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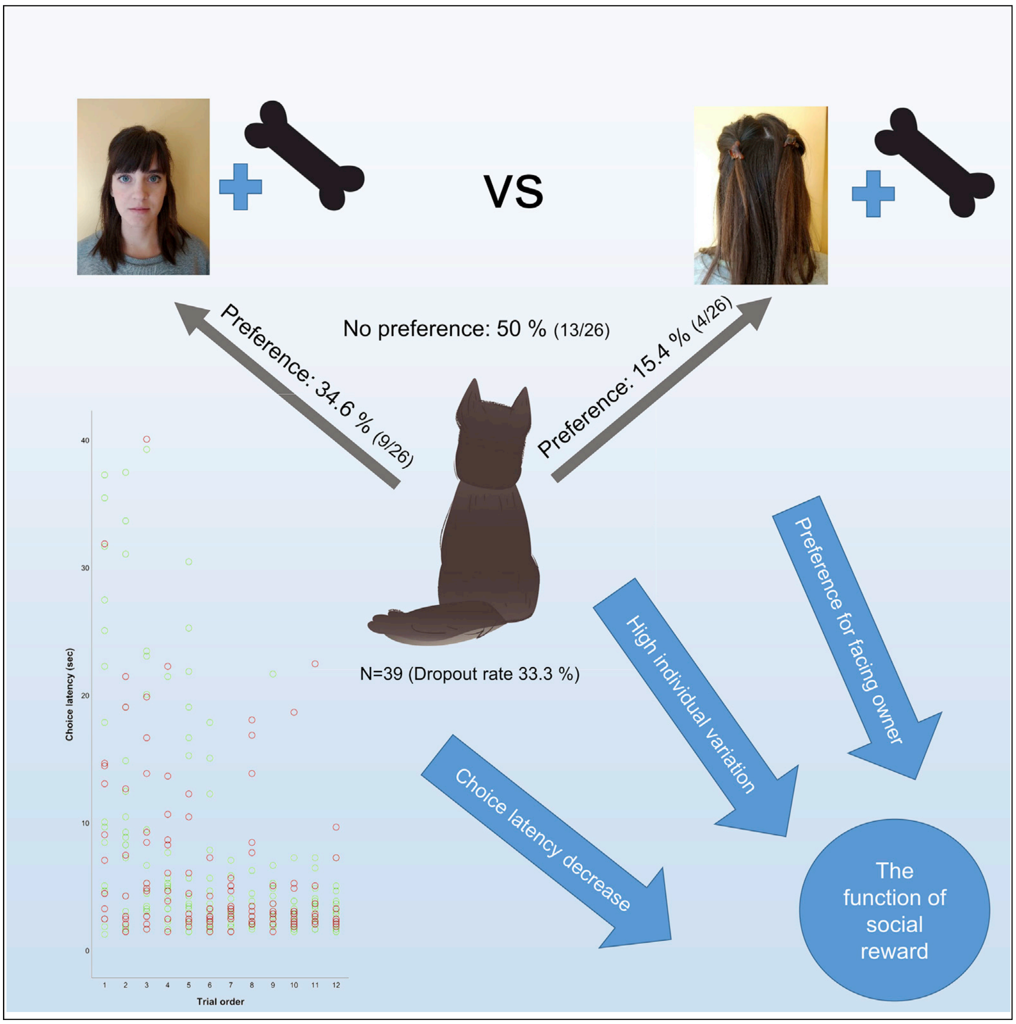


Henrietta Bolló, Orsolya Kiss, Anna Kis, József Topál

bollo.henrietta@ttk.hu (H.B.)
topal.jozsef@ttk.hu (J.T.)

