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Behavioral assessment and owner perceptions of behaviors associated with guilt in dogs

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ABSTRACT

Dog owners ascribe guilt to dogs, and we explored this attribution with pet dogs and their owners using a questionnaire and experiment. The questionnaire found that the majority of owners perceive dog behavior as guilty in certain situations and believe that dogs know when they have committed a disapproved act. As a novel finding, the questionnaire revealed that dog presentation of guilty behavior could lead owners to scold dogs less.

The experiment aimed to investigate the owner-reported anecdote that dogs sometimes greet owners displaying guilty behavior. Owners claim to be unaware of a dog's misdeed and assert it is the guilty behavior that informs them of the dog's infraction. We studied whether dogs that were disobedient in owners' absences showed associated behaviors of guilt (ABs) upon owners' return to a room. We also assessed whether owners could determine their dog's disobedience by relying solely on the dog's greeting behavior.

Behavioral analysis revealed no significant difference between obedient and disobedient dogs in their display of ABs after having the opportunity to break a rule in owners' absences. Analyses at the individual level, however, revealed a significant increase in cross situational presentation of ABs only by dogs that transgressed in owners' absences. While owners appeared able to determine whether or not their dogs ate in their absences, a subset of owners—those whose decisions were most likely based solely on dog greeting behavior and not earlier experiment-generated cues—were not better than chance in their determinations. Taken together, our findings suggest that dog presentation of ABs during greetings is not necessarily a reliable indicator whether or not a dog engaged in a misdeed. The investigated phenomenon appears to be very sensitive to the social condition, which includes owner prior experience with their dog in specific contexts.

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1. Introduction

Through a unique domestication process, dogs have become integrated into the anthropogenic social environment (Clutton-Brock, 1977; Schleidt and Shalter, 2003). Companion dogs display a social behavior set which readily allows for interspecific social interactions (Miklósi, 2009), and in some contexts, dog behavior can be construed as functionally analogous to that displayed by humans (Topál et al., 2009). Dog behavior facilitates close interactions with humans such as shared social experiences (Horowitz and Bekoff, 2007; Kubinyi et al., 2003), bidirectional communication and cooperation (Kerepesi et al., 2005; Naderi et al., 2001), emotional synchronization (Odendaal and Meintjes, 2003) and individual attachment relationships (Gácsi et al., 2001; Topál et al., 1998). Dog owners maintain various impressions of their relationships

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with dogs—perceiving dogs as family members (Albert and Bulcroft, 1987; Endenburg et al., 1994), attributing cognitive and emotional qualities to them (Rasmussen and Rajecki, 1995; Sanders, 1993) and even experiencing pathological mourning with their passing (Keddie, 1977).

Dog physical appearance (Serpell, 2003) and behavioral expressions (Mitchell and Hamm, 1997) invite humans' anthropomorphic gaze, which in turn could enhance the dog–human relationship. Owners not only perceive dogs as appreciative of the care and protection owners provide but also interpret dog behaviors as a sign of social support similar to that provided by other humans (Bonas et al., 2000). At the same time, human interpretation of dog behavior is not necessarily indicative of dog inner emotional states, and studies reveal both interobserver consistency in qualitative assessment of dog behavior (Walker et al., 2010) and interobserver inconsistency in judgments about dog behavior (Tami and Gallagher, 2009).

Among scientists, the emotional experience of social, non-human animals remains a contentious topic. While primary emotions, like anger and fear, serve an evolutionary function to adapt and respond to social and environmental demands (Ekman, 1992; Izard, 1992), the precursors for the experience of secondary emotions, like embarrassment, pride and guilt, are not widely attributed to non-human animals (Morris et al., 2008, but also see Bekoff, 2000).

Regardless, dog owners identify secondary emotions in dogs. Of note, owners report that dogs know disallowance (Pongrácz et al., 2001) and experience guilt (Morris et al., 2008). Owners of other companion animals do not report guilt with the same prevalence as dog owners: 74% of dog owners ascribe guilt; the next-highest attribution, at 36%, is from horse owners (Morris et al., 2008).

This widespread attribution of guilt within dog–human interspecific contexts could stem from humans' subjective experiences with guilt as well as behaviors displayed by dogs in particular interspecific social contexts. Succinctly stated, "I behave in a particular way when I feel guilty; my dog behaves in a similar way in equivalent circumstances; I know intuitively that my behaviour is motivated by guilt; therefore the behaviour I see in my dog is also accompanied by feelings of guilt" (Bradshaw and Casey, 2007, p. 151).

In humans, guilt is considered a self-conscious, evaluative emotion associated with a self-perceived violation against an established rule to which one has agreed to adhere (Lewis, 1971; Tangney, 1996; Teroni and Deonna, 2008). Guilt reinforces social relationships and minimizes the effects of transgressions against valued partners (Baumeister et al., 1995).

