Analysis of the intraspecific visual communication in the domestic dog (*Canis familiaris*): the case of calming signals.

Chiara Mariti[1*], Caterina Falaschi[1], Marcella Zilocchi[1], Jaume Fatjò[2], Claudio Sighieri[1], Asahi Ogi[1], Angelo Gazzano[1]

[1] Department of Veterinary Sciences, University of Pisa, Italy

[2] Department of Psychiatry and Legal Medicine, Autonomous University of Barcelona**,** Spain

*chiara.mariti@unipi.it

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Abstract

The study of intraspecific visual communication in the domestic dog started with the observation of its ancestor. However, studying domestic dogs is crucial to have a better knowledge and 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.

Twenty-four dogs, 12 females and 12 females, acted as senders; they were observed for the emission of the behaviors considered by Rugaas (2006) calming signals (CS). The behavior of each sender dog was analyzed during four 5-minute off-leash encounters, in which the dog met a recipient, respectively: 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. The display and trend of aggression in recipient dogs was also analyzed.

In total, 2130 CS were observed. Some behaviors were much more displayed than others, above all head turning, licking nose, freezing and turning away.

It was statistically more likely that the CS were emitted while the two dogs were interacting rather than when there was no interaction (χ^2 = 836.155; $p < 0.001$), allowing to hypothesize that CS have a communicative role.

The statistical analysis revealed that a higher number of signals were observed in the meeting between unfamiliar dogs (χ^2 = 108.721; $p < 0.001$). In detail, turning head, licking nose, freezing, making him/herself smaller, and paw lifting were emitted statistically more while interacting with unfamiliar dogs. Licking the other dog's mouth was instead more commonly directed towards familiar dogs.

Concerning aggression, in total 109 aggressive episodes displayed by the recipient dogs were registered. Aggressive episodes were never preceded by the display of a calming signal from the other dog. In the 70% of cases, at least one CS was displayed by the sender dog after the aggression from the recipient. When CS were displayed after an aggression, in 79.4% of cases there was a reduction in aggression in the other dog. It was statistically less likely that aggression increased (5.5%) or remained unvaried (15.1%; χ^2 = 13.17; $p < 0.001$). These findings suggest that CS indeed have a calming role. The term calming signals seems therefore to be appropriate in describing such behaviors.

Key words: aggression; behavior; calming signal; communication; dog.

Introduction

Domestic dogs are social animals, therefore communication is essential and all channels of communication are used. Visual communication, including both postures and mimics, is very important to maintain cohesion within the group, e.g. for conflict resolution, and it is in fact the basis for reconciliation (Cools et al., 2008; Cozzi et al., 2008).

The study of intraspecific visual communication in the domestic dog started with the observation of its ancestor. However, studying domestic dogs is crucial to have a better knowledge and understanding of this species. Drawing conclusions on dog behavior from studies on wolves has been found to be misleading (e.g. Bradshaw et al., 2009), due to the differences between the two species (Feddersen-Petersen, 1991; Miklósi et al., 2004). In fact, dog and wolf show some similarities, but their behavior is widely influenced by both phylogenetic (domestication) and ontogenetic factors (e.g. living in a domestic environment).

Dogs seem to show substantial differences about intraspecific social behavior (Bradshaw et al., 2009) and especially aggression compared to wolves (Fatjò et al., 2007). According to Scott (1950), most dog breeds have higher thresholds for aggression than wolves, and so the Author hypothesized that dogs may not need a body language as complicated as it is in wolves. Goodwin et al. (1997) found that paedomorphosis, 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 wolves, during intraspecific interactions, could display specific behaviors having the function of blocking the interaction, even if aggressive. Such behaviors were defined cut-off signals (Chance, 1962; Fox, 1969); some examples are 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 been assumed also in dogs (Beaver, 1982; Shepherd, 2009). Turid Rugaas (2006) indicated as calming signals some behaviors displayed by domestic dogs that, according to her observations, were able to interrupt aggression. Such signals are supposed by Rugaas to be even more effective than cut-off signals in wolves, being able to prevent aggression and therefore to avoid conflicts. Calming signals are largely mentioned in veterinary behavioral medicine and dog training, but neglected in ethological research.

