

Communication between domestic dogs and humans: effects of shelter housing upon the gaze to the human

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Abstract It is widely known that gaze plays an essential role in communicative interactions. Domestic dogs tend to look at the human face in situations of conflict and uncertainty. This study compares the gaze of shelter and pet dogs during acquisition and extinction phases in a situation involving a reward in sight but out of reach. Even though no significant differences between the groups were recorded during acquisition, gaze duration decreased in both groups during extinction, with shelter dogs showing a significant shorter duration. This could be related to their different living conditions and to the fact that through their ordinary everyday interactions, pet dogs have more opportunities to learn to persist in their communicative responses when they do not get what they want. These results highlight the relevance of learning experiences during ontogeny, which would therefore modulate communicative responses.

Keywords Domestic dogs · Shelter dogs · Gaze direction · Learning

Introduction

Gaze behavior is key to establishing communication. This is true not only for humans, but also for other species. For

example, it helps animals find relevant stimuli such as food, predators (Tomasello et al. 1998; Emery 2000). Human-directed gaze and the alternation between the receiver and the target object are considered referential responses in attention-getting behaviors (Gómez 2007).

It is known that in cases of uncertainty or conflict, dogs tend to gaze at the human face. For example, if an obstacle prevents a dog from opening a baited container, it will tend to make eye contact with its owner (Miklósi et al. 2003). Dogs are also known to alternate their gaze between the person and the hidden reward (Miklósi et al. 2000).

This type of response was also observed in an unsolvable task used to compare pets and guide dogs for the blind. In this task, the baited container had been locked and the food was no longer available. Results showed no differences in either the human-directed gaze or in the gaze alternation behavior between both groups, suggesting a degree of independence from the visual status of their respective owners (Gaunet 2008). These findings were replicated using toys as rewards (Gaunet 2009).

These evidences show that dogs tend to look at the human face as a way to communicate in cases of unsolvable situations and use humans as tools to achieve their purpose (Cooper et al. 2003; Hare 2004).

From a comparative point of view, in similar situations, dogs gazed more persistently at the human face than wolves (Miklósi et al. 2003) or other domesticated species like cats (*Felis catus*; Miklósi et al. 2005). Therefore, several authors concluded that the ability to gaze at the human face may well be the result of a genetic component derived from domestication processes and independent from acquisition by learning (e.g., Miklósi et al. 2007).

However, Marshall-Pescini et al. (2008) showed that in an unsolvable task, untrained dogs gazed more often at their owners than highly trained dogs that spent more time

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interacting with the baited apparatus. On the other hand, Marshall-Pescini et al. (2009) found that agility dogs gazed at their owners significantly more than both pet dogs and Search & Rescue trained dogs. In addition, Bentosela et al. (2008) found that Schutzhund trained dogs gazed at the handler significantly more than untrained pet dogs. These results suggest that previous training experiences modulate dog gaze responses.

In the same way, Bentosela et al. (2008, 2009) concluded that associative learning is involved in the mechanisms of interspecific communication. To prove this, a study was conducted exposing dogs to a conflict situation with food in sight but out of their reach. Results showed that gaze duration increased significantly when reinforced and decreased during (1) extinction, when rewards were no longer available; (2) omission, when the experimenter reinforced the dog each time it looked in another direction; and (3) contrast procedure, when a preferred reward was replaced with a less preferred one.

Given the controversy of the role of learning and ontogeny in communicative skills, gaze assessment in groups with different learning experiences (such as shelter and pet dogs) becomes relevant. Usually, animals that end up in a shelter have been exposed to abuse such as mistreatment or neglect (De Palma et al. 2005). Moreover, the environment of canine shelters tends to have multiple stressors such as social and spatial restrictions (Hennessy et al. 1997; Tuber et al. 1999). Shelter dogs hardly spend any time with humans, and if they do, it is only during cleaning and feeding activities (Wells and Hepper 1992; Wells 2004; Barrera et al. 2008). A sociability test has showed that shelter dogs, despite showing fear-appeasement behaviors like tucking their tails, flattening their ears, and crouching, tend to stay closer to unknown people than pet dogs (Barrera et al. 2010). These results indicate that shelter environmental conditions influence the relationship between dogs and humans.

