third-party interventions turned out to be more directed against lower than higher ranking individuals in an interacting pair and more against losers than winners (Netto et al., 1992). Also, trying to obtain a higher position does not need future planning, as Casey (2009) suggests. It just may happen provided there is some motivational factor that might be influenced by genetic (family) relationships, health, and environmental factors (see Chase and Seitz, 2011). That many domestic dogs, if not most, do *not* show such an “ambition” may be also the result of domestication. In this respect, individual and breed differences are to be expected. Also, breeds may differ in their possibilities to show submissive and other behaviors (Goodwin et al., 1997), and breed-specific tail and ear postures may influence communicative (im)possibilities (Mertens, 2004; Leaver and Reimchen, 2008).

Dominance in dogs: considering the pro and contra arguments in more detail

In this part, we follow the main arguments that would invalidate the concept of dominance for domestic dogs and comment on findings and conclusions.

1. Personality trait or dimension of relationship? Some authors claim that *dominance is not a trait, but a characteristic of a relationship* (Bernstein, 1981; Langbein and Puppe, 2004; Bradshaw et al., 2009). Consequently, ‘*use of the expression “dominant dog” is meaningless*’ (Bradshaw et al., 2009, p. 138). Comparable statements can be found in psychology. For example, Burgoon and Hale (1984) define dominance and submission as fundamental dimensions of personal *relationships*, whereas others recognize dominance as a *personality trait* (Kalma, 1991; Gangestad et al., 1992; Zebrowitz and Collins, 1997). There has thus been considerable debate in human and dog personality research on how to score and interpret certain traits and over the classification of certain behaviors within trait spectrums (e.g., Jones and Gosling, 2005; DeYoung et al., 2013). For instance, submissiveness has been classified as a trait in its own right (Jones and Gosling, 2005) and also as a subtrait of neuroticism (Ley et al., 2008).

Dominance, like subordination, reveals itself in interactions between individuals, but it is the differences between personal characteristics that define nature and outcomes of these interactions in terms of dominance relationships (see also Bernstein, 1981, p. 422). There is no logical reason why a trait like dominance/submission would not be present in canids and other social species. Data from studies on dog personality up to now were not linked to data on dominance in social groups. An attempt was made by Akos et al. (2014), who investigated leadership, dominance, and personality in a small group of dogs. These authors state on page 2 that “leader/dominant dogs have a unique personality: they are more trainable, controllable and aggressive, additionally they are older than follower/subordinate dogs.”

Gosling and John (1999) compared 19 studies in 12 species regarding the 5-factor model of personality. They included dominance and activity as factors in their analysis and concluded that evidence for a dominance factor was modest. Dominance appeared as a separate factor in 7 of the 19 studies they reviewed. In animals, the dominance factor was typically defined by assertiveness and boldness, physical aggression, and low fearfulness (p. 71). In humans, the dominance trait is typically only related to the E factor: extraversion vs. introversion (Gosling and John, 1999). Most likely dominant dogs will be of the “bold” type as defined by Svartberg (2005). This behavioral tendency often cannot be demonstrated at an early age in dogs or wolves (dogs: Beaudet et al., 1994; Diederich and Giffroy, 2006; wolves: Packard, 2003), although in a recent meta-analysis Fratkin et al. (2013) found substantial consistency for the dimensions aggression and submission in puppies, just as Svartberg et al. (2005) found consistency in personality in adult dogs. Inconclusive as the results are, they suggest that aspects of dominant and submissive personalities can be recognized in personality studies, including those on dogs. There are indeed dogs that show high postures toward many other dogs, just as there are dogs that show submissive behaviors toward many other dogs. This may reflect respectively *dominant* and *submissive personalities*, which may be recognized by many other individuals, although bold (certain) and shy (uncertain) would also be appropriate labels.