The aim of this study was to scientifically assess if the behaviors called calming signals have a communicative and a calming function.

Subjects, materials and methods

Subjects

Dogs in pairs, distinguished in senders and recipients, participated at this study. Senders were the focal dogs, who were observed for the emission of the so-called calming signals (below reported as CS; for the list, see table 1). Recipients were those dogs who met the senders, so they were not focal dogs for the emission of CS; recipients were instead observed for the possible display of aggressive behaviors.

Senders were 24 dogs, 12 females (8 spayed) and 12 males (6 neutered), ranging from 1.5 to 8 year old (4.3±1.2 year old), belonging to various breeds or mongrels. They were divided according to their size in: small dogs (height at withers $<$ 40 cm, n = 7), and medium-large dogs (n = 17). Recipients were divided using the same criterion and paired to senders of the same category, in order to avoid big differences in size between the meeting dogs.

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

Protocol

Meetings were organized so that each pair of dogs met within an outdoor 5 x 5 m fenced area. The enclosure was formed by three 2 m-high walls and a wire netting (see fig. 1). Each sender met 4 different dogs, one per meeting, with these features: 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 acted as its own control. Dogs were considered familiar when they had met each other, free to interact, in the last month at least 5 times for more than 15 minutes, and one of the meetings had occurred 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, it could not be guaranteed that dogs had any prior opportunities for visual, olfactory, or direct contact.

The order of execution was determined semi-randomly. Senders could not meet more than two recipients during the same day, and a break of at least 10 minutes was taken between a meeting and the following one. Before starting, each dog was individually accompanied in the fenced area, left free to explore it for 2 minutes, and took out. The two 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 two different peripheral positions, and to minimize their interaction with dogs (e.g. remaining silent, not staring at dogs, not chatting etc.). Owners were instructed to intervene only if the experimenter considered it necessary for safety reasons.

All the meetings were videoed with two video cameras: one was handheld by an operator positioned in a corner of the fenced area, and one was fixed, located on the wall of another corner (see fig. 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 the first in case it was needed for a better evaluation, e.g. when one dog was not completely visible.

The behaviors observed as CS are reported in table 1, together with their description. Such behaviors correspond to the list of the so-called calming signals described by Rugaas (2006). Splitting up, i.e.

115 putting one's body between two dogs, is included in Rugaas' list of calming signals, but it was
116 excluded in this study because only two dogs were present at the same time.
117 For each CS, the number of emissions by the sender was counted. Two trained observers analyzed the
118 10% of videos in order to check inter-observer reliability, which resulted very high (91.2%).
119 Consequently, one observer, expert in dog behavior and blinded to the familiarity of dogs, analyzed all
120 the 96 videos.
121 Every time that a CS (or a sequence of CS up to three) was observed, the kind of interactive situation
122 was registered and categorized as:
123 1. No interaction: dogs were at a distance longer than 1.5 times the length of the sender dog and they
124 had no eye-contact;
125 2. Interaction at distance: dogs were at a distance longer than 1.5 times the length of the sender dog
126 and they were interacting, e.g. they had eye-contact or were clearly communicating one to the other;
127 3. Close interaction: dogs were at a distance shorter than 1.5 times the length of the sender dog.
128 In addition, it was registered every time that the recipient showed an aggressive behavior, that was
129 operationally defined as any of the following behaviors, alone or in combination: biting, snapping,
130 growling and/or aggressive barking (i.e. barking + lunging, charging or staring). When an aggressive
131 episode was displayed by the recipient, two more types of information were recorded. The first was if
132 the sender, after having received an aggression, emitted at least one CS. The second thing was the
133 evolution of the aggressive behavior. Using the ladder of aggression suggested by Shepherd (2009), it
134 was evaluated if the aggression decreased, increased or did not vary.
135 Statistical analysis
136 The statistical analysis was carried out using the χ^2 test of Pearson ($p < 0.05$) with Yates correction;
137 when needed, because of the low number of observations, the Fisher test ($p < 0.05$) was used.

Results

In total 1445 behavioral sequences were registered in which the sender dog showed at least one CS. For each sequence, up to three CS were counted; the total number of observed CS was 2130.