As far as communicative skills are concerned, Hare et al. (2010) concluded that shelter and pet dogs were equally able to follow various cues (point to correct, mark correct, shake correct, shake empty) in order to find food. However, Udell et al. (2008) demonstrated that shelter dogs failed to follow a relatively complex human cue like momentary distal pointing to a target location. Also, their performance was lower than that of pet dogs and socialized wolves. Nevertheless, they were able to learn the task with additional training (Wynne et al. 2008; Udell et al. 2010a). These results could indicate that, at least in shelters where there is scarce human contact, experiences during ontogeny are not enough for achieving successful communicative behaviors. We are not aware of the existence of other studies carried out on shelter dogs' communicative skills.

The aim of this study is to compare the effects of associative learning on the production of interspecific communicative responses in shelter and pet dogs. We have specifically assessed two phases: acquisition and extinction of the human-directed gaze in a conflict situation with food in sight but out of reach. Considering the scarce human contact to which shelter dogs are exposed to, and taking into account previous findings on their communicative responses, we expect to find a shorter duration of shelter dogs' gaze versus pet dogs. Given the reaction of shelter dogs upon the presence of an unknown human (Barrera et al. 2010), it would be predictable to say that they will tend to be more sociable, while revealing more fear-appeasement behaviors during gaze training than pet dogs.

These results could demonstrate the significant role played by both associative learning and experiences during ontogeny in domestic dogs' interspecific communication mechanisms. In addition, they will contribute to the general description of shelter dogs' social characteristics relevant for dog–human interactions.

Methods

Subjects

Subjects were 32 adult dogs (*Canis familiaris*). Seventeen of them (8 males and 9 females, mean age: 5.06, SEM \pm 0.67 year) belonged to the Esperanza Animal Shelter, located in Entre Ríos, Argentina. The rest (5 males and 10 females, mean age: 3.47, SEM \pm 0.45 year) were pets raised since puppies by their owners. All of them were mongrels with no recognizable similarity to known breeds, and they had not received any previous training. The previous history of each dog was not available in the shelter. All dogs had been assessed in a sociability test in which they were exposed to an unknown human 1–9 months before gaze training.

Shelter dogs (SHD) lived in 2 \times 4 m kennels, each grouping 4–7 dogs. The shelter had a recreational area where dogs were taken for about 15–20 min a day, alternating between the groups of dogs in each kennel. Their contact with caretakers was limited to feeding and cleaning activities. All SHD that participated in the experiment had lived in the shelter for more than 2 years (seven dogs joined the shelter as puppies aged 1–4 months, three dogs joined at the age of 1–2 years, and exact data on the remaining seven dogs are not known). They were all in good health and had regular health checks.

The selection criterion for pet dogs (PD) was to choose animals that had lived most of their lives interacting with a family. All selected PD had been living with a family since they were puppies.

Experimental setting and apparatus

The experiment was performed where the dogs lived. In the case of SHD, observations were carried out in a $2 \times 3 \times 1$ m wire enclosure with a concrete floor, located approximately 10 m away from the kennels. During the evaluation, dogs had no visual contact with other dogs. On the other hand, PD were observed in a room at their owners' house, in a restricted area similar to the setting used for SHD.

Pieces of chicken weighting 0.6–0.8 and 1.3–1.5 g were used as rewards for small dogs and large dogs, respectively. Incentives were placed in a container located on a tall table. The container was visible to the animals but out of their reach. All trials were videotaped using a Sony DCR 308 camera. The person taping the trial was located behind the experimenter (E) and to her side, so as to be able to record the dog's gaze and head direction. Each session had the dog, the E, and the person operating the camera as participants. The E was always an unknown woman.

Procedure

Dogs were faced with a conflict situation with food in sight but out of their reach. Gaze training comprised three phases: warm-up, acquisition, and extinction.

Warm-up session

During a single session lasting 3–5 min, dogs were brought to the location where training was to take place so that they could explore it. The E called the dogs by their names and actively sought physical contact. The dogs' motivation for food was first confirmed by their acceptance of three pieces of chicken given from the hand of the E.

Acquisition phase

Immediately after the warm-up session, dogs received three trials of differential reinforcement for gazing at the E. Each trial lasted 2 min with an inter-trial interval (ITI) of approximately 2 min. Acquisition trials started with the E standing by the food container and calling the dog by its name just once. Dogs were reinforced every time they gazed at the E. Starting on the second trial, dogs were required to gaze at the E for at least 1 s before receiving a reward.

Dogs usually moved their gaze from the E's face to her hand as soon as she reached for the food. A new incentive was delivered when the dog turned its gaze back to the E's face for 1 s. At the end of each trial, the E withdrew to a different location, out of the dog's visual scope, while it remained in the training area. All the dogs in this

experiment responded to their names and gazed at the E at least twice during each trial.

