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I Look at You to Learn! Effects of the Owner's Sex on Social Learning in Domestic Dogs

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Dogs have been shown to be able to learn from a human demonstrator. However, to date, there have been no studies investigating the effect of the demonstrator's sex on such learning. The aim of our study was to evaluate this effect by comparing an experimental condition in which dogs received a demonstration from their owner on how to manipulate one of two possible containers to obtain food and a control condition without any human demonstration. Each of these conditions was divided into two groups: male-owned and female-owned dogs. Overall, the dogs performed better in the experimental condition compared to the control condition. This was evident based on a higher frequency of correct choices and opening the correct container, as well as a higher frequency of contact and gaze towards the demonstration. The female-owned group benefited from the demonstration by choosing the correct container more frequently in the experimental condition compared to the control. Conversely, male-owned dogs chose the correct container more often and looked more frequently at the demonstration than female-owned dogs, without differences between conditions. This could indicate a higher capacity for problem-solving in this group of dogs beyond the human demonstration, and therefore would not reflect a modulatory effect of the owner's sex over social learning in particular. In conclusion, the sex of the demonstrator seems to have an effect on social learning in dogs when the demonstrator is a female owner. This might have an impact on several applied settings as well as sampling criteria in canine social cognition research.

Keywords: domestic dogs, female owner, observational learning

Social learning is defined as learning that is influenced by the observation or interaction with another individual, commonly referred to as a demonstrator. This type of learning allows individuals to solve problems and access multiple reinforcements without the cost of direct learning (Heyes, 1994). There are various types of social learning ranging in complexity from stimulus/local enhancement to imitation. This implies a causal relationship between the observation of that movement and the execution of the action in the same way (Heyes, 2001). Unlike imitation, in social learning, it is not necessary for the topography of the observer's behavior to be the same as that of the model (Heyes, 2016).

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Over the last two decades, social learning has been extensively studied in domestic dogs (*Canis familiaris*), in part because they exhibit high levels of attention towards humans (Hare et al., 1998; Miklósi & Topál, 2013). During this time, evidence has accumulated demonstrating dogs' ability to learn through the observation of human actions. For example, after witnessing a human demonstrator, dogs showed (a) the phenomena of local enhancement (Hare & Tomasello, 1999; Range et al., 2013); (b) they manipulated an object more frequently to obtain a reinforcer by using a similar action as the one used by a human demonstrator (Kubinyi et al., 2003; Miller et al., 2009; Pongrácz et al., 2012; Range et al., 2009); and (c) they learned the "do as I do" rule by copying diverse behaviors performed by a person (Topál et al., 2006). In addition, they were able to move faster through a detour task (e.g., Pongrácz et al., 2001); and some evidence suggests that they would show overimitation (Huber et al., 2018) and selective imitation (Range et al., 2007).

Social learning arises early in ontogeny (Fugazza et al., 2018) and is produced by observation of both the owner and an unfamiliar person (Pongrácz et al., 2001). Furthermore, it can be regulated by a variety of factors such as the type and level of training (Fugazza & Miklósi, 2014), the use of ostensive cues (Range et al., 2009), and the dog's temperament (Pongrácz et al., 2021), among others. However, the mechanisms by which these learnings are formed remain unclear, and it has been hypothesized that they may, in many cases, rely on simple processes (Mersmann et al., 2011) and be fundamentally tied to the learning experiences of dogs throughout their lives (Range et al., 2011).

On the other hand, it has been found that dog behavior in various contexts is influenced by the sex of humans. Results with shelter dogs often demonstrate that they display more stress, fear or appeasement responses to males than to females when both are strangers (Wells & Hepper, 1999). For instance, when a person approached the kennel dogs exhibited more defensive behavior, such as barking and sustained eye contact towards men than towards women (Wells & Hepper, 1999). Additionally, shelter dogs' cortisol levels and heart rates dropped more when they were caressed by women than by men (Hennessy et al., 1998). Finally, shelter dogs showed more stress-related behaviors (less time with the tail held high, more eye gaze and lip licking) when being walked on a leash by men as opposed to women. In contrast, dogs exhibit greater affiliative responses (grooming and greeting rituals) and less fearful behaviors towards women (Shih et al., 2020). One possible explanation for these disparities is the way in which men and women differentially interact with dogs. In the aforementioned study by Hennessy et al. (1998) it was found that when men engage with dogs in a similar fashion to women, with a less threatening posture such as sitting on the ground, petting them gently and speaking to them in a friendly manner, there was no effect of sex. Finally, Shih et al. (2020) observed that during a walk, women were more likely to employ verbal commands and use infant-directed speech, with a higher pitched voice and slower pace, towards dogs compared to men.