Besides offering multiple benefits, living in groups also lays the ground for conflict among members, and social animals are expected to evolve different kinds of strategies to avoid, cope with and resolve conflicts (Aureli et al., 2002). A typical post-conflict interaction labeled as reconciliation was systematically investigated not initially in humans, but in non-human primates (de Waal & Roosmalen, 1979). Behavioral displays that humans associate with appeasement and reconciliation or the experience of guilt are also evident in other species (Darwin, 1872/1979), and relevant behaviors, such as constricting posture, moving head down and averting gaze, have been reported in non-human primates (Keltner, 1995). Functionally analogous behaviors of active and passive submission are found in the dog and their wild-type progenitor, the wolf (Harrington and Asa, 2003). For wolves, these postural displays serve to reinforce social bonds, reduce conflict and elicit tolerance from other members of the family (Schenkel, 1967). Within the domestic dog's behavioral repertoire, these behaviors may be displayed in the management of intra- and interspecific social relationships. We claim that the behavioral manifestations of what is labeled guilt could be advantageous for social species with interrelated dependencies and shared resources or responsibilities. At the same time, when dogs display these behaviors in particular interspecific social contexts, owners interpret the behavior to signify knowledge of transgression and therefore indicative of guilt (Horowitz, 2009).

Few studies empirically investigate dog behavior that is interpreted as guilty within interspecific social contexts. Vollmer (1977) created a scenario where, in the dog's absence, an owner performed the dog's typical misdeed of shredding paper. The dog was then left alone with the remnants of the misdeed, and upon the owner's return, the dog displayed guilty behavior despite not having shredded the paper. Although relying on a small sample size and an informal experimental design, the finding suggested guilty behavior was a conditioned response elicited by the presence of the owner and a notable stimulus.

Horowitz (2009) explored the prompts to dog presentation of associated behaviors of guilt—"ABs" as coined by the author. This study investigated whether dog disobedience led to an increase in ABs or whether ABs were instead displayed in association with owner behavior, such as scolding. The results suggested the so-called "guilty look" was a response to owner scolding, not an appreciation of a misdeed. However, in this study, factors apart from owner scolding could have contributed to dog presentation of ABs. Dogs who had not eaten the treat but were nonetheless scolded showed more ABs than scolded dogs that had eaten the treat. Presentation of ABs by scolded obedient dogs suggests dogs displaying guilty behavior could be inclined to be more expressive, confused or fearful. Taken together, these studies suggest that dog presentation of ABs is not entirely explained by owner scolding, and ABs might also appear in contexts where owners do not scold.

Our study investigated ABs in a scenario not previously explored—owners claim that a dog who has transgressed in their absence sometimes displays ABs before the dog's misdeed is discovered. We assumed our questionnaire would reveal that owners perceive dog behavior as guilty in certain contexts and associate dog performance of guilty behavior with knowledge of a misdeed. Additionally, should guilty behavior have an adaptive function within interspecific social contexts, owners might claim dog presentation of ABs leads owners to scold dogs less. The experiment explored two main questions: (1) is there a difference in dog presentation of ABs when greeting their owners between dogs that disobeyed a social rule in owners' absences and dogs that did not disobey, and (2) by relying solely on dog greeting behavior, can owners

determine, upon returning to a room, whether their dog transgressed.

2. Materials and methods

The study was conducted under the approval of the University of Edinburgh and the Department of Ethology, Eötvös Loránd University (ELTE), in Budapest, Hungary.

2.1. Subjects

We tested pet dogs ($N = 64$) living in households in and around Budapest, Hungary. Dogs were from various breeds (52 purebred dogs from 31 different breeds and 12 mixed-breed dogs) and included 37 females and 27 males with an average age = 3.62 ± 2.54. Owners' sex ratio was biased toward females (47 females and 6 males), and seven owners participated with two dogs and two owners with three dogs. Participants were recruited from an online newspaper article and the Department of Ethology, Family Dog Project website and database. To enter the study, owners confirmed that their dog complied with the following criteria: (1) dog was older than eight months; (2) dog had lived with the owner for at least six months; (3) dog could remain calm if left alone in an unfamiliar room for 3 min; (4) dog had not participated in food-reward studies at the Family Dog Project; and (5) after prohibiting their dog from eating food and leaving a room, owners had to be unsure whether or not their dog would eat in their absence. The final criterion was instrumental; if owners were certain dogs would always or never eat in their absence, owners could rely on this prior knowledge when assessing their dog in the experimental context.

2.2. Questionnaire

A questionnaire, designed by the authors, was completed by the 53 dog owners, yielding 64 total questionnaires, one for each dog subject. The questionnaire revealed owner perceptions of dog guilt and the specifics of each dog's performance of guilty behavior.

2.3. Experiment

2.3.1. Overview of experimental procedure

The experimental procedure had four main phases (Fig. 1).