## Highlights

Dogs prefer to approach the food next to the facing owner in a two-way choice task

The variation among dogs is probably due to individual differences in sociability

Dogs' tendency to approach the facing owner may stem from their internal motivation

Alternatively, dogs may have associated the owner's face with positive reinforcement

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# The implicit reward value of the owner's face for dogs

Henrietta Bolló,[1,3,*] Orsolya Kiss,[1,2] Anna Kis,[1] and József Topál[1,*]

## SUMMARY

**It is increasingly assumed that domestication has equipped dogs with unique socio-cognitive skills, which raises the possibility of intriguing parallels between the social motivational systems of the two species. However, the positive incentive value of human facial stimuli is a largely unexplored area. Here, we investigated whether the owner's face serves as a social reinforcer. In a two-way choice task N = 39 dogs were presented with a short video about their owners' head showing the face (facing owner [FO]) vs. the back of the head (non-facing owner). Despite both locations containing equal food reward, dogs approached the container associated with FO more frequently (p < .001), and this was not affected by side, trial order, and choice latency. However, the considerable inter-individual differences in dogs' task performance suggest that the added social component required special social skills which need to be further explored.**

## INTRODUCTION

During their long domestication history dating back 15,000–30,000 years (Savolainen et al., 2002), dogs have gained special socio-cognitive skills which helped them navigate in the human environment and made them man's best friends. As a consequence, dogs recognize humans as social partners (Gácsi et al., 2009; Hare and Tomasello, 2005) and have become sensitive to interspecific communicative cues (Topál et al., 2014). However, several questions remain regarding what constitutes this special interspecific bond and what exact function human social cues bear for dogs.

In current canine cognition research, it has become increasingly important from both theoretical and applied perspectives to understand how social reinforcement works for dogs. From a theoretical point of view, investigating how social cues affect dogs' preference can bring us with one step closer to understand how dogs have adapted to the human social niche through evolution and what motivates these two unrelated species to maintain this special relationship. On the other hand, from an applied perspective, it is useful to understand how social cues can become intrinsically rewarding to dogs because this is an important aspect of training efficiency and welfare conditions.

According to Ryan and Deci, (2000), intrinsic motivation "refers to doing something because it is inherently interesting or enjoyable". Intrinsic motivation was first acknowledged within animal studies, where it was shown that many organisms are prone to engage in exploratory, playful. or curiosity-driven behaviors even without any extrinsic reinforcement or reward (White, 1959). In line with Skinner's theory (Skinner, 1965) on operant conditioning—which states that all behaviors are motivated by rewards—intrinsically motivated activities are said to be ones for which the reward is in the activity itself.

Recent studies provide supporting evidence that dogs, at least in particular situations, find human social interaction intrinsically rewarding, and the quality of human interaction can modify even the hormonal level of dogs (for a review see Kis et al., 2017). Positive human interaction has the potential to increase oxytocin—a neurohormone related to attachment behaviors—(Hritcu et al., 2019; Kis et al., 2017) while social isolation (e.g. in case of shelter dogs) increases cortisol—a neurohormone associated with stress level (Gunter et al., 2019). Furthermore, using the fMRI method, Cook et al. (2016) found that dogs' ventral caudate—a core area involved in reward processing—showed equal or even greater activation in response to verbal praise than food in the vast majority of subjects (87%). Note, however, that dogs in this experiment received verbal praise from their re-entering owners, while subjects were rewarded with food in the absence of the owner. Although this discrepancy may potentially confound results and interpretation, this fMRI study serves

[1]Institute of Cognitive Neuroscience and Psychology, Research Centre for Natural Sciences, Magyar tudósok krt 2., 1117 Budapest, Hungary

[2]Center for Health Sciences, SRI International, Menlo Park, CA, USA

[3]Lead contact

*Correspondence: bollo.henrietta@ttk.hu (H.B.), topal.jozsef@ttk.hu (J.T.)

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further evidence for the importance of social reward to dogs. This brain area is also activated when dogs are presented with olfactory stimuli of familiar humans without any associated reward, suggesting that dogs are not only able to discriminate between unfamiliar and familiar people but the latter is associated with positive outcomes at the neural level (Berns et al., 2015).

Behavioral studies, which focus on how social cues affect dog performance, suggest that some dogs prefer social over non-social reinforcers (Bhattacharjee et al., 2017b). Others, however, found that human social reinforcement is not as effective as food reward for either family or shelter dogs (Feuerbacher & Wynne, 2012, 2014) and concluded that domestication has not necessarily resulted in specific changes in dogs' social motivational system. Based on the results, the authors proposed that family dogs' preference for petting over food can be explained in terms of the subjects' reinforcement history (i.e. as a result of learning associations between physical contact with the owner and food). Namely, the owner may act as a conditioned social reinforcer so that he/she becomes a discriminative stimulus for the dog (Michael, 1982). In line with these, although the physical contact with the owner (as reward-associated stimulus) can acquire both incentive and predictive motivational properties, such motivation is linked to external reward, and thus, dogs are not intrinsically motivated to approach and maintain contact with their owners. Feuerbacher and Wynne (2014) also noted that the high level of familiarity (owner vs. stranger) can increase dogs' preference toward the social reward, but this factor alone does not seem sufficient to overcome the preference for food.