2. *Explaining submissive actions as conflict defusing actions, instead of submissive ones*, leaves the one-sidedness of the performance of submissive behaviors unexplained: why should only submissive dogs defuse and not the dominant ones? There must be more to it than just reconciliation or appeasement. This does not mean that acknowledgment of the dominant status of the opponent is the only function of showing a submissive behavior. Because muzzle licking seems to be derived from juvenile begging behavior (Schenkel, 1947), both a submissive and an appeasing meaning could have been developed later on in evolution. This defusing function of submissive acts was recognized by Schenkel (1967). The one-sidedness of submissive behaviors, nevertheless, demonstrates that acknowledgment of status might be a primary function.
3. *The much used pack model of wolves does not apply for domestic dogs*; a conclusion that was drawn by Coppinger (2001), van Kerkhove (2004), Bradshaw et al. (2009), and Yin (2009).

In wild wolves, life appears far more peaceful than previously thought, and wolves form an extended family group (Mech, 1999; Mech and Boitani, 2003). Under natural circumstances, strict rank orders, separately between male and female wolves, were not found in the wild and fights about dominance were not observed by Mech (1999). Mech (1999) seems to equal alleged dominance by the breeding pair with the parenting role: “any parent is dominant to its young offspring,” so the dominance status is “trivial information,” and the term dominance “falsely implies a rigid force-based dominance hierarchy.” However, Mech (1999) may have overlooked here that between the breeding male and female, and also within the litter, dominance relationships may exist and depend on formal submissive signaling. On the other hand, Mech (1999) recognizes that there is rank-related communication in wild wolves and that it involves posturing. Unfortunately, he has neither appreciated nor investigated whether posturing could be a formal status signal in wild wolf packs and that its frequent occurrence suggests that it must be functional. In a later article, Mech and Cluff (2010) described a prolonged dominance interaction between 2 wolves. Based on his observations that dominant wolves, usually the parents in a family group, dominate offspring by forcing them to the ground (mostly not lasting longer than 30 seconds), he suggests

that adult wolves this way force mature offspring to leave the pack and disperse. Research by him was done in summer, and competition for food and mates in summer is less than in winter. This may explain why he has missed much of dominance-related communication.

Most data on dominance in wolves stem from groups in captivity, where group composition may be abnormal and where levels of competition and aggression may be higher because of the lack of opportunities to disperse as wild wolves have. Consequently, increased frequency and intensity of communicative acts facilitate the construction of rank orders by observers. Because competition arises mostly within sexes, resulting in far more interactions within rather than between sexes, separate rank orders may arise. Such hierarchies were not found in all studies on captive wolves: Moran (1982, p. 81) did not find an “overall social structure” in his captive group of wolves, although “there were pairs in the group whose interactions suggested a typical dominance/subordinate relationship.” Spotte (2012, p. 227) concluded that expressions of dominance hierarchies in wolf packs are largely artifacts of captivity. However, a more adequate view would be that the species has the property to form hierarchies when competition is increased. There are no reports of abnormal behaviors involved in this, so formation of dominance relationships can be seen as a normal process occurring in extreme conditions resulting in elevated competition.

Further arguments that the wolf model cannot be applied to dogs are first, that dogs do not live in wolf-like cooperative packs and second, that dog behavior differs radically from wolf behavior because of domestication (Bradshaw et al., 2009). The studies by Pal et al. (1998) and Pal et al. (1999) are cited by Bradshaw et al. to illustrate these differences (see later). More recent, however, a clear pack structure in free-ranging dogs has been revealed (Bonanni et al., 2010; Cafazzo et al., 2010, 2012). Although not all feral dogs may adopt a wolf-like pack structure, the data in the newer articles bear out that communication regarding status does *not* differ so much between wolves and dogs at all. The main results of the new studies on dogs are summarized in Table 1 and resemble closely