First, Greeting Phase 1 (G1): after a brief separation from their owners, we ascertained dogs' baseline greeting behavior within the experimental setting.
Second, Food Phase (F1, F2, F3): we enforced a social rule that food placed on a table was for humans and not dogs and then left dogs alone with the disallowed food.
Third, Greeting Phase 2 (G2): we assessed how dogs greeted owners after either eating or not eating the food in owners' absences and whether owners could determine whether the dog had eaten.
Fourth, Greeting Phase 3 (G3): after a brief separation from their owners, we ascertained how dogs greeted owners when the social rule was no longer in place.

2.3.2. Materials

The experiment took place in a test room (3.5 m × 4.5 m) at the Family Dog Project in the Department of Ethology, Eötvös Loránd University. The salient features were a table in the center of the room and a small barrier that obscured the view of the table from the test room entrance (Fig. 1). The height of the table used in the experiment depended on the height of the dog. Dogs whose top-of-the-head was higher than the large table, which was 0.43 m high, were tested with the large table. Smaller dogs were tested with the small table, which was 0.25 m high. Four video cameras affixed to the top of the room captured four different room angles.

2.3.3. Detailed experimental procedure

Two trained female experimenters carried out the procedure. Upon arriving at the Department of Ethology, owners completed the questionnaire. Before the start of each phase, owners received a detailed explanation of what was to come. Owners were not explicitly told that the study examined dog presentation of guilty behavior or owners' abilities to rely on dog behavior to determine dog transgression. Below is a detailed description of the four experimental phases.

Greeting Phase 1 (G1): Dogs greeted owners when no social rule was in place. Dog, owner (O) and experimenter (E) entered the test room. The dog was off-leash and free to explore, and E called the dog over to her once, assuring the dog sniffed her within the test room. After 3 min, E and O left, and O told the dog to stay in the test room. After 3 min, O re-entered the test room, and instead of interacting with the dog, O stood in front of the closed door and assessed the dog's behavior, which took approximately 3–8 s. O then spoke aloud, describing the dog's greeting behavior. To ensure O provided this information, E stood in the hallway and asked through the closed door, "What is your dog's behavior like?" O's verbal assessment helped O refrain from interacting with the dog and prepared O to report on the dog's behavior in the next Phase. When O finished answering, O leashed the dog and they both left the room.

Food Phase (F1, F2 and F3) aimed to establish and enforce the social rule that food placed on a table was for humans and not dogs.

F1: Ascertained how dogs behaved toward food that was simply placed on a table. F1 began with O, E and the dog entering the test room. The dog was immediately taken off leash, and O held a plate containing a 2 cm piece of hotdog. To create the desired social context—that the food was for humans and not dogs—whenever O held the plate with food on it, O and E pretended to eat from the plate. O and E stood at their designated spots by the table: O had his/her back to the table, and E stood facing O and the table. O and E spoke and pretended to eat for 30 s, at which time O put the plate of food on the table without saying anything to the dog. O and E continued speaking for up to 30 s. During this time, E monitored the dog to see whether the dog ate.