In another study, Feuerbacher and Wynne (2012) used nose touches to the experimenter's hand as an arbitrary measure to test the effectiveness of different types of reinforcers (social vs. food vs. extinction) among family dogs, shelter dogs, and hand-reared wolves. According to their results, responses decreased and latencies increased in the social reinforcement conditions. This finding is in agreement with the observation that many dogs experience aversion to be touched by an unfamiliar person (Bhattacharjee et al., 2017b; Topál et al., 2005). In line with this notion, Bhattacharjee et al. (2017a) and (2017b) found that free ranging dogs are biased against accepting food from the experimenter's hand; instead, they prefer to choose the food reward from the ground. However, as they progress toward becoming socialized (thereby paving the way for attachment formation), dogs increasingly prefer hand feeding. The authors concluded that long-term social reward—but not food reward—impacted dogs' tendency to make physical contact with the experimenter's hand, which suggests that compared to food, social reinforcement can be more effective in building attachment between humans and dogs. Altogether, these research findings raise the possibility that social reinforcement works specifically in different contexts and population of dogs and, at least in some cases, probably has a different function compared to food reward (i.e. social reinforcers are quite effective in increasing response frequency and other performance measures).

Building on this previous knowledge, the present study explores whether the human caregiver's neutral face—without any accompanying social interaction—can have an effect on dogs' preference in a two-way choice task. Ample evidence suggests that faces are intrinsically rewarding to humans: children, for example, find a face stimulus more rewarding than a non-face stimulus (Stavropoulos and Carver, 2014). We also know that dogs' behavior can be reinforced the same way as adults motivate human children (Bandura and McDonald, 1963; Harris et al., 1964; Horowitz, 1963). However, the possible positive value of human facial stimuli for dogs is still largely unexplored. It is known that dogs fulfill the pre-requisite of being able to extract various social information from human faces including the direction of gaze (Duranton et al., 2017; Riedel et al., 2008; Téglás et al., 2012), emotions (Huber et al., 2013; Racca et al., 2012), and attentional states of humans (Call et al., 2003; Gácsi et al., 2004). Thus, we hypothesized that in a two-way choice tasks dogs would prefer the side associated with their owner's face and would show increased response frequency and decreased latency.

## RESULTS

N = 13 dogs started with three consecutive "no choice" trials and thus were excluded from generalized linear mixed-effect models (GLMMs). Note, however, that the remaining N = 26 dogs fulfilled all 12 trials (i.e. made their choice within 40 s). At the group level, dogs approached the facing owner (FO) more frequently (59% of the cases) compared to the non-facing owner (NFO) (41% of the cases, binomial test, p = .001). At the individual level, however, only N = 9 out of the N = 26 subjects showed a significant preference toward the owners' face (at least 10/12 FO choices), while N = 4 of the subjects showed a significant avoidance of the owners' face (at least 10/12 NFO choices), with the remaining half of the subjects (N = 13) showing no significant preference for either of the stimuli (Figure 1).

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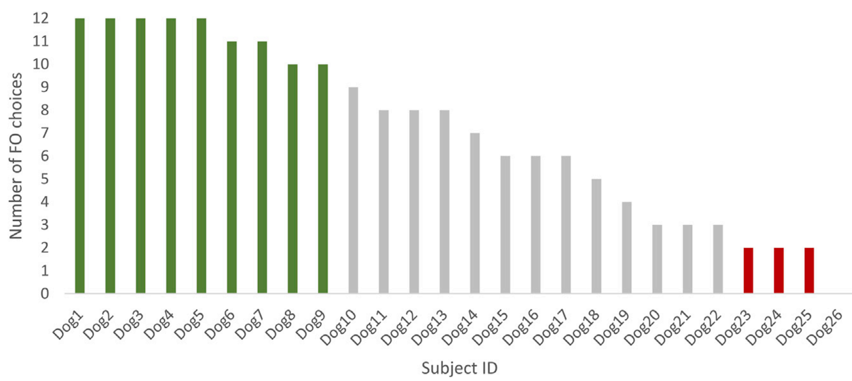


**Figure 1. Percentage of FO choices by the N = 26 subjects that completed the 12 trials**
At the individual level, dogs with ≥83% performance are significantly above chance level (indicated with green), while dogs with ≤17% are significantly below chance level (indicated with red).