These differences between how each of the sexes interacts with dogs were also noted in family-owned dogs during the Ainsworth's strange situation test (Prato-Previde et al., 2006). In this task, women tended to employ more verbal utterances and had a shorter latency to start talking to their dogs compared to males. However, they both reported to have a similar level of attachment to their pets (Prato-Previde et al., 2006).

Despite the relevance that human sex seems to have on dogs' behavior, its impact on observational learning has not yet been investigated. In light of this background, we aimed to explore the influence of the sex of the human demonstrator over observational learning in domestic dogs. For this purpose, a task of object manipulation in order to obtain food was used, and a comparison between an experimental condition in which dog's received a demonstration from their owner and a control condition with no demonstration was made. For half of the dogs in each condition, the owner acting as demonstrator was a woman and for the other half, a man. As possible modulatory variables of this learning, we measured the length of the dog's gaze to the demonstration, as an indicator of their attentional state (Call et al., 2003), and the level of the dog's bond with the owner, given its potential effect on social learning (Huber et al., 2022). Based on this, it is predicted that dogs will be able to learn to manipulate the object after observing their owners doing so and will perform the task better when the demonstrator is a female compared to a male, with a longer duration of gaze at the demonstration and a higher level of bonding being facilitators of this learning.

The study of this topic may yield useful information on how learning processes are modulated in interspecific contexts, whether in everyday situations or in different types of training. It is especially significant in the field of research because this variable is frequently uncontrolled and in the majority of studies, the participating owner is a woman.

Method

Ethical Approval

This study complies with the current Colombian law of animal protection (Law 1774) and the present protocol was approved by the ethics board of the Faculty of Engineering and Basic Sciences of the Universidad Central, Bogotá, Colombia. A favorable ethical concept was granted to carry out the experimental phase and the subsequent publication of this research. In addition, all dog owners expressed their written consent for participation in this study.

Subjects

The sample consisted of 43 domestic dogs that were healthy as reported by their owners and had been living with them for at least one year prior to enrollment. Each dog was assigned to one out of two conditions, experimental and control, and in both conditions, half of the owners were male and half female. That is to say, four groups were formed: experimental female (n = 15), experimental male (n = 14), control female (n = 9) and control male (n = 5). At allocation, the proportion of dogs in each group was homogenized as best as possible in terms of the variables sex, size, breed group (according to the American Kennel Club), and age (see Table 1). Owners were instructed not to feed the dog 4 hrs before participation and to keep water available at all times. This period was selected as it was used in previous studies to increase the motivation of dogs for food in other tasks (Carballo et al., 2022; Dzik et al., 2020; Fagnani et al., 2020). Dogs whose owners reported having observed signs of aggression or excessive fear in everyday life were excluded. Recruitment was done through social media announcements and participation was completely voluntary. All owners provided informed consent to participate in the study.