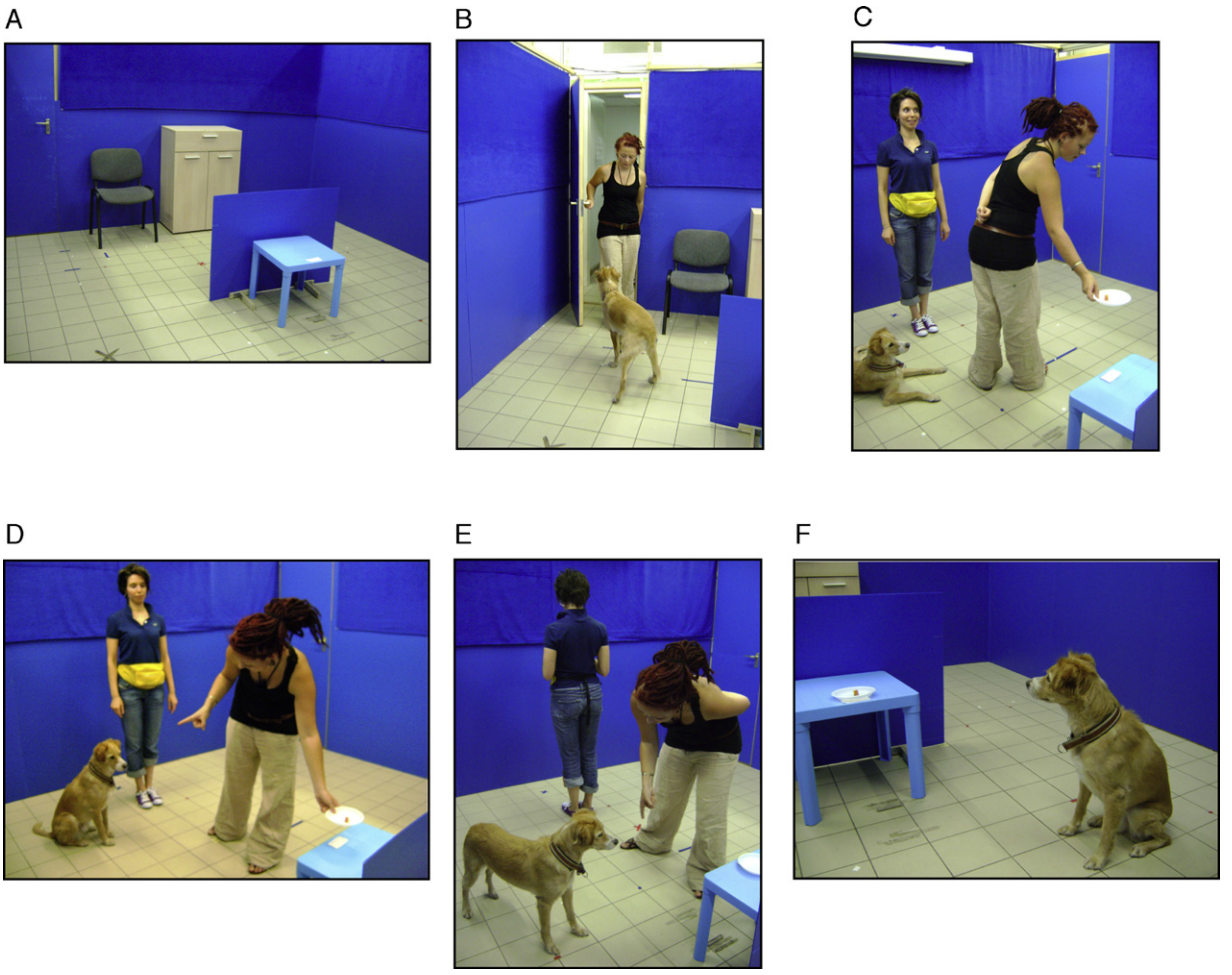

Fig. 1. Test room and illustrations of main aspects of experimental phases. (A) Test room; (B) Greeting Phases – dogs greet owners when social rule not in place (G1 and G3) and when social rule is in place (G2); and (C–F) Food Phase – establish and enforce social rule that food on table is for humans not dogs (F1 and F2) and dog left alone with food (F3).

If E noticed that the dog ate before 30 s, E turned her back to O which signaled for O to turn toward the table, find the food gone, and enforce the social rule by scolding the dog for up to 10 s. E turned her back to give O "privacy" and assist O in acting natural when scolding. If the dog did not eat within 30 s, E also turned her back to O which signaled for O to turn to the table, find the food still on the table and pick up the plate. E turned her back to O, regardless of whether the dog ate or not, to maintain methodological consistency and to ensure O turned to discover whether the dog ate or not. Regardless of how the dog behaved, after O picked up the plate, E and O walked around the perimeter of the test room to create an ordinary social context. If the dog ate, E put a new piece of hotdog on the plate from her waist pouch, and O and E continued pretending to eat. O and E returned to their designated spots by the table.

F2: Explicitly established the social rule within the experimental context. F2 replicated F1 exactly, the only difference being that when placing the plate of food on the table, O disallowed the dog from eating the food. As in F1, if the dog ate, O scolded to reinforce the rule, and if the dog did not eat, O picked up the plate. E and O then walked around the perimeter of the room, E replaced the hotdog if necessary, and the pair returned to their designated spots by the table.

F3: Dogs had the opportunity to break, or adhere to, the social rule in owners' absences. F3 replicated F2 exactly, except after disallowing the dog from eating the food, both O and E left the test room. The dog was alone in the test room for 3 min with the plate of food.

Greeting Phase 2 (G2): Dogs greeted owners after potentially breaking the social rule. After 3 min, O re-entered the test room and, as in G1, stood still by the door and observed the dog's greeting behavior. The small barrier prevented O from seeing the table and the plate. O had been instructed to decide, based on the dog's greeting behavior, whether the dog ate in their absence. O spoke aloud "yes," "no" or "not sure." To assure O communicated the reasoning behind their answer, E asked from the hallway, "Why do you think this?" O responded and, when finished speaking, O walked to the table to view whether the food was there. If the dog had eaten, O could scold; if the dog had not eaten, O could praise. After 10 s of O either scolding or praising, E entered the test room.

Greeting Phase 3 (G3): Dogs greeted owners when social rule was no longer in place. Upon entering the room, E picked up the plate, and then G3 replicated G1 exactly. O and E left the dog alone in the test room, and after 3 min, O re-entered the test room, assessed the dog's behavior and spoke his/her assessment aloud to E standing in the hallway.