Table 1
Signals related to (formal) dominance in wolves, dogs, and humans

Authors	Formal signals of dominance and submission in the wolf
Van Hooff and Wensing, 1987	Low & high posture, muzzle licking
Fatjo et al., 2007 Mech, 1999 Schenkel, 1947, 1967	Tail position Posturing Passive submission
Authors	Formal signals of dominance and submission in the dog
Bauer and Smuts, 2007 Cafazzo et al., 2010	Mounds, muzzle licks, muzzle bites Submissive affiliative behavior including low posture Submissive behavior Lowering of posture, muzzle licks, low tail wag = active submission of Schenkel, 1967
Trisko, 2011 van der Borg et al., 2012	
Authors	Signals of dominance and submission in humans
Morris, 1979; Mignault & Chaudhuri, 2003 Zivin, 1977; Schwartz et al., 1982; Eibl-Eibesfeldt, 1997; Carney et al., 2005	Lowering of posture: crouch, kneel, head down, kiss hand/foot High head/body posture
Rosa and Masur, 1979; Kalma, 1989 Strongman and Champness, 1968	Extended eye contact Gaze aversion

Bold print: signals designated by authors as formal signals; normal print: dominance/submission signals not designated as formal signals by respective authors.

those in the classic descriptive study of Schenkel (1947) and the quantitative study by van Hooff and Wensing (1987) on wolves, and are also in line with the study by Fatjo et al. (2007), who concluded that the most reliable indicator of status is the tail position. It should be noted that the captive group studied by van Hooff and Wensing (1987) in fact was an extended family: an original breeding pair with young and adult offspring.

Although the behavior of captive wolves may differ quantitatively from that of free-ranging wolves related to the level and intensity of competition, so far, the available data show that the principles of communication are identical. Because formal status signals in wild wolves do occur, dominance must also play a role there. That feral dogs do not always live in clear pack structures might complicate discovery of dominance relationships but does not inherently make them nonexistent. The argument that a wolf group must be seen as an extended cooperative family does not logically imply that dominance does not play an important role: data on humans and other primates (who often live in an extended family group structure!) show otherwise (Tiger, 1970; de Waal, 1977; Thomas, 2012). Mech and Cluff (2010) even stated that “dominance is one of the most pervasive and important behaviors among wolves in a pack, yet its significance in free-ranging packs has been little studied.”

4. *The outcomes of competition about resources have been used to investigate and define dominance.* It is important to note the often overlooked difference between dominance and the consequences thereof. For example, dominance has been defined by van Kerkhove (2004), following Drews (1993): “with reference to repeated conflicts between conspecifics over a scarce resource, whereby the same individual always gains access to the resource. With respect to only that specific resource, the winning animal is said to be dominant over the losing animal. Thus, social dominance is often *quite fluid* ...” (italics ours). In this reasoning, dominance is confused with a possible consequence of being dominant, and second, the implication is that dominance is flexible. Used in this way, the concept of dominance indeed would be superfluous. We have argued before that using the concept of dominance only makes sense if relationships tend to be stable over time and its behavioral expression consistent over contexts. This also is likely to hold for canids: Fatjo et al. (2007) mention a stable rank order in their captive wolf group lasting at least 12 months and comparable stability was found in the group of wolves studied by van Hooff and Wensing (1987) and later by Derix et al. (1993). Flexibility in the outcomes of conflicts may well be explained by individual differences in motivation and/or perception of the incentive value of a resource, leading to outcomes inconsistent with the dominance relationship. For example, a satiated dominant individual may leave food for a submissive one, but formal dominance signals will be exchanged as they were before: their main directions will not change. When formal dominance is not taken into account, and the focus of dominance studies is on the outcomes of conflicts only, this may lead to false assumptions regarding dominance status. Competitive ability is considered to differ from formal dominance (de Waal, 1989; Preuschoft, 1999).
5. *In feral dogs, reproduction is not linked with dominance.* Pal et al. (1999, 2003, 2005) could neither find clear displays of dominance or submission in their group of feral dogs nor frequent aggressive encounters between females. They found little reproductive suppression in females, and they found that infanticide only occurred rarely. However, Pal et al. (1998) established dominance hierarchies based on aggressive encounters, which is supposedly not an adequate measure, as