Table 1
Description of the Sample

Subject	Group	Owner's sex	Dog's age (years)	Dog's sex	Neutered Status	Breed
Saimon	Exp	Female	9	Male	Intact	Cocker Spaniel
Amonet	Exp	Female	4	Female	Neutered	Mixed breed
Milo	Exp	Female	9	Male	Intact	Cocker Spaniel
Bayle	Exp	Female	3	Female	Intact	Mixed breed
Ron	Exp	Female	7	Male	Neutered	Labrador Retriever
Emma	Exp	Female	3	Female	Neutered	Mixed breed
Simona	Exp	Female	3	Female	Neutered	Mixed breed
Polo	Exp	Female	1	Male	Neutered	Mixed breed
Lazka	Exp	Female	1	Female	Intact	Siberian Husky
Sico	Exp	Female	7	Male	Neutered	Mixed breed
Roco	Exp	Female	11	Male	Neutered	Mixed breed
Jack	Exp	Female	1	Male	Neutered	Mixed breed
Dexter	Exp	Female	3	Male	Neutered	Mixed breed
Tina	Exp	Female	4	Female	Neutered	Mixed breed
Chomelo	Exp	Female	1	Male	Neutered	Mixed breed
Charlie	Exp	Male	9	Male	Intact	Cocker Spaniel
Nessie	Exp	Male	10	Male	Neutered	Labrador Retriever
Lluvia	Exp	Male	7	Female	Neutered	Mixed breed
Darko	Exp	Male	3	Male	Intact	Siberian Husky
Perla	Exp	Male	2	Female	Neutered	Mixed breed
Elie	Exp	Male	5	Female	Neutered	Mixed breed
Luna	Exp	Male	3	Female	Neutered	Mixed breed
Orion	Exp	Male	1	Male	Neutered	Mixed breed
Oreo	Exp	Male	6	Male	Neutered	Mixed breed
Tara	Exp	Male	6	Female	Neutered	Mixed breed
Usher	Exp	Male	1	Male	Intact	Cocker Spaniel
Ruffus	Exp	Male	2	Male	Neutered	Alaskan Malamute
Spike	Exp	Male	1	Male	Intact	Border Collie
Celeste	Exp	Male	2	Female	Neutered	Siberian Husky
Dastan	Ctrl	Female	8	Male	Neutered	Golden Retriever
Ankor	Ctrl	Female	1	Male	Neutered	Siberian Husky
Sasha	Ctrl	Female	8	Female	Neutered	Mixed breed
Archis	Ctrl	Female	1	Male	Neutered	German Shepherd
Kimi	Ctrl	Female	11	Female	Neutered	Standard Schnauzer
Rayo	Ctrl	Female	4	Male	Neutered	West Highland White Terrier
Goldin	Ctrl	Female	8	Female	Neutered	Mixed breed
Mottas	Ctrl	Female	4	Male	Intact	Mixed breed
Nala	Ctrl	Female	5	Female	Neutered	Mixed breed
Enzo	Ctrl	Male	1	Male	Neutered	Mixed breed
Pimienta	Ctrl	Male	1	Female	Neutered	Dalmatian
Violeta	Ctrl	Male	1	Female	Neutered	Samoyed
Kiara	Ctrl	Male	6	Female	Neutered	Mixed breed
CLuna	Ctrl	Male	5	Female	Neutered	Mixed breed

Note. Exp: Experimental, Ctrl: Control.

Materials

Two cylinder-shaped containers were used. Cylindrical containers were used as they are easier to handle than those with other shapes. The first was a small container (25 cm high x 20 cm wide), grey and black with red stripes and a handle (5 cm long and 7 cm wide). The second container was larger (34 cm high x 26 cm wide), white with blue stripes and a handle (7 cm long and 11 cm wide). Both containers had a double bottom with a heavy rock inside to prevent them from moving or falling to the floor and three pieces of food to control for odor cues. When the target container was baited, the food was placed on top of the double bottom lid, easily accessible to the dog. The food consisted on small pieces of cooked chicken of approximately 2 cm^2. In preliminary tests this food proved to be highly appetizing for dogs. The containers were set 1.20 m apart from each other and 1 m away from the dog and their owners (see Figure 1).

Figure 1

Note. (A) Experimental setting at the beginning of the task; (B) dog solving the task in the experimental condition.

Due to restrictions imposed by the COVID-19 pandemic, the study was conducted virtually, following validated citizen science methodology (Hecht & Rice, 2015; Stewart et al., 2015). The assessment of each dog was carried out via Zoom video conference, from a quiet room at each dog's house. Participants joined Zoom through two video devices (mobile phone, computer, tablet), and placed one pointing at the containers and the other at the dog, to capture where the dog was looking at during the demonstration. The researchers guided and supervised the owners online during the task to reduce experimental error. Each assessment was recorded on the platform itself.

