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Analysis of the intraspecific visual communication in the domestic dog (*Canis familiaris*): A pilot study on the case of calming signals

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ABSTRACT

Studying the signaling of domestic dogs is crucial to have a better understanding of this species. The aim of this study was to scientifically assess if the behaviors called calming signals have a communicative and a calming function (i.e., de-escalating the aggressive display in the other dog). Twenty-four dogs, 12 females and 12 males, acted as senders; they were observed for the display of the behaviors considered by Rugaas (2006) as calming signals (CSs). The behavior of each sender dog was analyzed during four 5-minute off-leash encounters, in which the dog met 4 different recipients, respectively: a familiar and an unfamiliar dog of the same sex; a familiar and an unfamiliar dog of the other sex. The display and trend of aggressive behaviors in recipient dogs was also analyzed. In total, 2,130 CSs were observed. Some behaviors were displayed more often than others, especially, head turning, licking nose, freezing, and turning away. It was statistically more likely that the CSs were sent while the 2 dogs were interacting rather than when there was no interaction ($\chi^2 = 836.155$; $P < 0.001$), suggesting these signals have a communicative role. The statistical analysis revealed that a higher number of signals were observed during meetings between unfamiliar dogs ($\chi^2 = 108.721$; $P < 0.001$). Head turning, nose licking, freezing, making him/herself smaller, and paw lifting were displayed by the sender statistically more frequently while interacting with unfamiliar dogs. Licking the other dog's mouth was more commonly directed toward familiar dogs. In total, 109 episodes of aggressive behaviors were displayed by the recipient dogs. Aggressive episodes were never preceded by the display of a calming signal from the other dog. In 67.0% of cases (N = 73), at least 1 CS was displayed by the sender dog after having received an aggressive behavior from the recipient. When CSs were displayed after an aggressive interaction, in 79.4% of cases ($N = 58$), there was a de-escalation in the aggressive display of the other dog. It was statistically less likely that the intensity of aggressive behaviors increased (5.5%/N = 4) or remained unvaried (15.1%/N = 11; $\chi^2 = 13.17$; $P < 0.001$). These findings suggest that these CSs indeed may have a role in social facilitation and preventing further aggressive behaviors.

Introduction

For practical purposes, communication can be defined as the transfer of information that occurs when an individual (sender) sends a signal that may modify another individual's behavior (recipient) (Landsberg et al., 2013). The signal bears information, and for effective communication, both sender and recipient must use and understand the same code.

Domestic dogs are social animals, so communication is essential and all modes of communication are used. Visual communication, including both postures and facial expressions, is very important to maintain cohesion within the group, for example, for conflict resolution and reconciliation (Cools et al., 2008; Cozzi et al., 2010).

The study of intraspecific visual communication in the domestic dog started with the observation of its ancestor, the wolf, but drawing conclusions on dog behavior from studies on wolves has been found to be misleading (e.g., Bradshaw et al., 2009) due to the

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differences between the 2 species (Feddersen-Petersen, 1991; Miklósi et al., 2004). Although dogs and wolves show some similarities, their behavior is widely influenced by both phylogenetic (domestication) and ontogenetic (living in a domestic environment) factors.

Dogs seem to show substantial differences in intraspecific social behavior (Bradshaw et al., 2009), especially with respect to aggressive behavior, compared to wolves (Fatjó et al., 2007). According to Scott (1950), most dog breeds have higher thresholds for aggressive behavior than wolves. If true, this will influence body language in agonistic encounters. Goodwin et al. (1997) found that pedomorphosis, the retention of juvenile morphology and behavior in the adult dog, led to the loss of some visual signals, especially in the canine breeds which most differ from the lupine morphology.