2.4. Data collection and analysis

2.4.1. Behavior coding and analysis

Experiments were video-recorded, and dog behavioral data were collected by coding test videos. The owner-completed questionnaires generated a list of associated behaviors of guilt (ABs) that were used to code in-test dog behavior. From the questionnaires, eleven associated behaviors of "guilt" were revealed. The variables used during behavior coding were: lowering body, tail down, moving away from owner, freezing, turning head away from owner, lowering head and lack of jumping. Feuerstein and Terkel (2008) informed several variable definitions. Lack of jumping was included as an AB in G2 if the dog jumped in G1 (the first greeting) and did not jump in G2 (when O returned to the room to decide whether the dog ate or not). No dog did not jump in G1 and then jumped in G2. Due to video zoom capacity and variability in dog morphology, three variables generated from the questionnaires—putting ears back, averting eyes and approaching low and slow—could not be reliably coded, and another variable, lack of barking, revealed itself to be rare.

During the Greeting Phases (G1, G2 and G3), dog behavior was coded for ABs for 10 s upon the owner's return to the room. ABs were coded using one-zero sampling; each variable was only coded once during the 10 s even if it occurred more than once. If dogs ate during Food Phase (F1, F2 or F3), owners scolded and dog behavior was coded for ABs in the same manner as in the greeting phases. Jumping was not observed during scolding. For practical reasons, and as in Horowitz (2009), ABs were considered on an ordinal scale for analysis to represent reaction intensity.

We recorded whether or not dogs ate the food in F1, F2 and F3. Dogs that ate in F3, when humans were not present in the test room, were called 'eaters', while dogs that did not eat in F3 were called 'non-eaters'. Owner answers in G2 as to whether they thought the dog ate or not in their absence were coded as yes, no or not sure. We noted whether these owner responses included mention of actual dog behavior or whether the responses incorporated other contextual cues, such as describing the dog's previous in-test eating history during F1 or F2, or supposing what the dog was doing during the 3-min separation.

Dog behavior was coded when dogs were alone in the test room. During each separation, dogs received a score of yes or no as to whether they showed marked separation distress, which was behaviorally defined as standing within 1.5 m of the door for more than 2 min with vocalizations and/or making physical contact with the door.

While 64 dogs and 53 owners participated in the experiment, six dogs and their video recordings were excluded from data analysis due to incorrect procedure execution. Therefore, 48 owners upon returning to the room in G2 provided 58 separate assessments as to whether their dog ate or not in F3. Of the 58 dogs contributing to experimental data analysis, six had some form of minor missing data due to owner difficulty in procedure execution. These six videos were included in data analysis, but depending on the type of statistical test, the specific datum was not included in analysis.

2.4.2. Reliability

Dog behavior from the 58 videos was coded by the corresponding author twice. The first coding acclimatized the coder to the definitions and revealed rare and non-codable behaviors. Data collected from the author's second coding session was used in data analysis. Dog greeting behavior during G2, when the owner returned to the test room and assessed whether the dog had eaten, was coded by a blind coder. To ensure dog behavior coding in G2 was not influenced by whether the dog ate or not, the table on the computer monitor was obscured during coding. Inter-observer agreement with a naïve observer was assessed on behavior variables using parallel coding of 11 of the 58 videos (Martin and Bateson, 1993). The following high Cohen Kappa reliability measures were obtained: head turn = 0.85; head low = 0.81; low body = 0.94; tail = 0.88; jump = 0.93; away = 0.90; freeze = 0.73.

2.4.3. Statistical analysis

To analyze dog presentation of ABs, variable scores were added together resulting in an ordinal scale (as in Horowitz, 2009). Tests used for statistical analysis are embedded within the results. To test for normality, the Kolmogorov–Smirnov test with Lilliefors correction was applied.

2.4.4. Questionnaire analysis

While six dogs were removed from experimental data analysis, the 64 questionnaires, completed for each dog, contributed to the questionnaire results. We considered that all owners completed a separate questionnaire for each dog they brought—seven owners completed separate questionnaires for two dogs and two owners completed separate questionnaires for three dogs. When a question solicited an owner's general opinion, their opinion was only counted once, but if a question asked for an owner's opinion about a particular dog, the owner's opinion of each individual dog contributed to the total data.

3. Results

3.1. Questionnaire

In accordance with our hypothesis, most owners, 92.5%, perceived dogs as being guilty in particular situations. Of those owners, 91.8% claimed that when showing "guilty" behavior, their dog knows it has done something the owner disapproves of. Additionally, of owners who claim their dog shows guilty behavior, more than half, 59.2% (29/49), claim their dog's "guilty" behavior leads them to scold their dog less. Of the 56 individual dogs described by their owners as being a dog who shows guilty behavior, 28 dogs were