Procedure

Prior to the evaluation, the owners received the containers and food reinforcements, delivered by the experimenter (E). They signed the informed consent form and completed the Mexican version of the Monash Dog Owner Relationship Scale (MDORS; González-Ramírez et al., 2017). This scale measures the level of bond between dog and owner and consists of 28 questions answered on a 5-point Likert scale and three subscales: Owner-dog Interaction, Perceived Emotional Closeness, and Perceived Costs. The final measure for each dog-owner bond was obtained by adding all the items of the scale and inverting the value of those pertaining to the relationship's perceived cost subscale.

At the beginning of the video conference, the E assisted the owners in preparing the set and went over the protocol in the absence of the dog. Each dog's main owner (O1) was established based on the owners' report on who spent the most time playing, walking, feeding, and generally caring for the dog. O1 served as the demonstrator in all cases. With the exception of pre-training (see below), the dog was always held by the secondary owner (O2) with their own leash.

The procedure consisted of three consecutive phases with no interval between them.

Pre-training

All dogs went through pre-training to familiarize themselves with the containers and to learn that there was food in the containers. This phase consisted of four trials, two with each container, during which these remained open. At the start of each trial, O2 showed the dog a piece of food, said the dog's name and placed the food in the container. O1 then released the dog and allowed them to eat. Four trials per session were conducted, since in preliminary tests the dogs decreased their attention when performing a greater number of trials, probably because they were not reinforced.

Demonstration 1 (D1)

In this phase, the procedure varied for each condition.

Experimental condition:

Both containers were closed. O2 held the dog leashed at the starting point, while O1 approached one of the containers (hereafter, baited container) carrying food in one hand, then raised the free hand, called the dog by its name and said "Look!". When the dog looked, O1 partially lifted the container's lid with their hand three times, opening it fully on the third time while dropping a piece of chicken inside. The container was then closed and returned to its initial position. Four consecutive identical demonstrations were performed by O1 who left the room at the end of the demonstration.

Control condition:

O1 arranged the set in the absence of the dog so that when the dog entered the room held by O2, the containers were already there. In this condition, the baited container was open, with 4 pieces of food visible to the dog, while the other container remained closed. O1 stood midway between the containers, facing forward, without looking at the dog. O2 held the dog on a leash at the starting point. At the start of the trial, O1 called the dog's name once, looking straight ahead ignoring the dog and remained in this position for 15 s. Then O2 would take the dog out of the room so that O1 could close the baited container. Finally, O2 and the dog returned, and O1 left the room.

Test 1 (T1)

For both conditions, the test started after O1 left the room. O2 released the dog, and stood with their back turned, avoiding eye contact with the dog and the containers. The dog was free to explore the environment and interact with the containers. The dog could open the container by pushing the lid upwards with its snout or head. The test lasted 2 min or until the dog was able to go to the baited container, open it, and eat the food. If the dog did not open the baited container, O1 re-entered the room, opened it, and left it open so that the dog could eat. This was done to keep the dogs motivated to participate in the task.

Demonstration 2 (D2) and Test 2 (T2)

Immediately after the first test, a new demonstration phase was carried out followed by a second test, both with the same characteristics as described above (D1 and T1). Thus, the dogs went through two sessions with four demonstration trials and two tests (see Table 2 and video sample). The baited container and which side it was placed on were counterbalanced between the dogs.

Table 2

Summary of the Experimental Design

Group		Pretraining 4 trials	D1 4 trials	T1 1 trial	D2	T2
Exp	Containers	Both open	Both closed	Both closed	Same as D1	Same as T1
	Owner	Ostensibly puts food in both containers	Ostensibly shows how to open the correct container and puts food inside	Leaves the room	Same as D1	Same as T1
	Dog	Eats from both containers	Does not eat	Explores for 2 min or until opening the container and eating	Same as D1	Same as T1
Ctrl	Containers	Both open	Correct container open with visible food inside	Both closed	Same as D1	Same as T1
	Owner	Ostensibly puts food in both containers	Stands neutrally between both containers	Leaves the room	Same as D1	Same as T1
	Dog	Eats from both containers	Does not eat	Explores for 2 min or until opening the container and eating	Same as D1	Same as T1

Note. Exp: Experimental, Ctrl: Control.