Furthermore, according to the logistic GLMMs, dogs' FO vs. NFO choices were not affected by either "trial order", which "side" the facial stimuli was projected to, or "choice latency" (all $p > .05$). According to the GLMM, "choice latency" was affected by "trial order" ($F_{11,287} = 8.16$, $p < .01$), indicating that dogs choose

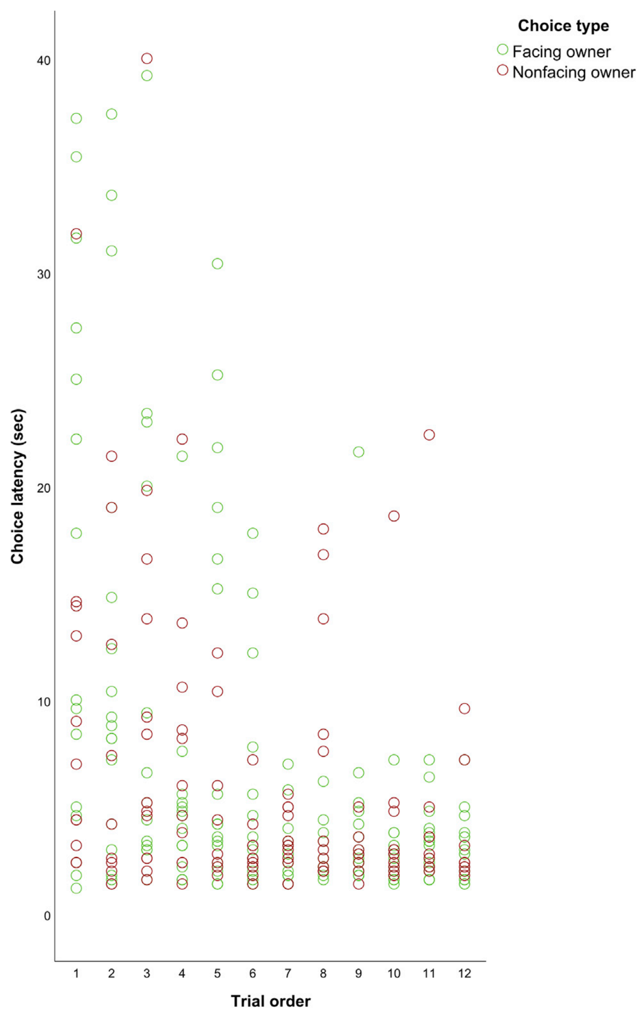


**Figure 2. The relationship between choice latency and trial order across 12 trials**
Note that choice latency was not associated with FO/NFO choices.

faster toward the end of the experiment (see Data S1). Visual inspection of the data (Figure 2) also shows that some individuals performed with a short latency from the first trial on, and the group-level latency decrease is due to a sub-group of individuals.

Finally, we did not find significant correlation between the degree to which dogs find social interactions rewarding (sum of the answers to questions with Likert scale) and the dogs' tendency to prefer the food location that had been previously "marked" by the video demonstration of the facing owner ($r = -.076$, $p = .713$).

## DISCUSSION

The present study investigated whether the mere presence of the owner's neutral face would have an effect on the dog's choice between two identical rewards. A two-way food choice task was conducted with a facing and non-facing owner and we found that similarly to children (Stavropoulos and Carver, 2014), dogs showed significant selection bias toward the food placed next to their owners' video-projected face.

Previous studies used complex human social cues including emotions, gestures, and facial, verbal, and olfactory stimuli to investigate the possible rewarding effect of social cues (Berns et al., 2015; Bhattacharjee et al., 2017b; Cook et al., 2016; Feuerbacher & Wynne, 2012, 2014). In the present study, however, we used only visual stimuli (emotionally neutral face of the owner and back of his/her head) and found that the owner's face has an additional rewarding effect when subjects are allowed to make a choice between two identical pieces of food.