Fox (1972) observed that during intraspecific interactions, wolves could display specific behaviors that function to block the interaction, even if the interaction was aggressive. Such behaviors were defined as cutoff signals (Chance, 1962; Fox, 1969). Some examples include diverting the gaze, turning the head, lying on a side, raising a forelimb, and urinating. The presence of visual signals that increase the distance between individuals and avoid the risk of an overt aggression has also been assumed in dogs (Beaver, 1982; Shepherd, 2009). Rugaas (2006) indicated some behaviors displayed by domestic dogs were able to de-escalate or interrupt an aggressive encounter. Such signals were hypothesized by Rugaas to be even more effective than cutoff signals in wolves and able to prevent aggressive episodes to avoid conflicts. Rugaas labeled these signals as "calming signals." Other terminology is also used to describe behaviors that may de-escalate aggressive episodes, such as appeasement behaviors (Shepherd, 2009; Landsberg et al., 2013; Kuhne et al., 2014). However, replicable, rigorous quantitative studies using sequence analysis within interactions are lacking for the achievement of an agreed-on dog ethogram (Overall, 2013). Such studies are needed for a deep, reliable understanding of dog signaling.

The aim of this study was to scientifically assess if the behaviors called "calming signals" have a communicative and a de-escalating function with respect to the aggressive display in the other dog. Due to the complexity of intraspecific communication in domestic dogs, this should be regarded as a pilot study.

Subjects, materials, and methods

Subjects

Dogs in pairs, distinguished as senders and recipients, participated at this study. Senders were the focal dogs, who were observed for the display of the so-called calming signals (CSs; for the list, see the Table). Recipients were those dogs who met the senders. Recipients were observed for the possible display of aggressive behaviors.

The senders were comprised of 24 dogs, 12 females (8 spayed) and 12 males (6 neutered), ranging from 1.5 to 8 years (4.3 ± 1.2 year), belonging to various breeds or mixes. The senders were divided according to their size into 2 groups, small dogs (height at withers < 40 cm, $n = 7$) and medium-large dogs ($n = 17$). The recipients were divided using the same criterion and paired to senders of the same size category, to avoid large differences in size between the meeting dogs.

Before participating in the organized meeting, the owners of involved dogs were interviewed by a veterinary behaviorist to assess their dog's suitability for the study, that is, the absence of physical and behavioral problems that could have altered the intraspecific communication and endanger other dogs and people.

Table
Behaviors analyzed in this study as possible calming signals and their relative description

Behavior	Description
Head turning	Turning the head either to the side and back, or holding the head to one side
Softening the eyes	Lowering the lids
Turning away	Turning the body to the side or back of the other dog
Lip/nose licking	Sticking the tongue out, licking the nose or the lips
Freezing	Stopping any movement, either standing, sitting or lying still
Slow movements	Moving, for example, walking slowly
Play bow	Flexing the forelimbs and remaining with the hindlimbs high
Sitting	Being in a position in which dog's weight is supported by the buttocks on the ground and forelegs are high
Lying down	Being in a horizontal position on the ground, with the belly to the ground
Yawning	Opening widely the mouth, teeth may show, tongue may curl and protrude, eyes are usually closed
Sniffing ground	Placing the nose close to the ground (or the wall of the fenced area) for less than 2 seconds and seemingly using the nose to explore it
Curving	Walking in a curve
Low wagging	Moving the tail held in a low position
Smaller	Reducing body size
Licking other dog's mouth	Passing the tongue over the other dog's mouth or attempting to do it
Blinking	Fluttering eyelashes
Smacking lips	Closing and opening the mouth producing a noise for the smacking of lips
Paw lifting	Lifting a forepaw

Adapted from Rugaas, 2006.

Protocol

Meetings were organized so that each pair of dogs met within an outdoor 5 × 5 m fenced area. The enclosure was formed by three 2-m-high walls and a wire netting (see Figure 1). Each sender met 4 different recipient dogs, 1 per meeting: an unfamiliar dog of the same sex, an unfamiliar dog of the other sex, a familiar dog of the same sex, and a familiar dog of the other sex. In total, 96 meetings were carried out, 48 between familiar dogs and 48 between unfamiliar dogs, in which each subject (sender dog) acted as its own control. Dogs were considered familiar