Data Analysis

The following dichotomous variables were analyzed for each test:

1. Correct choice (yes-no)
2. Opening the correct container (yes-no).

Additionally, a number of continuous variables were measured in each test:

1. Gazing at the demonstration: total amount of time (s) that the dog spent looking at the set during the demonstration phase. Since demonstrations did not have a fixed length, the dog's gaze time was divided by the total duration of the demonstrations.
2. Opening latency: elapsed time (s) from the start of the test until the dog managed to open the baited container. If the dog did not open the container, the maximum latency was considered to be 120 s.
3. Contact with the correct container: total duration (s) that the dog spent in physical contact with the baited container.
4. Contact with the incorrect container: total duration (s) the dog spent in physical contact with the empty container.

All behaviors were measured from the video recordings. Since the tests were not of equal duration, a ratio of the time in contact with the correct and incorrect containers was made for each test by dividing the contact time by the total duration of the test. The recorded videos were encoded using the free software BORIS v. 7.9 (Friard & Gamba, 2016; https://www.boris.unito.it/). Inter-observer reliability was carried out with one observer coding 100% of the videos and a second observer 30% of the videos. High levels of inter-observer reliability were obtained for all measures (Spearman correlation coefficient: Rhos > .80, $ps < .001$, $N = 13$). Finally, two trials of the second test were discarded from the final analyses (one dog from the experimental and one dog from the control condition) due to technical difficulties in the quality of the recording devices that prevented obtaining clear images of the task.

Generalized Linear Mixed Model (GLMM) tests were constructed to analyze each of the following dependent variables: gazing at the demonstration, correct choice, opening the correct container, opening latency, contact with the correct container, and contact with the incorrect container. Gazing at the demonstration had a gamma distribution with an identity link function. The correct choice and opening the correct container had a binomial distribution with a logit link. Finally, opening latency, contact with the correct container, and contact with the incorrect container followed a normal distribution with an identity link.

The initial models included: group, owner's sex, phase, dog's sex, dog's age, gazing at the demonstration (except when gazing at the demonstration was analyzed as a dependent variable), and MDORS total score as fixed factors. They also included the two-way interactions between group and owner's sex, and group and phase. Non-significant factors were removed step by step according to the backwards method. The factors group, phase, owner's sex, and the interaction between group and the factors phase and owner's sex were preserved due to their theoretical relevance. For all models, the random effects structure included intercepts to account for variability across the subject's ID. We used the Satterthwaite approximation to estimate the degrees of freedom due to different cluster sizes in the between and within-participants factors. Post hoc comparisons were conducted using paired contrasts (sequential adjusted Bonferroni) when required. Furthermore, standard errors (SE) and confidence intervals (CI) (95%) were reported as an indication of the degree of change in the results. Model residuals were tested for normality and homogeneity using Levene's test. For opening latency and contact with the target the residuals were normally distributed, and the variances were homogeneous (*ps* > .05). For other models, the residuals did not fit the assumptions criterion, therefore the powerful estimation correction method was used. All tests were two tailed ($\alpha = .05$). Data analysis was done with SPSS 24. Graphics were created with Prism 7.

Results

The models did not yield significant results for the dog's sex and age, gazing at the demonstration, nor MDORS total score, therefore they were not included in the final models. For all variables, the factors group, phase, and owner's sex as well as the interactions between group and the factors phase and owner's sex remained in the model.