discussed before. Moreover, Pal et al. (1999) could not detect a relationship between dominance and the number of matings. From this, Bradshaw et al. (2009) concluded that “reproduction in feral dog groups ... appears not to be controlled by a wolf pack type of dominance hierarchy.” It can be questioned if such a conclusion can be made based on data on this small group of animals; and it certainly should not be generalized. It remains also unclear from their article if Pal et al. (1998) have investigated whether asymmetries in behavioral exchanges are concordant before lumping behaviors into groupings for investigating dominance and its consequences. In a later study, Pal (2010) refers to Cafazzo et al. (2010) regarding their defining criteria for dominance in litters of feral dogs: he now used “upright and stiff body postures with head held high and ears pricked, and growling and baring teeth.” In this study, he states that dominance hierarchy develops at an early stage of life and that “female and male domestic dogs form intra-sexual dominance relationships” (p. 150). This result agrees with those on wolves of Schenkel (1947), Woolpy (1968), and Zimen (1975) but not with that of van Hooff and Wensing (1987).

Data analysis in several species has shown that lumping behaviors that are not distributed in an identical way may prevent finding existing rank relationships to emerge. For example, combining offensive with defensive aggression in horses masks an otherwise linear rank order (van Dierendonck et al., 1995). Thus, Pal's findings might be simply a matter of a small data set, data arrangement, and analysis. As mentioned before, a recent study by Cafazzo et al. (personal communication) has shown a relationship between dominance and reproductive success in free-ranging dogs.

6. *Dogs are not likely to strive for dominance.* Bradshaw et al. (2009) and Casey (2009) presented some data of their own research, on a group of neutered male dogs. In this study, no clear rank order could be found, but they did find some “consistent dominant or subordinate relationships” within that group. Based on these findings, they concluded that “it now seems unlikely that interactions between dogs are always, or indeed ever, driven by the aim to achieve status within a social group.” This conclusion is based on the investigations of a group of castrated individuals of the same sex, seemingly lacking any competitive incentives (e.g., females, food or other highly valued objects). In such a situation, there is not much use to achieve a higher rank. Furthermore, the concordance between distributions of behaviors was not investigated before lumping behaviors into categories. Additionally, formal status signals like posturing were not included in the analysis as a separate item. It is a fact that the degree of competition influences the performance of conflict-related behavior, including utterances of dominance and submission. So, if competition for resources is practically absent, and an attenuating influence on agonistic behavior might be expected by the neutering, dominance relationships are expected to be harder to recognize. This also suggests that generalization from these data is questionable. The fact that Bradshaw et al. (2009) found *some consistent dominance-related relationships* may thus confirm dominance rather than to deny it.

Being the dominant may in itself become a desired outcome. This means that conflicts about dominance are possible (Bernstein, 1981) because obtaining a higher position may help in securing resources in the future. Such conflicts have been found in other species also. Andersen et al. (2004) described intense fighting between piglets that were grouped together and found that the

intensity was related to the competition level and changes therein correlated to group size.

7. *Learning and the resource holding potential (RHP) model is proposed as alternatives for dominance* (Casey, 2008; Bradshaw et al., 2009). Bradshaw et al. (2009) stated that “the development of stable relationships can be entirely explained using the principles of associative learning.” Learning, including social learning, certainly plays an important role in establishing dominance relationships (Bernstein, 1981; Beacham, 2003). Bernstein speaks of “trained losers” when individuals after losing a conflict emit submissive behavior toward other individuals and he defines a dominance relationship as a relationship in which one can predict that an animal will perform submissive behavior to a particular animal as a function of a past history of interactions with that particular animal (Bernstein, 1981, p. 420).

Spotte (2012, p. 225) also claims that dominance relationships depend on learning: “One animal learns to dominate a familiar conspecific ...” However, this nor Bernstein’s reasoning does explain the formal status signaling that instantly may occur between dogs that meet for the very first time and also the unidirectionality in it.