Extinction phase

Three extinction trials lasting 2 min each were performed. ITI between acquisition and extinction phases lasted 2 min. This phase was similar to the acquisition one, except that the reward was not available. It started by calling the dog by its name, but no food was delivered. E stayed at the same place where she had been on previous trials. She left the place after the end of each trial.

Behavioral observations

During the first acquisition trial, latency (s) was recorded to assess time differences between the beginning of the trial and the first gaze response in order to acknowledge previous group variances. Gaze duration (s) was manually calculated on all trials using a stopwatch to record total time of dog–E visual contact.

Frequency rate was also recorded for other behaviors in the last acquisition trial and during the extinction phase. Four dependent variables were recorded on a continuous basis: ambulation, sniffing, vocalizations, and rearing. Other measures, such as approaching the E, tail down, ear flattening, lying down, and side orientation, were scored by instantaneous sampling every 5 s (See Table 1). Frequency rate was expressed as the proportion of all observations on which the behavior pattern was occurring, i.e., times the behavior occurred divided by total number of observations.

The data were recorded by two independent observers; one of them was blind to the experiment's purpose. Inter-observer reliability was calculated in the 20% of the videos except for gaze latency (100%) using Pearson's correlation coefficient (continuous data) and Cohen's Kappa coefficient (all other data). In continuous measures, $r_s > 0.95$, $P < 0.01$ and in the rest of the measures, $k \geq 0.97$.

Data analysis

A *t* test for independent samples was used to compare SHD and PD latency responses in relation to the first gaze toward the E. In order to evaluate group effect on gaze duration, a repeated-measures ANOVA was performed on trial data gathered, with gaze duration as a within-subjects factor and group as a between-subjects factor, one each, for acquisition and extinction phases.

Since the other behavioral measures did not meet the assumptions for parametric tests, they were analyzed using Mann–Whitney *U* tests for group comparisons.

Considering that (1), there were no significant age differences between groups ($t_{30} = 1.93$, $P = 0.63$), (2) all

Table 1 Definition of the behaviors and method of registration

Behavior	Method of registration	Definition
Gaze duration	Continuous measurement Accumulative duration (s)	Visual contact of the dog with the experimenter
Ambulation	Continuous measurement Accumulative frequency	Each behavioral unit involved the action of walking or running at least two steps without stopping. A sequence ends when the animal stops for at least 1 s
Sniffing	Continuous measurement Accumulative frequency	Putting the muzzle on the ground, on the wall, person, or objects, also includes sniffing the air that is when the dog raises the head, moving the nostrils and breathing the air to perceive odors. A unit was assessed since the dog put his muzzle on the surface until he/she raised it again
Vocalizations	Continuous measurement Accumulative frequency	Included barks, groans, and snorts. When there was at least a 1 s interval between vocalizations, a new unit was scored
Rearing	Continuous measurement Accumulative frequency	To jump or to stand on hind legs with front paws on person or object
Experimenter approach	Instantaneous sampling 5 s Accumulative frequency	<i>Near</i> : if the dog was within one meter from the experimenter. <i>Far</i> : if it was more than a meter
Lying down	Instantaneous sampling 5 s Accumulative frequency	Lying down on the ground
Orientation	Instantaneous sampling 5 s Accumulative frequency	<i>Experimenter</i> : dog remains oriented toward the experimenter with its body and head, independently of its gaze direction. <i>Side</i> : it orients toward either side relative to the experimenter, independently of its gaze direction. When body and head were oriented differentially, the position of the head determined how orientation was categorized

dogs were mongrels, and (3) they had not received any previous training, said data were not included as variables in the analysis.

The alpha level of significance was set at 0.05. All analyses involved two-tailed tests.

Results

Gaze latency and duration

During the first acquisition trial, comparison between the two groups, SHD (10.58, SEM \pm 4.28) and PD (4.74, SEM \pm 0.78), showed no significant differences in gaze latency, $t_{30} = 1.26$, $P = 0.217$. This result indicates that both groups showed similar reaction times for the first gaze response. Taking into account that this variable's range is small, we performed a more accurate assessment by means of a frame by frame (0.3 s) analysis. The results showed that there is no significant difference between SHD (9.93, SEM \pm 3.61) and PD (4.57, SEM \pm 0.77) groups, $t_{30} = 1.36$, $P = 0.181$.