The time spent by dogs in the three 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 distribution of time dramatically differ from the distribution of behaviors emitted in the three contexts: 65.9% of CS were observed when dogs were involved in a close interaction, 25.1% in an interaction at distance, and only 9.0% in a non-interactive situation. It was statistically more likely that the CS were emitted while the two dogs were interacting rather than when there was no interaction ($\chi^2 = 836.155$; $p < 0.001$).

The number of CS observed in the different interactive situations are reported in Figure 2.This diagram shows that some behaviors were much more displayed than others, above all head turning, licking nose, freezing and turning away. A trend for a higher display during close interactions, followed by interaction at distance and then when not interacting, was found for all signals, except sniffing the ground and yawning, which were more frequently shown when the two dogs were interacting at distance.

Other interesting results concern the comparison between meeting familiar and unfamiliar dogs (fig. 3). The statistical analysis revealed that a higher number of signals were observed in the meeting between unfamiliar dogs ($\chi^2 = 108.721$; $p < 0.001$). In detail, turning head ($\chi^2 = 17.082$; $p < 0.001$), licking 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 emitted statistically more while interacting with unfamiliar dogs. Licking the other dog's mouth ($\chi^2 = 12.903$; $p < 0.001$) was instead more commonly directed towards familiar dogs.

Concerning aggression, in total 109 aggressive episodes displayed by the recipient dogs were registered; 68 occurred between unfamiliar dogs and 41 between familiar dogs. Aggressive episodes were never preceded by the display of a calming signal from the other dog. In 30% of cases (n = 36), aggression was not followed by the emission of any CS by the sender. In the 70% of cases, instead, at least one CS was displayed by the sender dog. It therefore resulted statistically more probable that, after having received an aggressive signal, the sender dogs displayed a CS compared to not displaying any of them ($\chi^2 = 5.46$; $p = 0.019$). In particular, the display of a CS was more probable when aggression was received from an unfamiliar dog rather than from a familiar dog (75.0% versus 53.7%; $\chi^2 = 4.346$; $p = 0.037$).

When CS were displayed after an aggression, in 79.4% of cases there was a reduction in aggression in the other dog. It was statistically less likely that aggression increased (5.5%) or remained unvaried (15.1%; $\chi^2 = 13.17$; $p < 0.001$). The number of emission of each CS after receiving an aggression is reported in Figure 4.

Looking more closely at aggressive episodes in which calming signals were not reported, 24 out of 36 cases involved one individual dog, who seemed often to provoke other dogs and to fail the emission of CS. Instead of CS, in most of these 36 episodes senders were increasing their distance from the aggressors; in other cases, the senders answered aggressively or kept doing the same action, leading to an increased or unvaried aggression.

Discussion

Visual communication in domestic dogs is complex, affected by many factors such as underlying emotions and dog morphology (Goodwin et al., 1997), and therefore difficult to study. To our knowledge, this is the first scientific study dealing with the so-called calming signals in domestic dogs.

184 The findings should therefore be considered as a starting point from which carrying out research aimed
185 to address specific questions, such as the value of the single signal and the differences related to the
186 sex, morphology etc. of the individual dogs.
187 The first remarkable result is that, although dogs spent much time without interacting, the analyzed
188 behaviors were mostly (and statistically more often) displayed when the two dogs were interacting.
189 This allows us to hypothesize that such behaviors have a communicative role and, therefore, that they
190 are signals.
191 The second relevant finding is that, when the so-called calming signals were displayed after an
192 aggression, in most of the cases, according to the ladder of aggression presented by Shepherd (2009),
193 there was a reduction in aggression; it was statistically less likely that aggression increased or remained
194 unvaried. This finding suggests that they indeed have a calming role. The term calming signals,
195 therefore, seems to be appropriate in describing them.
196 The high frequency of emission observed for the analyzed behaviors suggests a paramount role of these
197 signals in canine visual communication. However, some behaviors were displayed much more
198 frequently than others (e.g. head turning and nose licking); future studies should investigate such
199 difference, to understand if it is related to a differing salience or other factors.
200 The majority of behaviors described by Rugaas as calming signals are reported by other authors as
201 indicative of stress in dogs: for instance yawning, looking elsewhere, turning the head, nose licking and
202 paw lifting (Beerda et al., 1998; Schilder & Van der Borg, 2004; Tod et al., 2005; Rooney et al., 2009;
203 Mariti et al., 2012). However, this is not in contrast with their calming function, because it is likely that
204 stressed dog can communicate their state to another dog and that consequently recipients decrease their
205 aggression.