Contrary to the dominance model that predicts relatively stable relationships to prevent severe future conflicts, the RHP model does not take into account the results of previous interaction. Instead, fighting ability, motivation, and context play an important role here. However, the subjective value of a resource may differ between contestants, and it is this difference that should be a major factor to predict the outcome of the conflict. The asymmetry in fighting ability is the major aspect of the RHP model (Maynard Smith and Parker, 1976, p. 159) and in fact includes dominance. So a result might be that a satiated dominant dog (dominant, because of its formal signals) may leave food to a subordinate (subordinate, because of its formal signaling) because its motivation to defend the asset is low at that specific moment. This example shows that dominance may function alongside more motivational aspects to explain an outcome of an interaction, and that both learning and RHP cannot be seen as alternative explanations for dominance nor can the incentive value of a resource. Learning should be considered as a part of the mechanism that enables dominance relationships to develop, but it leaves the existence of formal dominance/submission signals unexplained. An individual trait, a tendency, to show either submissive or dominant behavioral patterns as a coping strategy cannot be excluded. The RHP model may explain variable outcomes of conflicts (see Barnard and Brown, 1984 for shrews), whereas formal status signals remain largely independent on the outcomes of conflicts around resources.

Dominance and the human–dog relationship

The 3 recent quantitative studies demonstrate that a limited number of formal status signals shown by dogs indicate dominance relationships (Table 1). They confirm the idea of Bauer and Smuts (2007) that formal dominance in dogs exists. Again other behaviors like staring, growling, and showing teeth at the opponent may primarily signify a tendency to become physically aggressive (a motivation) rather than having a communicative function concerning status (cf. Fatjo et al., 2007). We can support the notion of King (2004) and van Kerkhove (2004), that in fact the situation of dogs in a household may actually more resemble the situation of wolves in captivity than that of wild wolves or feral dogs. This would imply that stronger clearer dominance relationships may be formed or even need to be formed (van Kerkhove, 2004).

Interestingly, extensive literature is available on dominance and related concepts (status and power) in humans. Social power, dominance, and submission are considered fundamental dimensions of personal relationships (Miller-Day and Jackson, 2012), pervading every aspect of human social life (Carney et al., 2005). Much research was done in small groups of unacquainted individuals, who were gathered to perform some tasks. These persons were observed and questioned beforehand and/or afterward. It appeared that a first assessment of dominance relationships was made in the first minute after meeting the other persons in such a study group, even before any verbal communication had taken place (Kalma, 1991). Participants of these experiments were able to indicate who was dominant, but often they were not able to explain rationally why this was their perception. So, this primary assessment was quick and unconscious. If such a very quick assessment takes place in our own species where competition and cooperation are so important, it seems likely that an identical quick assessment may take place in other social animal species as well. A comparable quick assessment may occur in dogs and explain the spontaneous behavioral exchanges between unfamiliar dogs as shortly mentioned in the previous section.

McGreevy et al. (2012) give an interesting overview of (dis) similarities between dogs and people regarding communicative signals. They mention a number of behaviors (Tables 4, 5, 6: p. 110–112) like stand over, stare, place paw on to forequarter, averting eye contact, submissive grin, and submissive posture as signals that occur in humans and dogs. Apart from the designation “submissive” they did not mention that some of these signals could have a bearing on signaling dominance or submission. Therefore, the similarities regarding dominance/submission-related communicative signals that we summarize below and in Table 1 are an important supplementation.

A number of relevant behaviors are reported to be nonverbal indicators of dominance and submission in humans: sitting in a straight-up manner (Schwartz et al., 1982) and the chin-high posture (Zivin, 1977), also called the head tilt or raised head (Mignault and Chaudhuri, 2003; Carney et al., 2005). On the contrary, if the head is bowed downward, this turned out to be related to submission (and some emotions not relevant for this article). A third behavior mentioned was extended eye contact (Rosa and Masur, 1979; Kalma, 1989), and a fourth behavior was breaking eye contact (Strongman and Champness, 1968). The latter also may be labeled “gaze aversion” and is a signal of submissiveness or subordination (Mazur and Booth, 1998). Gesticulation during speech was mentioned by Freedman (1972), but it is hard to see how that would be relevant to dogs. Another nonverbal behavior by dominant people is sitting or standing on an elevated seat or platform (Eibl-Eibesfeldt, 1997; Mignault and Chaudhuri, 2003), whereas submissive people make themselves smaller or take a lower spatial position, for example, by kneeling, bowing, kissing a hand or shoe, backing down (Morris, 1979; Mignault and Chaudhuri, 2003).