Figure 1 shows cumulative gaze duration of SHD and PD groups during acquisition and extinction trials. A global

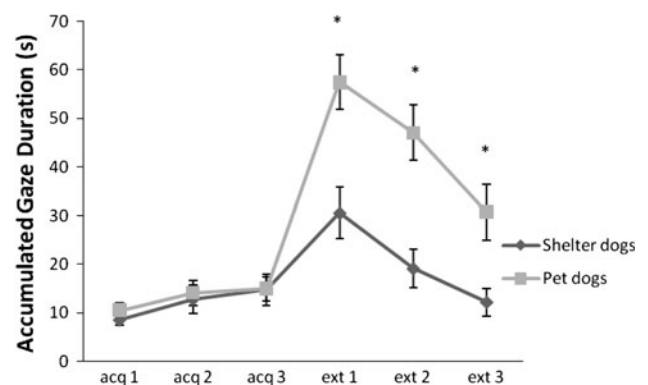


Fig. 1 Gaze duration (s) in acquisition (acq) and extinction (ext) trials for shelter and pet dogs (means \pm 95% confidence intervals). Dogs were required to gaze at the experimenter for 1 s to receive food in the acquisition phase. During extinction, no food was delivered. * $P < 0.05$

analysis, comparing SHD and PD groups using a repeated measures ANOVA, revealed trial significant differences during the acquisition phase, $F_{2, 60} = 9.83$, $P = 0.001$; however, there was no group differences, $F_{1, 30} = 0.12$, $P = 0.728$, nor group trials interaction significant effect, $F_{2, 60} = 0.22$, $P = 0.801$. These results show that dogs

increased gaze duration in acquisition trials despite group differences.

A comparison between SHD and PD groups during the extinction phase revealed significant trial differences, $F_{2, 60} = 20.90$, $P = 0.001$ and group differences, $F_{1, 30} = 19.06$, $P = 0.001$; however, the group trials interaction was not significant, $F_{2, 60} = 1.07$, $P = 0.346$. Gaze duration decreased during extinction trials, and this reduction varied across groups. SHD displayed shorter gaze duration compared to PD, evidencing a faster extinction rate for their group.

Behavioral pattern

Figure 2 shows the frequency rate assessed for approaching the E, tail down, ambulation, and side orientation during the third acquisition trial and the three extinction trials for SHD and PD groups.

Mann–Whitney U test analysis of each trial showed significant differences between groups when approaching the E

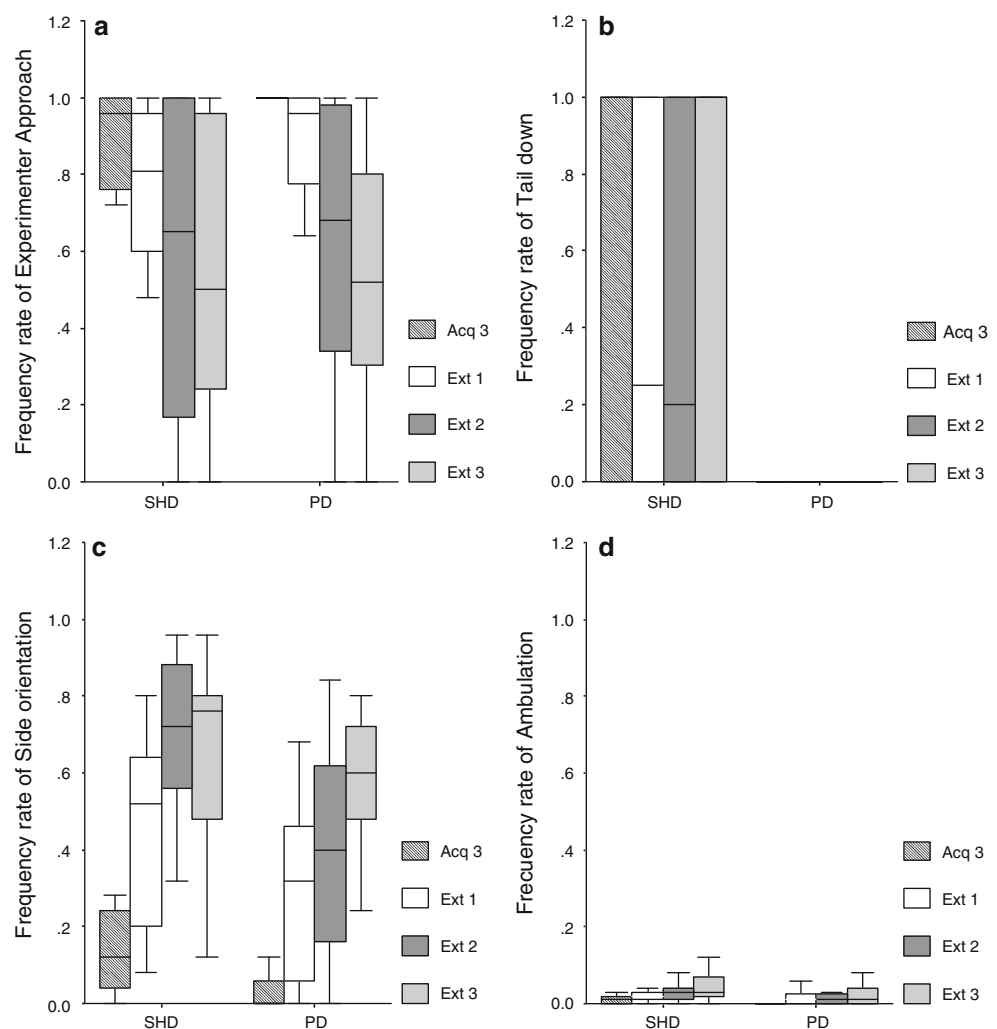
during the third acquisition trial ($Z = 2.64$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.008$), but not during extinction phases (extinction 1: $Z = 1.42$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.153$; extinction 2: $Z = 1.73$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.863$ and extinction 3: $Z = 0.01$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.99$).