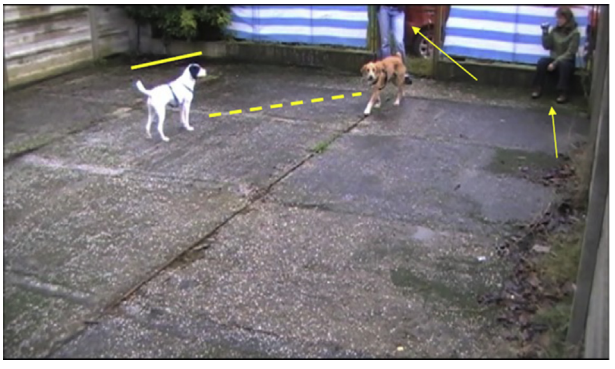

Figure 1. A picture captured from an analyzed video. The yellow lines show the length of the sender dog (solid line) and the distance between the 2 dogs (dashed line); their ratio provides a measure of the close/distance interaction. The yellow arrows show the position of one of the owners (standing) and of the operator using the mobile camera (sitting). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

when they had met each other and were free to interact at least 5 times for more than 15 minutes during the last month. One of the meetings had to occur in the 10 days preceding the test. Dogs were considered unfamiliar when, according to owners, they had not met in the last year and did not meet regularly in the past. Because all the dogs lived in the same town, we could not guaranteed that dogs had no prior opportunities for visual, olfactory, or direct contact.

The order of execution was determined semi-randomly. Senders could not meet more than 2 recipients during the same day, and a break of at least 10 minutes was taken between meetings. Before starting, each dog was individually accompanied in the fenced area, left free to explore it for 2 minutes, and then removed from the area. The 2 dogs were then led by their owners into the enclosure, let off the leash, and left free to move and interact for 5 minutes. Owners were asked to stay within the fence, in 2 different peripheral positions, and to minimize their interaction with dogs (e.g., remaining silent, not staring at dogs). Owners were instructed to intervene only if the experimenter considered it necessary for safety reasons.

All the meetings were videoed with 2 video cameras: 1 was handheld by an operator positioned in a corner of the fenced area, and 1 was fixed, located on the wall of another corner (see Figure 1).

Video analysis

Videos were analyzed frame-by-frame. The analysis was carried out using the 5-minutes videos of the handheld camera. The videos from the fixed camera were used to integrate those from the handheld camera if this was needed for a better evaluation (e.g., when 1 dog was not completely visible).

The behaviors suggested as CSs which were observed are reported in Table, together with their description. Such behaviors correspond to the list of the so-called calming signals described by Rugaas (2006). Splitting up (i.e., putting one's body between 2 dogs) is included in Rugaas' list of calming signals, but it was excluded in this study because only 2 dogs were present at the same time.

For each CS, the number of listed behaviors displayed by the sender was counted. Two trained observers analyzed the 10% of videos to check interobserver reliability, which was high (91.2%). Consequently, 1 observer, expert in dog behavior and blinded to the familiarity of dogs, analyzed all the 96 videos.

Every time that a CS (or a sequence of up to 3 CSs) was observed, the interactive situation was registered and categorized as follows:

1. No interaction: dogs were at a distance longer than 1.5 times the length of the sender dog and they had no eye contact;
2. Interaction at distance: dogs were at a distance longer than 1.5 times the length of the sender dog and they were interacting (e.g., they had eye contact or were clearly communicating one to the other);
3. Close interaction: dogs were at a distance shorter than 1.5 times the length of the sender dog.

In addition, we recorded every time that the recipient showed an aggressive behavior. These behaviors were operationally defined as any of the following, alone or in combination: biting, snapping, growling, and/or aggressive barking (i.e., barking + lunging, charging, or staring). When 1 or more of these aggressive behaviors were displayed by the recipient dog, 2 more types of information were recorded. The first was whether the sender dog displayed at least 1 CS after the recipient dog had shown an aggressive behavior. The evolution of the aggressive encounters was also recorded. Using the ladder of aggression suggested by Shepherd (2009), the interactions were evaluated with respect to evidence for de-escalation, escalation, or no variation in intensity.

Statistical analysis

The statistical analysis was carried out using the Pearson χ^2 test with Yates correction. If the number of observations were low, the Fisher test was used.

Results

In total, 1,445 behavioral sequences were registered in which the sender dog showed at least 1 CS. For each sequence, up to 3 CSs were counted. The total number of observed CS was 2130.