Reflecting on status-related communication signals, it can be concluded that a number of human characteristics of communicative signals related to dominance and submission resemble distinct aspects of dog–dog communication related to dominance, especially postural elements. Extended eye contact resembles staring at an opponent, a signal of an aggressive motivation (Feddersen-Petersen, 2004) rather than dominance in dogs. The opposite could be breaking eye contact (e.g., looking away as it is often called in dog ethology), as a sign of appeasement, one of the means to avoid (escalation of) a conflict (Schenkel, 1967).

These similarities may have facilitated the communication between both species during domestication. Furthermore, dogs are likely to interpret human postural information in terms of a dominance/submissive relationship, and they may interpret prolonged

eye contact as a threat. Whether humans are able to interpret dog behavior correctly remains to be seen (see Kujala et al., 2012). Additionally, it may be expected that dogs may also use a quick assessment of the dominance position of their human counterpart as well. This in turn could explain some clinical observations on dog aggression toward humans. It explains why dogs that have an unclear rank relationship with their human partner are more likely to attack when the human partner shows a relatively “low posture” (e.g., human lies on the floor, bends down to clean the floor, falls down, or the dog sits on the human’s lap or sits on the couch close to the human), or when the human is sick or feels weak, or when direct eye contact is made with a dog (Schilder, 2005). Such kinds of attacks that may well happen in noncompetitive contexts facilitate the interpretation that at least some dogs may show a tendency to raise their status. This is in line with Bernstein (1981) but contrast with the statement by Bradshaw et al. (2009) that dogs do not tend to do just that. All these indications suggest that dogs are well able to read at least an important part of our nonverbal communication relevant to dominance.

In conclusion, the notion of dominance in dogs in our opinion is a useful concept. It explains an important aspect of the relationship between dogs and also between dogs and humans. We want to emphasize that stability in a relationship does not arise from exerting dominance (over dogs by humans by using forceful acts) but by showing formal submissive signals (by the dog toward humans). Teaching a dog to accept humans as dominants and to accept related behavioral limits should be different from teaching appropriate behavior like sitting or lying down on command. The former depends heavily on learning to accept a submissive status, which chiefly necessitates an adequate socialization of the dog and a clear and consistent behavior by the owner. The latter involves reward-based training, which is being facilitated by a clear dominance relationship but not dependent on it. We strongly feel that this message should be promoted and clearly explained by dog professionals like instructors, behavior counselors, and veterinarians. Denying the concept of dominance is not helpful to lenient owners who have a truly dominant dog and are struggling with control problems. The assessment of the dominance relationship between dog and owner should be based on observations of postures and accompanying behaviors shown by the dog. In diagnosing aggression problems, application of the dominance concept and observing associated formal status signals in dogs during its interactions in different contexts is very useful, as this gives insight whether the dog’s aggression was fear motivated or whether the dog was far more confident in its situation and that exerting dominance in the relationship may play a role. To this purpose, it is necessary to ask the owners to report formal signals of dominance or submission of their dog during behavior consultation. Questions on the postural communication and other (formal) signals the dogs have shown should always be a part of anamneses. For owners, it is therefore important to recognize formal signals of submission or dominance.

Formal signals of active and passive submission are foremost shown by young dogs toward their owners before puberty. Although testosterone during puberty can boost male dogs to try to restructure their relationship with their owner, most dog–human relationships will overcome this hormone-driven challenge. It is also very important to realize that aggression is not the equivalent of dominance; neither is it necessarily an expression of dominant behavior.

Finally, we want to emphasize that accepting the scientific concept of dominance should not legitimate the application of forced dominance signals like *alpha rolls* in training. They are dangerous in provoking aggression and will in general not be helpful in establishing a respectful and harmonious human–dog relationship.

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Conflict of interest

The authors declare no conflict of interest.

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