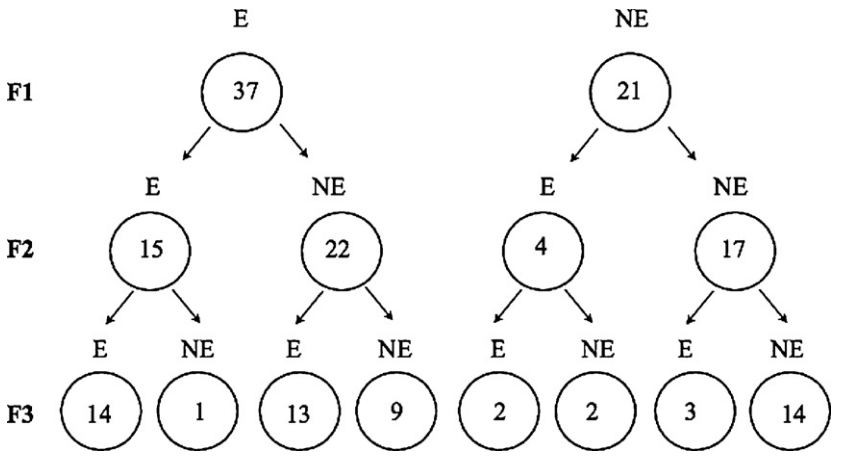

Fig. 2. Summary of dog in test eating history ($N = 58$). F1 – O does not disallow dog from eating the food. F2 – O disallows dog from eating the food, and F3 – O disallows dog from eating the food and humans leave the test room. E = Eat; NE = No Eat.

reported to display "guilty" behavior before the owner has discovered a misdeed.

3.2. Dog in-test eating history

In F1, F2 and F3, dogs showed different in-test eating patterns regarding the social rule that food on a table is for humans, not dogs (Fig. 2).

3.3. Validating associated behaviors of guilt (ABs)

First we assessed whether dogs displayed the ABs described by owners in the questionnaire more frequently when being scolded than when greeting owners. Dogs scolded at least once during the entire experiment ($N = 44$) were included in this analysis. A greeting value of ABs was obtained from an average of G1 and G3 and aimed to provide baseline greeting behavior. G2 did not contribute to the greeting mean as it offered the additional food challenge. For dogs scolded more than once ($N = 30$), a scolding value was obtained from an average of ABs during scolding in F1, F2 and F3. When greeting owners, dogs showed significantly fewer ABs than when being scolded by owners (Wilcoxon signed ranks test; $N = 44$, $z = -5.082$, $P < 0.001$).

3.4. Can behavior coding reveal ABs in the greeting behavior of disobedient dogs?

We compared ABs displayed in G2 between dogs that had transgressed in owners' absences and dogs that had not transgressed. Analysis of this sample revealed no difference between eaters ($N = 32$) and non-eaters ($N = 26$) in their display of ABs (Mann–Whitney U-test; $z = -1.512$, $P = 0.131$).

To further investigate a possible difference in presentation of ABs between eaters and non-eaters, dog separation behavior was considered. Dogs who exhibited separation distress during any of the three separations were excluded from the next analysis. Of dogs who did not show separation distress, no significant difference was found between eaters ($N = 19$) and non-eaters ($N = 14$) in their presentation of ABs when greeting owners (Mann–Whitney U-test; $z = -0.709$, $P = 0.506$).

As a separate analysis, we excluded dogs whose owners described them on the questionnaire as not showing ABs before the owner has discovered a misdeed. Two dogs reported by owners to show ABs in this context had been otherwise excluded from experimental data analysis, and we assessed the remaining 26 dogs reported to show ABs in this context and did not find significant difference between eaters ($N = 12$) and non-eaters ($N = 14$) (Mann–Whitney U-test; $z = -0.323$; $P = 0.781$).

Finally, we excluded dogs that might not have adhered to the social rule in question; that is, dogs who disobeyed and ate in F2 after owners explicitly stated the rule by disallowing the dog from eating when placing the plate of food on the table. Dogs that ate in F1 were included in this analysis as the rule had not been explicitly stated, and if the dog ate in F1, the owner had the opportunity to enforce the social rule in F2. Again, we found no significant difference in the display of ABs (Mann–Whitney U-test; $z = -0.565$; $P = 0.572$) between eaters ($N = 16$) and non-eaters ($N = 23$).

It seemed possible, however, that the specific behaviors under analysis could only be revealed in a within-subject design; that is, by comparing the same dog's behavior in control greetings (mean of G1 and G3) with their greeting after disobedience (G2). No significant difference was found in eaters' presentation of ABs when comparing control greetings with greeting after disobedience (Wilcoxon signed ranks test; $N = 32$, $z = -1.444$, $P = 0.149$).