The time spent by dogs in the 3 categorized interactive situations was not equally distributed: dogs spent 40.5% of the entire time without interacting; 17.5% interacting at distance; and 42.0% interacting closely. Such distributions of time dramatically differ from the distribution of behaviors displayed in the 3 contexts: 65.9% of CSs were observed when dogs were involved in a close interaction, 25.1% in an interaction at distance, and only 9.0% in a noninteractive situation. It was statistically more likely that the CSs were displayed by the sender while the 2 dogs were interacting rather than when there was no interaction ($\chi^2 = 836.155$; $P < 0.001$).

The number of CSs observed in the different interactive situations is reported in Figure 2. This diagram shows that some behaviors more often displayed than others: head turning, licking nose, freezing, and turning away. The diagrams also show that almost all signals were more frequently displayed during close interactions compared to both interaction at distance and no interaction. Sniffing the ground and yawning were instead more frequently shown when the 2 dogs were interacting at distance.

The statistical analysis revealed that a higher number of signals were observed in the meeting between unfamiliar dogs ($\chi^2 = 108.721$; $P < 0.001$; Figure 3). Turning the head ($\chi^2 = 17.082$; $P < 0.001$), licking the nose ($\chi^2 = 11.688$; $P < 0.001$), freezing ($\chi^2 = 36.275$; $P < 0.001$), making him/herself smaller ($\chi^2 = 4.523$; $P = 0.033$), and paw lifting ($\chi^2 = 5.712$; $P = 0.017$) were displayed statistically more often while interacting with unfamiliar dogs. In contrast, licking the other dog's mouth ($\chi^2 = 12.903$; $P < 0.001$) was more commonly directed toward familiar dogs.

A total of 109 aggressive episodes displayed by the recipient dogs were recorded; 68 occurred between unfamiliar dogs and 41 between familiar dogs. Aggressive episodes were never preceded by the display of a CS from the other dog. In 33.0% of cases (N = 36), aggressive behaviors were not followed by the display of any CS by the sender. In the 67.0% of cases (N = 73), at least 1 CS was displayed by the sender dog. After having received an aggressive signal, the sender dogs more often displayed a CS ($\chi^2 = 5.46$; $P = 0.019$). In particular, the display of a CS was more probable when aggressive behavior was received from an unfamiliar dog rather than from a familiar dog (75.0% vs. 53.7%; $\chi^2 = 4.346$; $P = 0.037$).

When the sender dogs displayed a CS after an aggressive behavior was displayed by the recipient, in 79.4% (N = 58) of cases, there was a reduction in the aggressive interaction [i.e., the recipient showed a behavior that is located lower in the ladder of aggression proposed by Shepherd (2009)]. It was statistically less likely that the aggressive encounter increased (5.5%/N = 4) or remained unvaried in intensity (15.1%/N = 11; $\chi^2 = 13.17$; $P < 0.001$). The number of displays of each CS after receiving an aggressive behavior is reported in Figure 4.