There are two possible explanations for these results. Based on previous studies showing that dogs find social interaction with humans intrinsically rewarding at hormonal (Kis et al., 2017), neural (Cook et al., 2016), and behavioral (Bhattacharjee et al., 2017b) levels, we may assume that dogs' tendency to approach the facing owner in our study was an intrinsically motivated behavior, which probably originated from attachment regulation processes (Topál et al., 2005). An alternative explanation might be that during their previous reinforcement history with their owner dogs just simply learned that the owner's face is predictive for reinforcement. If so, the observed choice bias has nothing to do with intrinsic motivation but rather with discriminative learning (i.e. the owner's face serves as a discriminative cue for the dogs—Michael, 1982). To determine whether this explanation is plausible, dogs should be tested at least with a stranger with whom they have no previous reinforcement history, although they could still be generalizing from their history of reinforcement with their owner. Testing dogs from animal shelters (i.e. subjects deprived of human social contact) may also be a viable option, although in case of shelter dogs, probably due to their deprivation and the lack of an attachment figure might make human interactions from anyone reinforcing (Feuerbacher and Wynne, 2014).

However, it is important to mention that there are several methodological differences between prior studies and the current study. First, food was presented as a reward in an otherwise neutral context (sausages were placed on the top of two identical containers) in our study, whereas dogs in previous studies were observed in a potentially aversive situation (forced contact with a stranger). Furthermore, we did not aim to compare food vs. social reinforcement, as we supposed that the two different rewards have different functions. Food reward can be more effective in a performance context as it quickly increases response frequencies (Feuerbacher and Wynne, 2012), but social reward can be more effective to strengthen the special bond between humans and dogs (Bhattacharjee et al., 2017b). Both processes are fundamental elements for successful learning. The fact that dogs' choices were faster toward the end of the 12 trials also supports that food and social reinforcement goes hand in hand when enhancing performance and the question is not which one is the better reinforcer but how and under what context they complement each other.

It is also important to note that there was a quite big dropout rate (33%) in our study compared to other similar two-way choice task protocols in which this rate is usually around 10%. That is, approximately one-third of our subjects were extremely hesitant to make their choice; they failed to successfully complete even a single trial within a time limit of 40 s. This is surprising because we used sausage as a food reward, which is a strong incentive to dogs. Furthermore, there is good evidence that dogs can recognize their owners based on a picture (Eatherington et al., 2020), and although we used videos, which are more complex stimuli than pictures, it seems unlikely that dogs were not able to recognize their owners. Note,

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however, that owners were asked to remain present during the test trials of our study because many dogs show signs of separation anxiety when the owner is not present (Topál et al., 2005). We may therefore assume that some dogs that have never seen their owner previously on a screen talking to them were not able to cope with such situational ambiguity and thus they responded hesitantly. Although dogs can reliably use pre-recorded videos of humans as a source of information in a pointing task (Péter et al., 2013; Pongrácz et al., 2003), it is still not clear how dogs process video recordings. Even 2- and 3-year-old children often become confused when presented with a video recording (Flavell et al., 1990; Jaglom and Gardner, 1981), as it requires dual representation of the stimuli (DeLoache, 1987, 1991). The ability for dual representation means that to respond appropriately to an image, the viewer must be aware of two independent factors at the same time: the content of the image and information indicating that this is merely a representation. It is reasonable to assume that the relatively high "non-response rate" stems from the ambivalent nature of this two-way choice task.

In sum, we conclude that dogs, similarly to humans, show a behavioral preference toward human social stimuli and these have a rewarding effect to them. However, a considerable individual variation is present that can be partly explained by differences in dogs' individual sociability. Social and food rewards are complimentary and can intensify each other for dogs which are important from a practical perspective as well. Furthermore, our results are in line with earlier studies suggesting that dogs perceive neutral human faces positive rather than negative. Finally, from a methodological and welfare perspective, future research should put more emphasis on the individual differences that may underlie this process as well as on how dogs react to the experimenters when the owner is eliminated from the test.