When analyzing the data of eaters and non-eaters, we compared relevant ABs applying both a between-subject (ABs presented in G2 of eaters vs. non-eaters) and a within-subject (ABs presented by eaters in G2 vs. mean of G1 and G3) design. As there was no difference in dog presentation of ABs between G1 and G3 (Wilcoxon signed ranks test; $N = 58$, $z = -1.735$, $P = 0.083$) we used the average of G1 and G3 to create a control greeting behavior for avoiding potential order effects. Nevertheless, a subtle analysis of the greeting data across the entire experiment revealed changes in dog presentation of ABs according to obedience in F3. In the case of dogs who ate in F3 when owners were

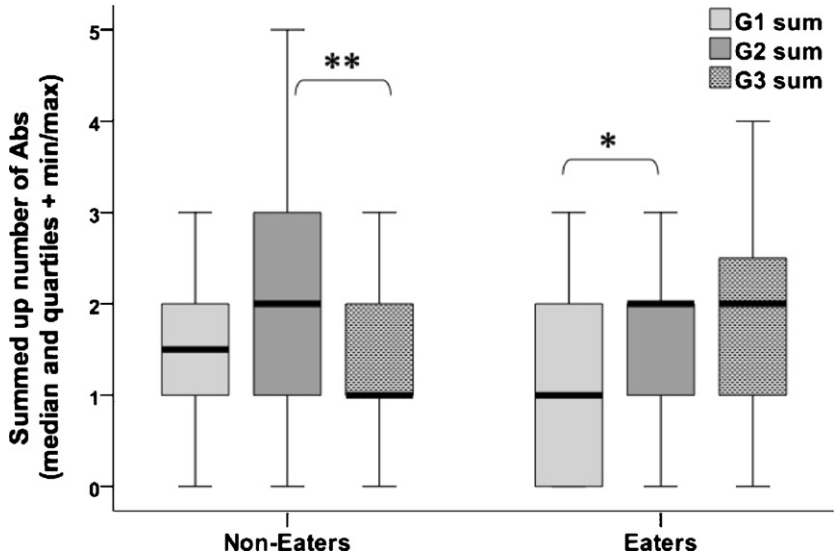

Fig. 3. Presentation of ABs by non-eaters and eaters during greeting of the owner in G1 (control), G2 (after challenged by the presence of forbidden food) and G3 (control). Box-plot figures show medians (bold lines), upper and lower quartiles (boxes) and minimum and maximum (whiskers). $^{*}P < 0.05$. $^{**}P < 0.01$.

Table 1
Owner assessment whether their dog ate or not in their absence.

	Did not eat in F3	Ate in F3	Total
Owner answer			
No	13 (correct negative)	9 (false negative)	22
Yes	5 (false positive)	16 (correct positive)	21
Total	18	25	43

out of the room, there was a significant increase in ABs in G2 compared to G1 (Wilcoxon signed ranks test; $N = 32$, $z = -2.335$, $P = 0.02$). In contrast, non-eaters showed significantly fewer ABs in G3 compared to G2 (Wilcoxon signed ranks test; $N = 26$, $z = -3.072$, $P = 0.002$) (Fig. 3).

3.5. Can owners determine whether dogs ate or not in Food 3 (F3)?

Of the 58 owner responses as to whether their dog ate in their absence, four answers were excluded because owners claimed to be unsure. Of the 54 definitive answers, 40 answers were correct and 14 were incorrect. Owners' success was above chance level $\chi^2(1, N = 54) = 11.266$, $P < 0.001$).

To further assess if owner responses were based on dog actual greeting behavior or were assisted by other factors, the 11 owners whose verbal assessments mentioned the dog's previous in-test eating history during F1 or F2 or mentioned what they thought the dog was doing during the 3-min separation, were excluded from the next analysis. The remaining owners were also able to determine significantly better than chance whether their dog ate or not $\chi^2(1, N = 43) = 5.495$, $P = 0.019$) (Table 1).

Finally, we excluded owners whose dog's in-test eating behavior in F1 and F2 was suggestive and might have assisted owners in determining whether their dog had eaten in F3, when the humans were out of the room. The owners in the remaining subgroup were deemed most likely to base their assessments in G2, upon returning to the room, solely on each dog's actual, in-the-moment greeting behavior. The owners in this analysis saw their dogs eat in F1 (when the rule was not explicitly stated), not eat in F2 (when the rule was explicitly stated) and then these dog either ate or did not eat when owners were out of the room in F3 ($N = 22$). These owners ($N = 21$, one owner was unsure what the dog did) were not better than chance in determining whether their dogs ate or not in F3 (Fisher's exact probability test; $P = 0.623$).

4. Discussion

The present study comprised a questionnaire and experiment to explore owner perceptions and dog behavioral displays considered associated with guilt. Our questionnaire findings supported previous studies; owners perceive guilt in dogs (Morris et al., 2008) and report that dogs respond to statements of disallowance (Pongrácz et al., 2001). Our novel questionnaire finding that dog guilty displays could lead owners to scold dogs less is in accordance with claims that attributing human-like emotions to non-human animals could affect how humans interact with these animals (Bekoff, 2000; Sanders, 1993). In social species, conflict resolution serves to avoid harmful conflict escalation in relationships, and social rules function to minimize the possibility of negative consequences (de Waal, 1996). In particular, displays that combine elements of fear, appeasement, and attraction are known to promote social integration (Schenkel, 1967) and therefore could be advantageous for dogs during interactions with humans. As dogs moved into the human environment, these displays could have been promoted either directly or indirectly through anthropomorphic selection (Serpell, 2003) and individual learning experiences (Horowitz, 2009). Our questionnaire results suggest that such displays could serve as appeasement within interspecific social contexts. On the other

hand, Rajecki et al. (1999) found that when guilt or blame was ascribed to a dog's transgression, people more likely recommended punishment as opposed to forgiveness. Additionally, owners might perceive guilty displays as motivated by spite (Lindsay, 2000; Vollmer, 1977) and might punish harshly. The disparity in the literature suggests that the actions owners take in response to their perceptions of dog emotional or mental states, and the implications for the dog–human relationship, warrant further investigation.