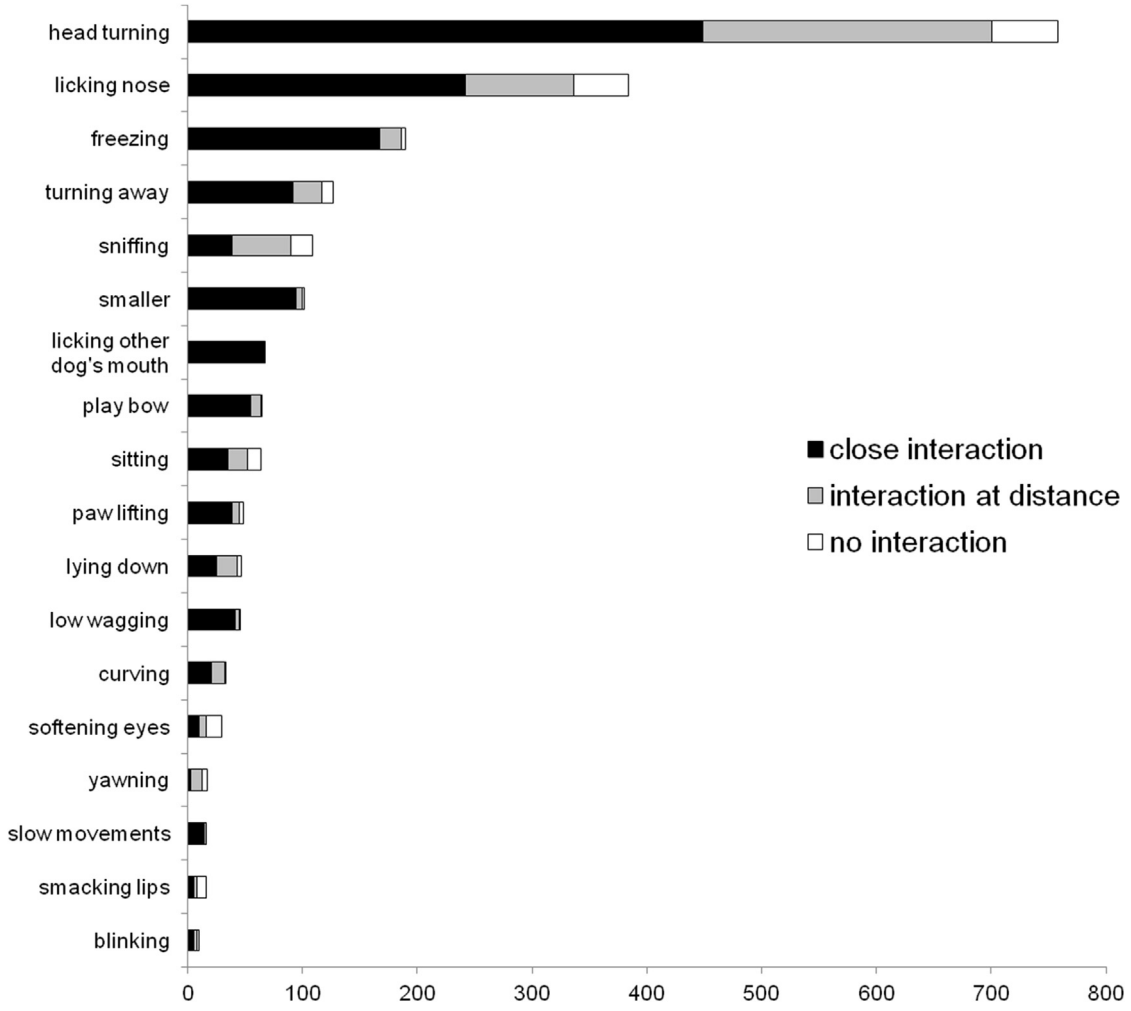

Figure 2. Number of times the analyzed behaviors have been displayed according to the kind of interaction between dogs.

Looking more closely at aggressive episodes in which CSs were not reported, 24 of 36 cases involved 1 individual dog who seemed to provoke other dogs and to fail to signal with a CS. In most of these 36 episodes, senders were increasing their distance from the aggressors (walking away or fleeing), but the senders also responded aggressively or kept doing the same action, leading to an increased or unvaried level of aggressive behavior.

Discussion

Visual communication in domestic dogs is complex, affected by many factors such as underlying emotions and dog morphology (Goodwin et al., 1997). The findings of this pilot study should be considered as a starting point from which future research designed to address specific questions, such as the value of the single signal and the differences related to the sex, morphology, ontogeny, and so forth of the individual dogs. A more detailed analysis, including other signals or other factors (e.g., context, individual, and dyad features.), is needed before considering the findings conclusive.

The first remarkable result is that, although dogs spent much time without interacting, the analyzed behaviors were mostly (and statistically more often) displayed when the 2 dogs were interacting. This allows us to hypothesize that such behaviors have a communicative role and are signals.

The second relevant finding is that, when the so-called CSs were displayed after having received an aggressive behavior, in most of the cases, according to the ladder of aggression presented by Shepherd (2009), there was a de-escalation in the display of aggressive behaviors; it was statistically less likely that the intensity of aggressive episodes increased or remained unvaried. This finding suggests that these signals have a de-escalating role.

The high frequency of display observed for the analyzed behaviors suggests an important role for these signals in canine visual communication. However, some behaviors were displayed much more frequently than others (e.g., head turning and nose licking). Future studies should investigate these differences to understand if they are related to a salience or other factors.