Tail down significant differences were recorded during the third acquisition trial ($Z = 3.54$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.001$) and the first ($Z = 3.05$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.002$), second ($Z = 3.46$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.001$) and third ($Z = 3.76$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.001$) extinction trials.

Ambulation significant differences were recorded in the third acquisition trial ($Z = 2.71$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.007$), the first extinction trial ($Z = 1.96$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.049$) and the third extinction trial ($Z = 2.13$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.033$) but not the second trial ($Z = 1.50$, $N_{SHD} = 17$, $N_{PD} = 15$, $P = 0.133$).

Finally, significant differences in side orientation were only recorded during the third acquisition trial ($Z = 3.00$,

Fig. 2 Shelter (SHD) and pet dogs (PD) frequency rate for **a** approaching the experimenter, **b** tail down, **c** side orientation, and **d** ambulation during the third acquisition trial (*dotted line box*) and the three extinction trials (extinction 1: *white box*, extinction 2: *dark gray box*, and extinction 3: *gray box*). The *box* represents the interquartile range, containing 50% of the values, and the *bold lines* indicate the median. The *error bars* extend from the box to the highest and lowest values



$N_{\text{SHD}} = 17$, $N_{\text{PD}} = 15$, $P = 0.003$) and the second extinction trial ($Z = 2.70$, $N_{\text{SHD}} = 17$, $N_{\text{PD}} = 15$, $P = 0.007$) but not during the first, $Z = 1.89$, $N_{\text{SHD}} = 17$, $N_{\text{PD}} = 15$, $P = 0.058$ and third extinction trials, $Z = 1.59$, $N_{\text{SHD}} = 17$, $N_{\text{PD}} = 15$, $P = 0.111$.

In summary, during the last acquisition trial, SHD were more reluctant to approach the E and increased tail down, ambulation, and side orientation behaviors compared to PD; however, no significant differences were observed in ear flattening, sniffing, rearing, and lying down behaviors, $Z_s \leq 1.94$, $N_{\text{SHD}} = 17$, $N_{\text{PD}} = 15$, $P_s \geq 0.051$. On the other hand, during extinction, SHD showed a higher frequency of tail down, ambulation, and side orientation behaviors than PD, but there were no significant differences in approaching the E, ear flattening, sniffing, vocalizations, rearing, and lying down behaviors, $Z_s \leq 1.98$, $N_{\text{SHD}} = 17$, $N_{\text{PD}} = 15$, $P_s \geq 0.058$. These results reveal that higher rates of tail down, ambulation, and side orientation behaviors are displayed in both phases.

Discussion

The aim of this study is to evaluate acquisition and extinction of the gaze toward the human face in a conflict situation for SHD and PD. In general, changes in dogs' gaze response were associated with environmental contingencies. Gaze duration significantly increased during reinforcement and decreased during extinction. This conforms to previous findings (Bentosela et al. 2008, 2009) and supports the hypothesis related to the role played by associative learning in interspecific communication mechanisms in domestic dogs.