## Limitations of the study

Despite the group-level preference, there was a considerable individual variation among subjects, as our sample even included a few dogs that avoided the owners' face and consistently chose the food bait on the side associated with the back of the head. It is plausible to assume that variation in dogs' sociability traits would explain some part of such between-subject differences. In the present study, an owner-reported questionnaire was used to assess social reward sensitivity. Questionnaire scores, however, did not differ between subjects with different performance regarding the preference toward the owner's face. This result can implicate two explanations. First, the owners' perception about their dogs' sensitivity to social reward might not be a good source of information and the owners might not be able to predict how their dogs would react to this type of reinforcer. This phenomenon has several implications in the field of dog training. Raising owners' attention more toward using social reinforcers can enhance learning processes. Second, the lack of difference between the groups can be caused by the fact that our questions were not applicable to measure social reward sensitivity among dogs, and there are other factors which can cause a difference in dogs' preference toward the facial stimuli in the present study.

Furthermore, different types of food and social reinforcers might have different reward values, and this might also depend on the context as well and individual differences among dogs regarding their age, breed, and personality traits (Gerencsér et al., 2018). For example, Hegedűs et al. (2013) compared the effect of different quality food reward (sausage vs. carrot) in a pointing task and found that incentive contrast plays a relatively minor role in dog-human social interactions and that when interacting with humans, following social signals can override the effect of changed incentive power.

Finally, as noted and discussed above, the presence of the owner and the use of video recordings could be challenging for some dogs.

## STAR★METHODS

Detailed methods are provided in the online version of this paper and include the following:

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## SUPPLEMENTAL INFORMATION

Supplemental information can be found online at https://doi.org/10.1016/j.isci.2021.102763.

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## AUTHOR CONTRIBUTIONS

H.B., O.K., and J.T. contributed to conception and design. H.B. contributed to acquisition of data. H.B., O.K., A.K., and J.T. contributed to analysis and interpretation of data. H.B. drafted the article. All authors revised the article critically for important intellectual content and final approval of the version to be published. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved by all authors.

## DECLARATION OF INTERESTS

We declare we have no competing interests.

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## STAR★METHODS

### KEY RESOURCES TABLE

| REAGENT or RESOURCE | SOURCE | IDENTIFIER |
|---|---|---|
| Biological samples | | |
| *Canis familiaris* | various families owned dogs | NA |
| Software and algorithms | | |
| SPSS software package (v. 25.0) | IBM | NA |

### RESOURCE AVAILABILITY

#### Lead contact

Further information and requests for resources should be directed to and will be fulfilled by the lead contact, Henrietta Bolló (bollo.henrietta@ttk.hu).

#### Materials availability

All materials are available upon request to the lead contact.

#### Data and code availability

All datasets are available upon request to the lead contact.

### EXPERIMENTAL MODEL AND SUBJECT DETAILS

#### Ethics statement

Research was carried out in accordance with the Hungarian regulations on animal experimentation and the Guidelines for the use of animals in research described by the Association for the Study Animal Behavior (ASAB). The Hungarian "Animal Experiments Scientific and Ethical Committee" issued a statement (under the number PE/EA/55-4/2019). All owners volunteered to participate in the study and they gave written informed consent.

#### Subjects

Task naive adult pet dogs from various breeds (N = 39, $M_{age}$ = 4.18 years, $SD_{age}$ = 2.34 years, 19 male, 20 female) and their owners were recruited on a voluntary basis and participated in the 12 trial choice task. The only criterion for selection was that the dogs had to be at least one year old.