Another finding to be highlighted is that the display of the so-called calming signals was strongly affected by the familiarity of the individuals interacting. In fact, it has been found that the number of signals was significantly higher in meetings between unfamiliar dogs. These findings are in agreement with Pullen et al. (2013), who found that dogs have higher intraspecific interactions in the first three minutes after being left off-leash and, in this period, the number of interactions and the time spent in contact were higher if dogs were unfamiliar. More in detail, in the current 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 emission may be related to the higher pressure when meeting an unfamiliar dog, with whom the relationship is not already 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. On the contrary, licking the other dog's mouth was more commonly directed towards familiar dogs. The latter result seems to be sensible, as this behavior exposes the animal to a certain risk (being close to the other's dog mouth), and therefore familiarity is probably preferable for acting it out.

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 displayed, alone or in association with others. Such data suggest that some of the so-called calming signals have a higher effectiveness in reducing aggression when it has already been triggered, but future research is needed.

When dogs, after receiving an aggression, were not observed to show any calming signals, they usually moved away from the aggressor. Going away and fleeing, for their own nature, consist in increasing the

distance between the two dogs and therefore these behaviors usually lead to a decrease in aggression. Although not included in the list of calming signals, we may say that they have this function.

A point remains unanswered, that is if such signals, as proposed by Rugaas (2006), have also a role in preventing aggression. This question is hard to be investigated, because without the display of any aggressive behaviors, it would be difficult and maybe very subjective to assess if an aggression may had occurred. However, considering that after the emission of a CS no aggressive episodes were observed, it cannot be excluded that such signals play also a role in preventing aggression. In this case, calming signals in domestic dogs would be more effective than cut-off 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 environment requires a low probability of overt aggression. Dogs are less reactive than wolves (Bonanni & Cafazzo, 2014), probably due to the domestication process. However, in order to manage frequent, unavoidable encounters in confined spaces, it is likely that dogs also developed the ability to emit and recognize subtle signals. It must also be considered that the analysis of behaviors in wolves were based on unnatural conditions, which have been found to considerably enhance the number and level of aggressions among individuals (Bradshaw et al., 2009). It is possible that wolves living in the wild, in situations of lower social tension, use more subtle visual signals, whilst in captivity their communication is exaggerated in order to compensate for the shortage of space and the impossibility to distance, flee or disperse. Recent studies have in fact demonstrated the need for more accurate observations on wolf too (Fatjò et al., 2007).

The findings of the current study are referred to a sample of dogs with specific inclusion criteria. It is possible that the analysis of dogs showing behavioral problems and overt aggression would have led to different results. For instance it is possible that, during an overt aggression, one of the dogs involved

lacks in the display and/or recognition of such signals, thus blocking their preventative role. However, these findings are relevant for daily inter-dog encounters, because owners who allow their dogs to socialize off-leash are usually self-selecting, self-monitoring and self-limiting in regard to dog aggression (Shyan et al., 2003). In fact, some previous studies on intraspecific communication and aggression in domestic dogs have been carried out in public places (Bradshaw & Lea, 1992; Shyan et al., 2013). The current research has therefore the advantage of reproducing daily situations in a standardized manner.

Mariti et al. (2012) found that subtle signs, displayed in the earlier stages of emotional arousal (Kerswell et al., 2009), often go unnoticed and can even be misinterpreted by owners. Owners instead tend to focus their attention on vocalizations and gross body movements and more subtle signals may be disguised by a dog's morphological traits (Kerswell et al., 2009). It is up to the veterinary surgeon, and especially veterinary behaviorists (Mariti et al., 2015), to 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 play a specific role in canine communication, namely reducing aggression and therefore calming the receiving dog. Thus, they can correctly be identified as calming signals. Further research is needed to better understand the relevance and impact of each signal on dog aggression.

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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.

Conflict of interest

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

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346

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 two 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).

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

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

Figure 4: number of times the analyzed behaviors have been displayed after an aggression in meetings between familiar and unfamiliar dogs.