Contrary to our predictions, no differences were found between groups during acquisition. Both groups showed similar human-directed gaze latency in the first acquisition trial. Also, SHD as well as PD increased gaze behavior when reinforced. The lack of differences suggests that the time needed for the first response and the ability to develop gaze behavior are relatively independent from the housing conditions. Moreover, these findings would demonstrate amazing dog abilities to quickly increase their interspecific communicative responses. However, these results might be due to several reasons. On one hand, a ceiling effect, since this task is probably rather easy for the animals. On the other hand, the fact that dogs must interrupt the gaze response each time they eat the food. In this sense, dogs cannot actually perform the gaze behavior throughout the total trial time.

The most relevant finding is that SHD displayed faster extinction than PD. As we had predicted, SHD showed shorter gaze duration compared to PD when reinforcement was no longer provided. This difference might be

associated with various explanations, and further studies are needed to evaluate them. Firstly, extinction differences could be linked to stress (Wells and Hepper 1992; Hennessey et al. 1997), fear-appeasement behaviors (Barrera et al. 2008), and various traumatic situations such as abandonment (De Palma et al. 2005) usually observed in SHD. From this perspective, SHD displayed more frequently tail down behaviors, a fear-submission sign (e.g., King et al. 2003; Mizukoshi et al. 2008). However, considering that this behavior was also observed during acquisition, it hardly explains the shorter gaze duration of SHD during extinction. Tail tucking could be a typical response of SHD when faced with an unknown person (Barrera et al. 2010).

Secondly, the groups also had different responses in other behaviors during gaze training. For instance, SHD showed more ambulation and side orientation than PD during extinction. An explanation might be that animals tend to retreat and avoid contexts associated with the omission of an expected reward (Daly 1974; Papini and Dudley 1997) and to increase side orientation when the reward is not delivered (Bentosela et al. 2009). Nevertheless, these differences are not exclusively related to the extinction phase, they were also observed during the third acquisition trial.

SHD's higher frequency of tail down, ambulation, and side orientation regarding the E's position could reflect some typical characteristics of these dogs. Such behaviors are present in their social interactions even when food is not part of the equation. Therefore, they might not be the key factors responsible for the differences in gaze response observed in both groups.

Thirdly, SHD's faster extinction could be the result of their limited interaction with humans. One possible way to evaluate this hypothesis could be to stratify and evaluate SHD according to their levels of socialization. However, this explanation seems unlikely, considering that such limited interaction with humans should have also modified the acquisition phase, but the pattern did not apply.

The most plausible explanation is that PD have had more opportunities to learn communicative responses through their daily interactions with humans. Their behaviors are often intermittently rather than continuously reinforced. Such reinforcement schedule increases extinction resistance in learned responses (e.g., Amsel 1962) and could explain the longer gaze duration displayed in PD. Therefore, previous ontogeny background could modulate the extinction of the gaze response in dogs.

However, two important aspects have to be considered. First, these findings can only be applied to shelters characterized by inadequate housing conditions and limited human contact. Second, taking into account that the origin and previous history of the dogs are unknown, it is impossible to discriminate between the effects of the

experiences during the sensitive period, after it, and during their housing in the shelter.

Our results provide important information on factors modulating interspecific communication in domestic dogs. In the first place, they show that associative learning is involved in the mechanisms of communication. Gaze behavior is modified according to reinforcement contingencies: it increases during acquisition and decreases during extinction. In the second place, they contribute to understanding the role of ontogeny in the development of communication with humans, displaying the differences in communicative skills between SHD and PD who have had different experiences with people during their daily interactions. These findings are consistent with the “two stages hypothesis” (Udell et al. 2010b) that states that domestication is not enough to account for dogs’ communicative skills. Two kinds of experiences during ontogeny must be mentioned: (1) human interactions in a sensitive period leading the dog to accept the human companion and (2) learning and living conditions during such interactions. Finally, our results increase current knowledge of SHD’s characteristics. As we mentioned above, SHD usually displayed stress responses, changes in social behavior, and fear-appeasement responses toward humans. Associative learning could help improve communicative responses in these dogs, leading to a more successful adoption process.

In conclusion, previous interactions with humans, especially those related to the opportunities of learning communicative responses, could modify the interactions between both species.

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