The majority of behaviors described by Rugaas as CSs are reported by other authors as indicative of stress in dogs: for instance yawning, looking elsewhere, turning the head, nose licking, and paw lifting (Beerda et al., 1998; Schilder & Van der Borg, 2004; Tod et al., 2005; Rooney et al., 2009; Mariti et al., 2012). However, this is not in contrast with their de-escalation function because it is likely that stressed dogs can communicate their state to other dogs, that receivers of such information decrease the display of their aggressive behaviors.

The display of CS was strongly affected by the familiarity of the individuals interacting, and the number of signals was significantly higher in meetings between unfamiliar dogs. These findings are in

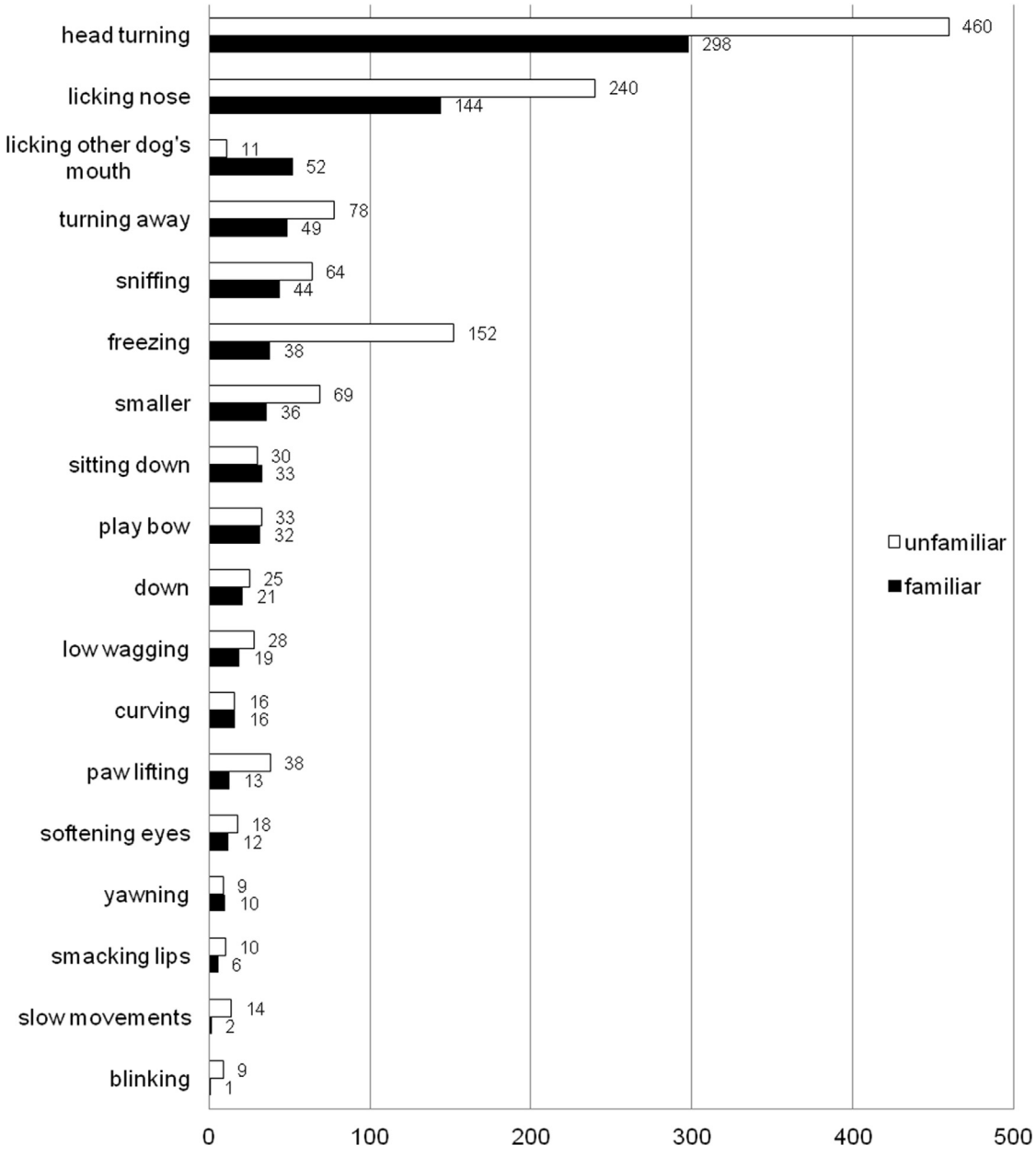

Figure 3. Number of times the analyzed behaviors have been displayed according to the kind of relationship between dogs.