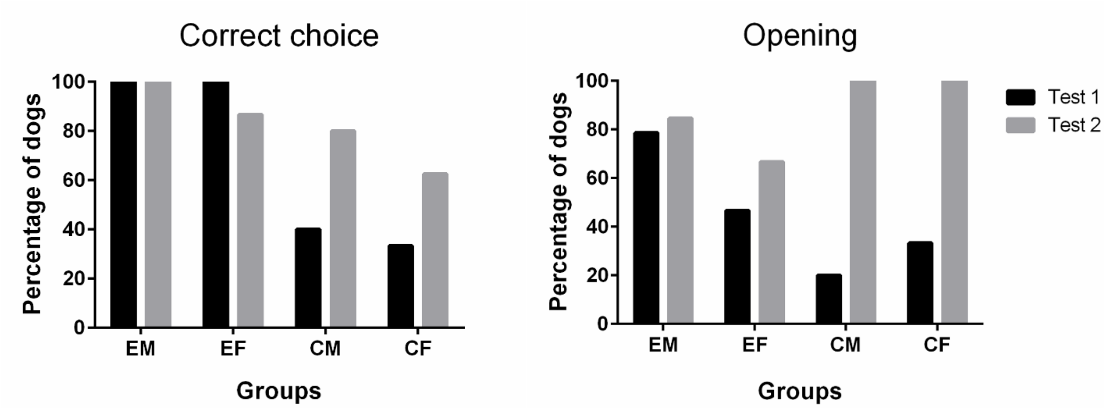
Below are the variables related to the performance of the dogs in the manipulation task that evaluate the presence of learning by observation, comparing a group that received a human demonstration on how to solve the task, and another that did not. Also, a possible effect of the sex of the demonstrator and the interaction between him/her and the presence or absence of the demonstration is analyzed in each one of them.

Concerning the correct choice, the model revealed a significant effect of group, $F(1,19) = 318.18$, $p < .001$. The odds of correct choice were 0.10 lower in the control than in the experimental group, 95% CI [0.01, 0.69]. Also, there was a main effect of owner's sex, $F(1,14) = 256.56$, $p < .001$. The odds of correct choice were 0.55 lower in dogs with a female demonstrator than with a male demonstrator, 95% CI [0.07, 4.61]. Moreover, we found an interaction of group by owner's sex ($F(1,14) = 224.70$, $p < .001$), as dogs with a female owner demonstrator made more correct choices in the experimental group than those in the control group, 95% CI [0.03, 0.72], $p = .036$. This difference was not observed in male-owned dogs, $p = .066$. See Figure 2.

For the variable opening the correct container, we found a main effect of group, $F(1,32) = 5.83$, $p = .022$. The odds of opening the target were 0.46 lower in the control than in the experimental group, 95% CI [0.07, 3.15] (see Figure 2).

Figure 2

Percentage of Dogs that Chose and Opened the Correct Container



Note. EM: Experimental group with a male owner; EF: Experimental group with a female owner; CM: Control group with a male owner; CF: Control group with a female owner, during Tests 1 and 2.

For opening latency, we found a main effect of phase, $F\ (1,40) = 13.76$, $p < .001$. Compared to the second phase, opening latency was longer by 27.68 s in the first phase, $SE = 12.32$, 95% CI [12.62, 62.42].

For contact with the correct container, the model yielded a significant interaction between group and phase, $F\ (1,41) = 7.10$, $p = .011$. Considering the first phase, time spent in contact with the correct container was higher by 0.29 (61.83%) in the experimental than in the control group, $SE = 0.10$, 95% CI [0.09, 0.50], $p = .004$). Additionally, in the control group, the rate of time in contact with the correct container during the second phase was higher by 0.20 (52.36%) than in the first phase, $SE = 0.08$, 95% CI [0.04, 0.36], $p = .016$) (see Table 3).

Lastly, for contact with the incorrect container, we found a main effect of group, $F\ (1,12) = 9.15$, $p = .011$. The rate of time in contact with the incorrect container was lower by 0.04 (75.47%) in the experimental compared to the control group, $SE = 0.04$, 95% CI [-0.14, 0.05], $p = .011$ (see Table 3).