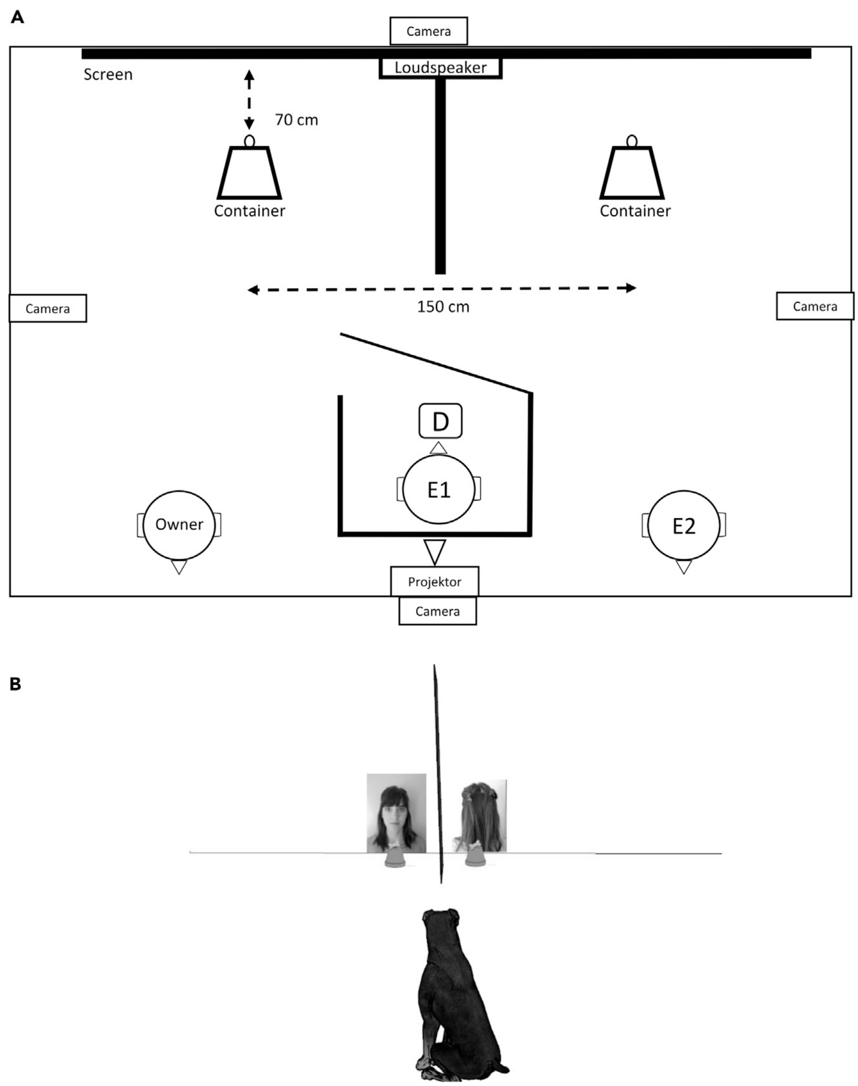
### METHOD DETAILS

#### Stimulus recording

The test started with recording two videos and the audio about the owner. Dogs arrived with their owners to the laboratory of the Research Center for Natural Sciences (an empty room of 5 m × 6 m size equipped with a four-camera observation system). After arriving, dogs were unleashed for 5-7 min of free exploration while Experimenter 2 (E2) was taking a short video recording of the owner's head above the shoulder-line from the front and from the back. E2 asked the owner to stand calmly, look ahead into the camera and do not smile until E2 said she was finished. At the same time as filming the back of the head, the owners were asked to repeat the command 'Listen!' three times with approximately 3 s silence intervals in between while maintaining a neutral facial expression and looking ahead, otherwise the owner's head was motionless. Afterward, the owner, the dog and Experimenter 1 (E1) left the room, while E2 edited the recordings and prepared the setup. These preparations took approximately 5 min.

#### Experimental arrangement

The recordings were simultaneously projected to a white wall in 70 × 30 cm size (providing an approximately life-sized picture about the owner's head) and there were two identical containers (20 cm tall) placed upside down in front of the two locations where the videos were projected. The video was projected right from the floor but as the shoulders were included the containers did not cover the head area. On the top of the containers there were one identical food bait each (a piece of sausage). We decided to place the containers in this position to direct the attention of the dogs more toward the wall instead of the floor. Recording the owner's 'Listen!' vocal command was also used for this purpose, to attract dogs' attention toward the screen, as the loudspeaker was placed right in front of the middle of screen. The panel (300 × 150 cm) between the containers was placed in order to block dogs to quickly eat both food baits.




**Experimental setup from above (A) and from the dog's perspective (B)**

## Familiarization

After settling the arrangement, E1 came back with the owner and the dog. The dog was unleashed and encouraged to freely explore the room for approximately 5 min and find the food baits. E1 asked the owner to sit on the chair facing the corner and fill in a questionnaire while the test is taken and do not interact or even look at the dog to avoid any potential bias caused by gazing (Soproni et al., 2001; Virányi et al., 2004). Since the owner was present during the trials we could also test those 'socially dependent' dogs that would have shown separation anxiety without their owners. We have to note however, that dogs' responses toward the video-projected images may be more or less affected by the presence of their owners.