Experimentally, we explored the owner-reported anecdote that sometimes a dog who has transgressed in an owner's absence is said to display ABs to an owner who is otherwise unaware of the dog's misdeed. Owners claim that because they are ignorant of the misdeed, their personal behavior is not prompting the dog to present ABs, and the guilty behavior stems from the dog's knowledge of a misdeed. In contrast to the anecdote, coding of dog greeting behavior revealed no difference in presentation of ABs between dogs that transgressed in owners' absences and dogs that did not, even when considering possible contributing experimental aspects. However, when we analyzed individual dogs' behavior within the different greeting situations, we could identify specific changes during the course of the experimental greetings, both for eaters and non-eaters. Dogs that transgressed in owners' absences showed more ABs when greeting their owner after they broke the social rule (G2) than during the previous control greeting situation (G1). In contrast, non-eaters did not change their presentation of ABs from G1 to G2, but they did present significantly fewer ABs in the final greeting situation (G3) than when challenged by the presence of the food (G2). Taken together, an ambiguous social situation generated by repeated scoldings and greetings—not uncommon for experiments investigating guilty behavior—could affect the behavioral displays in question in a complex way.

Owners appeared successful in determining whether dogs transgressed or not. Even when excluding owners who specifically mentioned contextual cues, such as previous dog in-test eating or dog separation behavior, owners accurately assessed whether dogs had eaten or not. This appeared to support the anecdote and corroborate the questionnaire results. On the other hand, a subset of owners—those deemed most likely to base their assessments on dog actual behavior that was presented when they returned to the room in G2 (as opposed to other in-test experimental cues)—were unable to correctly determine whether their dog ate or not. Taken together, our findings suggest that owners do not necessarily correctly assess whether their dog ate or not using in-the-moment dog behavioral expressions.

There are a number of possibilities why our data, both behavior coding and owner assessment, did not provide unambiguous results. It is possible that the attribution of guilty behavior to dogs in this anecdotal context is merely an owner's anthropomorphic projection, as Horowitz (2009) found dogs presented ABs independent from disobedience and in accordance with owner scolding.

Alternatively, the present experimental procedure might not have enabled the display of ABs if such displays can be fully revealed only in home environments or ritualized contexts. "Guilty" behavior is deemed associated with learned ritualization—the learned anticipation of punishment in similar contexts (Lindsay, 2000). For example, Vollmer (1977) concluded that a dog's "guilty" displays resulted from the dog being conditioned to associate reprimand with shredded paper, regardless of having performed the shredding. Our rule ascription might not have been clear enough to elicit presentation of ABs, or previous in-test scolding or separations could have affected subsequent greetings as dogs who ate or did not eat in owners' absences presented ABs over the course of the experiment.

Moreover, the owner's act of assessing the dog's behavior might have altered the dog's responses. In the present study, owners were asked not to greet their dogs, that is, to remove themselves from a customary social exchange between themselves and their dog. Dogs are sensitive to contextual and behavioral cues of known interspecific social partners (Győri et al., 2010) and the unusual social exchange could have stunted dogs' behavioral exchanges with owners as well as owner's ability to interpret the dog's behavior.

5. Conclusion

The present study supported earlier findings that dog owners ascribe guilty behavior to dogs. Such displays could have an adaptive function within dog–human exchanges because when owners perceive guilty behavior, owners could be inclined to scold or punish dogs less.

Coding of dog greeting behavior revealed no significant difference in presentation of associated behaviors of "guilt" between dogs that broke a social rule in owners' absences and dogs that did not. These findings were not in accordance with the anecdote that dogs display "guilty" behaviors prior to owners realizing dogs' misdeeds. However, analysis of individual dog presentation of ABs throughout the experiment revealed specific changes, both for eaters and non-eaters, which could lend support to the anecdote while also supporting the idea that regardless of transgression, dogs display ABs within interspecific social contexts. Owner assessment of whether dogs transgressed in their absence questioned whether owner evaluations were based solely on dog greeting behavior and not other factors, such as extrapolation from past in-test experiences. Future research should investigate the anecdote in a non-novel environment and examine a social rule of known relevance to a particular human–dog dyad. A dog personality assessment and examination of owners' training, scolding or punishment practices could also explore factors which facilitate dog presentation of associated behaviors of guilt.

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