Table 3

Mean ± SD of the Latency (s) to Open the Container and the Rate of Time Spent in Contact with the Correct and the Incorrect Container of Each Group

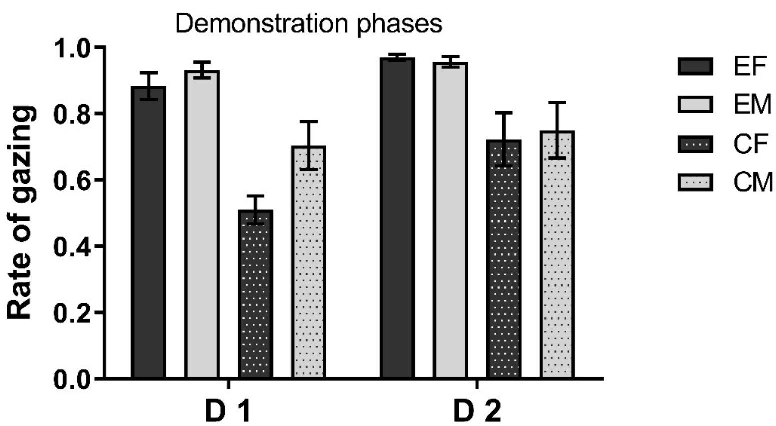
Group	Test	Latency to open	Contact Correct	Contact Incorrect
EM (*n* = 14)	1	42.25 ± 51.29	0.59 ± 0.30	0.01 ± 0.02
	2	28.04 ± 41.31	0.50 ± 0.28	0.00 ± 0.01
EF (*n* = 15)	1	79.52 ± 52.56	0.35 ± 0.36	0.02 ± 0.06
	2	56.95 ± 55.77	0.32 ± 0.23	0.00 ± 0.01
CM (*n* = 5)	1	87.05 ± 47.72	0.19 ± 0.01	0.03 ± 0.02
	2	60.00 ± 55.48	0.31 ± 0.17	0.07 ± 0.12
CF (*n* = 9)	1	79.83 ± 44.66	0.19 ± 0.27	0.08 ± 0.08
	2	35.78 ± 42.85	0.46 ± 0.26	0.09 ± 0.02

Note. E: Experimental; C: Control; M: Male; F: Female.

On the other hand, the duration of the gaze at the demonstration was measured as an indicator of the dog's attention to it. In this case, there was a main effect of group, F (1,23) = 79.36, p < .001. Compared to the control group, the rate of time spent gazing at the demonstration was higher by 0.26 (28.35%) in the experimental group, SE = 0.05, 95% CI [0.04, 0.27]. Also, we found a main effect of phase, F (1,6) = 7.69, p = .034. Compared to the second phase, the rate of time gazing at the demonstration was lower by 0.11 (12.80%) in the first phase, SE = 0.08, 95% CI [-0.36, 0.03]. Moreover, we found a significant effect of the owner's sex, F (1,24) = 7.93, p = .010. Compared to dogs with a male demonstrator, the rate of time gazing was lower by 0.08 (9.52%) in dogs with a female demonstrator, SE = 0.05, 95% CI [-0.24, -0.04]. Furthermore, we found an interaction between group and owner's sex, F (1,24) = 4.33, p = .048. The demonstration by owners of both sexes were more gazed at more in the experimental than in the control group, for the female-owned dogs gazing at the demonstration was higher by 0.32 (34.59%) (SE = 0.05, 95% CI [0.23, 0.42], p < .001), and for male-owned dogs was higher by 0.21 (22.22%), SE = 0.03, 95% CI [0.13, 0.28], p < .001. However, in the control group, gazing at the demonstration was higher by 0.14 (18.92%) in male-owned than in female-owned dogs, SE = 0.05, 95% CI [0.04, 0.24], p = .009) (see Figure 3). No other significant differences were found, ps > .05.

Figure 3

Rate of Gazing to the First (D1) and Second (D2) Demonstration



Note. EF: Experimental group with a female owner; EM: Experimental group with a male owner; CF: Control group with a female owner; CM: Control group with a male owner.

Discussion

The findings of the present study suggest that human demonstration facilitated dogs' performance in an object manipulation task to obtain food. When comparing an experimental condition, in which dogs observed their owner open and bait a container with the reinforcer, and a control condition, in which they only observed the food inside the container, a number of differences were found. In particular, dogs chose the correct container more often and showed a higher frequency of opening it when witnessing the demonstration in the experimental condition than in the control condition. Likewise, they stayed longer in contact with the correct container during T1 and less time in contact with the incorrect one during T1 and T2, although it should be noted that the latter effect was weak. These results are in line with previous studies showing that dogs can learn by observing people (e.g., Huber et al., 2018; Kubinyi et al., 2003; Pongrácz et al., 2001; Range et al., 2013; Topál et al., 2006).