The eight-item questionnaire included three questions about demographic information (age, breed and sex of the dog) and also included five descriptive questions to assess the degree to which dogs find social interactions rewarding—as perceived by the owner. These questions were as follows:

- How often does your dog try to get into close physical contact, i.e. cuddles up or nuzzles without trying to get something? for e. g. he/he is not trying to get some food or initiate play or walking?
- How often does your dog try to stay close to you, nonetheless you are paying attention to him/her? For e.g. when you are watching television or reading, is there your dog around you?
- How often does your dog detects that you are sad, depressed or worried? For e.g. does he/she tries to get close to you and asks for cuddling without calling him/her?
- How much does your dog likes to be among people? For e.g. when there is a party at your home, he/she tries to avoid people?)
- How often does your dog tries to get involved in or tries to imitate what you are currently doing? For e.g. when you are digging in the garden the dog is also digging.).

A standard 5 point Likert scale was used to rate the frequency with 1 meaning never and 5 meaning very often and an ''I do not know'' option was provided.

### Demonstration

After the free exploration of the experimental arrangement, E1 got the dog back to his/her initial position on the leash and sit together in the box at the predetermined place in the middle, facing the screen. The experiment continued with a demonstration phase, where dogs were presented with a video showing either the Facing Owner (FO) or the Nonfacing Owner (NFO) one after the other which took approximately 2 × 9 s. The previously recorded 'Listen!' vocal command was played during both the FO and NFO conditions. Videos were presented on the two sides of the screen and the sequence was LRLRLRLRLR in case of 50% of the dogs and the opposite for the other half. There were five repetitions of this presentation in total (approximately 90 s), before the test trials began.

### Test trials

After the demonstration, the experiment continued with 12 test trials. E1 closed the box with a mobile panel to avoid the dog seeing E2 placing the two food baits on the top of the two containers (i.e. both containers were baited so dogs could obtain reward regardless of the choice they made). When E2 arrived back to her place, E1 removed the visual barrier. E1 made sure that the dog sits in his/her predetermined initial position, facing the apparatus from the middle, then let the dog free (saying 'You can go!') and dogs were allowed to choose between the two containers. FO and NFO was simultaneously projected during the test trials and side was counterbalanced across subjects. After making a choice, dogs were called back (i.e. the dog was not allowed to approach the other baited container). If the dog did not come back, E1 approached the dog, put him/her on a leash and went back together in the box. There were no breaks between the trials. If the dog refused to approach either container within 40 s, the trial was terminated and coded as 'no choice'. After 3 consecutive 'no choice' trials, the procedure was stopped and the dog was excluded from further testing.

## QUANTIFICATION AND STATISTICAL ANALYSIS

Dogs' behavior was recorded by four cameras fixed in the midpoints of the ceiling of the laboratory. Behavior coding was done with Solomon Coder in 0.2 s resolution (beta 091110, ©2006e 2008 by András Péter, http://solomoncoder.com/). 'Start trial' was indicated when the dog left the small box and 'Reach target' indicated when the dog arrived to either of the containers and started to pick up the food bait. 'Choice latency' was exported in seconds for all trials indicating the time between 'Start trial' and 'Reach target'. 'Choice type' was coded as a dichotomous variable (FO vs. NFO). Furthermore, which 'Side' the FO was projected was coded as Left or Right.

Dogs' choice preference was analyzed with binomial test (test proportion was set to 50%). To test how choice was affected, logistic generalized linear mixed-effect models (GLMM) was conducted, including 'Choice type' as a dependent variable. 'Trial order'(1-12), and 'Side' (FO on the left or on the right) were included as fixed factors and subject ID was included as a random factor. Moreover, 'Choice latency' was included as covariate and the model also contained all possible two-way and three-way interactions. Furthermore, another GLMM analysis was conducted including 'Choice latency' as a target variable, 'Trial order' and 'Side' as fixed factors, their interaction and ID as a random factor. Statistical tests were two-tailed, the $\alpha$ value was set at 0.05.

Owner-reported questionnaire data was used to investigate if dogs that performed differently in the behavioral test were also different regarding this trait by summing the answers to the five questions with Likert scale responses. Pearson correlation was conducted, between the scale and individual FO preference index (FO choices/12).

All statistical analyses were carried out using SPSS software package (v. 25.0).