agreement with Pullen et al. (2013) who found that dogs have higher numbers of intraspecific interactions in the first 3 minutes after being left off-leash, and in this period, the number of interactions and the time spent in contact is higher if dogs were unfamiliar. In our study, the lack of familiarity led to a marked increase of turning head, licking nose, freezing, making him/herself smaller, and paw lifting. These behaviors are described in the scientific literature as possible signs of stress (Beerda et al. 1997, 1998; Mariti et al., 2012), and their display may be associated with uncertainty when meeting an unfamiliar dog, with whom a relationship is not established. The hypothesis that more tension was present when unfamiliar dogs were involved is supported by the higher number of aggressive episodes observed in such meetings. In contrast, licking the other dog's mouth was more commonly directed toward familiar dogs. This behavior exposes the animal to some risk (being close to the other's dog mouth), so familiarity may be required to facilitate it.

Only some of the analyzed behaviors were observed during an aggressive interaction. Among those, freezing, turning the head, turning away, and making themselves smaller were the most often displayed, alone or in association with others. Such data suggest that some of the so-called "calming signals" may exert their effectiveness by de-escalating the aggressive display when it has already been triggered, but future research is needed.

After receiving an aggressive behavior, dogs were not observed to show any calming signals and instead usually moved away from the aggressor. Walking away and fleeing increase the distance between the 2 dogs and so these behaviors usually lead to a de-escalation of the aggressive encounter. These behaviors are not included within CS, but they have the same function here.

A question remains as to whether such signals, as proposed by Rugaas (2006), may also play a role in preventing aggressive interactions. In this study, no aggressive episodes were observed after the display of a CS, so we cannot rule out that such signals