On the other hand, gazing at the demonstration was found to have a facilitating effect on learning, given that it lasted longer in the experimental condition, in which the person manipulated the container, compared to the control condition. This could be due to the fact that gaze is regarded as an indicator of dogs' attentional state (Call et al., 2013) and that people pose a high salience for them (Bolló et al., 2021; Cook et al., 2016).

In addition, a general learning effect was observed during the task as the opening latency decreased in T2 compared to T1 in all dogs. Moreover, in the control condition, time spent in contact with the correct container increased in T2 compared to T1. Finally, in both conditions, gaze duration was found to be longer in the second demonstration than in the first, indicating an increased attention towards it. This could be attributed to a higher motivation for the task after receiving food during the first test. However, this result should be interpreted with caution as it had a low effect size.

On the other hand, an interaction was found between the demonstrators' sex and the experimental and control conditions. Female-owned dogs made more correct choices in the experimental than in the control condition, indicating an effect of the owner's sex on the effectiveness of the demonstrations. This finding is consistent with previous studies (e.g., Hennessey et al., 1998; Shih et al., 2020), in which dogs experienced less stress during a task when the person present was a woman. However, as no stress-related indicators were measured, further research is required to support this hypothesis. It is important to highlight that this effect of the demonstrator's sex on social learning should be interpreted with caution, as it was found only in one of the assessed variables.

Overall, dogs whose primary owner was a man performed better on the task than those with a female primary owner. The former group made more correct choices in both experimental and control conditions. The fact that the male-owned dogs solved the problem better, regardless of condition, was unexpected and would indicate that this is not a sex-specific effect on social learning. It could be that these dogs had undergone different experiences during ontogeny compared to those with a female owner, and as a result, received more cognitive stimulation in their daily life. In accordance with this hypothesis, they gazed at the demonstration more than those in the female-owned group, in both conditions. However, given that we found no previous evidence in the literature nor did we collect information on the different types of daily interactions with dogs as a function of their owners' sex, this hypothesis cannot be sustained without further research.

Regarding the effect of the dog-owner bond, no significant correlations were found between the MDORS scores and the task variables, suggesting that the level of bond is not associated with dogs' performance in an observational learning task. It is possible that this is due to a ceiling effect as most of the dogs participating in this study had a high bond with their owners. This result is consistent with the work of Huber et al. (2022) who found no relationship between bond quality and overimitation. In this sense, it would be interesting to replicate the present study using strangers as demonstrators to assess if the effect of their sex on dogs' social learning is modified. Likewise, it would be interesting to evaluate in future studies, if there are differences between breeds in this paradigm. For example, Jakovcevic et al. (2010) found that retrievers gaze more at the human face than sheepdogs and poodles. Increased attention could facilitate observational learning. On the other hand, breed differences in reactions to men and women is an area that has not yet been explored.

A limitation of the current study is the small sample size of the control condition. This was because it was included for the purpose of demonstrating the presence of observational learning in dogs during this task and was not intended to account for owners' sex effects in the absence of a human demonstration. It would be necessary to increase the sample size in future studies. Another important point to take into consideration is the necessity to include more control groups. An example of this would be that the dogs observe the person performing another task, which would allow evaluating the importance of human actions themselves in the observational learning of dogs.

Conclusions

Dogs were better at solving an object manipulation task to acquire food after they had witnessed a demonstration by their owner. The sex of the demonstrator appears to facilitate this learning only when the owner is female. Strikingly, dogs with male owners performed better on the task regardless of whether or not they received a demonstration. Although these effects need to be further investigated, they represent a valuable contribution to the knowledge of the factors modulating dogs' social learning and their possible implications in applied settings, such as various types of training and other activities involving dogs. Specifically, in canine social cognition research, these findings warn about the importance of considering the owner's sex as possibly having a modulating effect on different abilities in dogs.

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