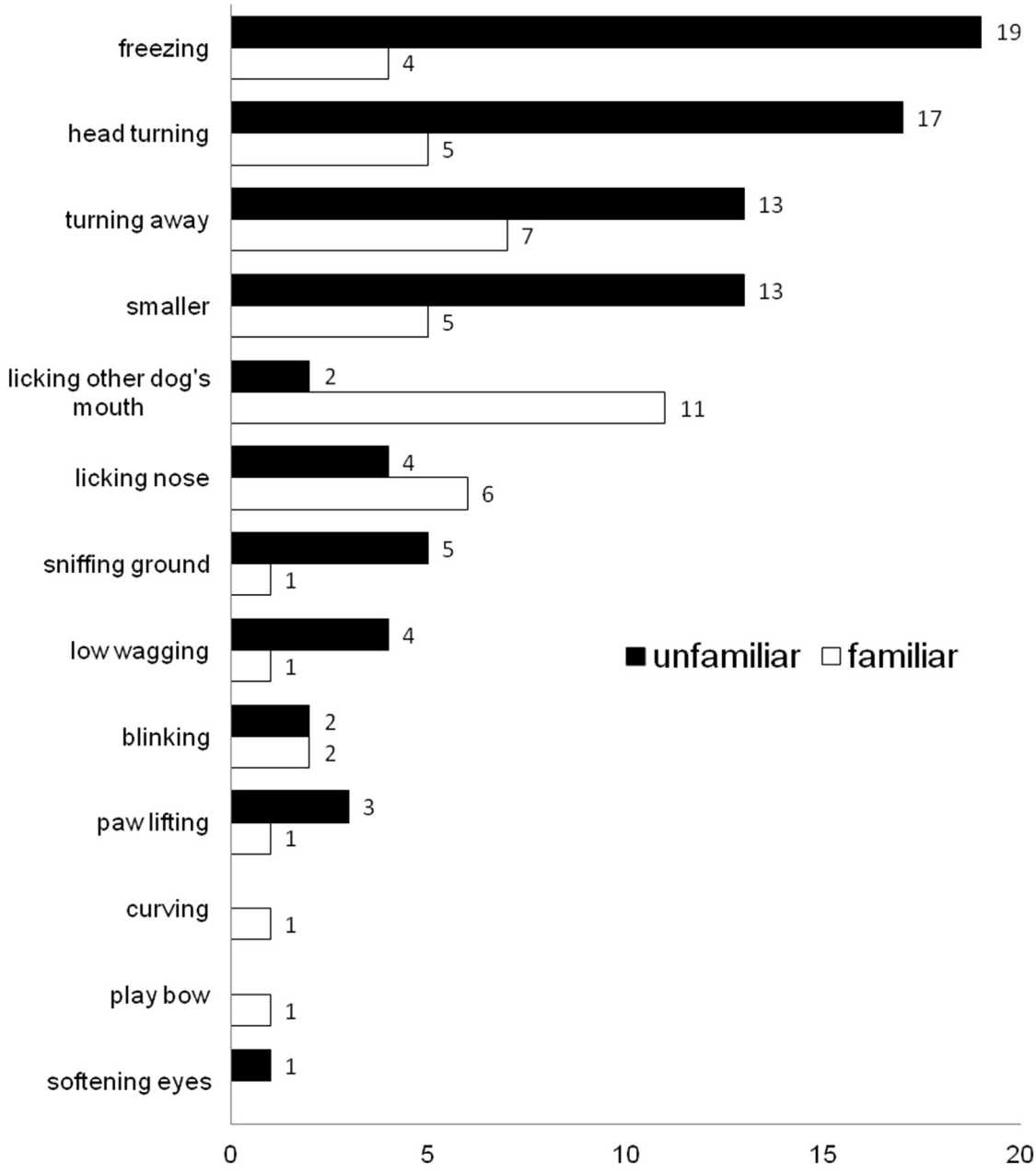

Figure 4. Number of times the analyzed behaviors have been displayed after an aggressive behavior in meetings between familiar and unfamiliar dogs.

could play also a role in preventing the display of aggressive behaviors. In this case, calming signals in domestic dogs would be more effective or specific than cutoff signals described by Fox (1972). Domestic dogs live in a human environment, meeting many animals belonging to their own and to other species, some of them familiar and some of them unfamiliar (Shyan et al., 2003). Living in such a "crowded" environment has selected for a low probability of overt aggression, due to the risk of injuries and reduced fitness aggressive episodes may imply. It is likely that the species of domestic dogs have developed signals that are very effective in reducing aggressive episodes.

The findings of the present study refer only to a sample of dogs with specific inclusion criteria. It is possible that the analysis of dogs showing behavioral problems and overt aggression would produce different results. It is possible that, during an overt aggressive interaction, one of the dogs involved lacks the ability to communicate and/or to recognize of such signals, thus blocking their preventative role. Our findings are relevant for daily interdog encounters because owners who allow their dogs to socialize off-leash are usually self-selecting, self-monitoring, and self-limiting in regard to dog aggressive behavior (Shyan et al., 2003), so our research has the advantage of reproducing daily situations in a standardized manner.

Mariti et al. (2012) found that subtle behavioral signs, displayed in the earlier stages of emotional arousal (Kerswell et al., 2009), often go unnoticed and can be misinterpreted by owners. Owners tend to focus their attention on vocalizations and gross body movements, and more subtle signals may be easily disguised by a dog's morphological traits (Kerswell et al., 2009). Veterinarians, and especially veterinary behaviorists (Mariti et al., 2015), must explain to owners and, if necessary, to point out the more subtle signals and indicators of stress in dogs (Mariti et al., 2012).

Conclusions

The findings of this study support the hypothesis that the analyzed behaviors may play a specific role in canine communication, namely reducing the aggressive display. Further research is needed to better understand the meaning, relevance, and impact of each signal on dog aggressive encounters.

Acknowledgments

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Ethical considerations

This research was an observational study involving owned dogs; thus, it did not require the approval by an ethical committee. Owner informed consent and authorization to video record were obtained before testing each dog.

Conflict of interest

We have read and understood this journal's policy on declaration of interests and declare that we have no competing interests.

Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jveb.2016.12.009.

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