Fetching what the owner prefers? Dogs recognize disgust and happiness in human behaviour

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Abstract

Research using the two–object choice paradigm showed that dogs prefer the object associated with the happy human emotion. However, they provided rather ambiguous results regarding the negative emotions. We assumed that differences between the dogs' and owners' interest towards the 'negative' object might be responsible for this. In our experiment, dogs observed their owner expressing different emotions towards two uniform plastic bottles. Five dog groups were tested based on the condition they received: (1) happy versus neutral, (2) happy versus disgust, (3) neutral versus disgust and (4–5) neutral versus neutral, as control groups. Contrary to previous studies using free choice paradigm, we used a task–driven approach. After the demonstration, the dogs had to retrieve one object to the owner. The dogs' performance in the two neutral–neutral groups did not differ from the chance level. In contrast, subjects were able to distinguish between the happy and neutral expression of the owner: they both approached and fetched the 'happy' object. In the happy–disgusted and neutral–disgusted groups, the dogs approached the bottles randomly, suggesting that they found the 'disgusting' and 'neutral' objects equally attractive. Nevertheless, the dogs preferentially retrieved the object marked with the relatively more positive emotion (happy or neutral) to the owner in both conditions. Our results demonstrate that dogs are able to recognize which is the more positive among two emotions, and in a fetching task situation, they override their own interest in the 'disgusting' object and retrieve what the owner prefers.

Keywords: emotion recognition, dog, cooperation, disgust, happiness

1. Introduction

In the last 2 years, several studies investigated dogs' ability to discriminate between human facial expressions or between different tones of voices. Deputte and Doll (2011) showed still facial expressions of the experimenter to dogs, and they found that subjects reacted more to the facial expressions of anger and joy than to neutral faces. Nagasawa et al. (2011) reported that dogs can discriminate between photographs of smiling and blank faces of their owners. In contrast, Hori et al. (2011) found no difference in the dogs' looking time at the photographs of their owners' smiling, angry and neutral expressions. Regarding the acoustic modality, the results are more contradictory. Dogs can discriminate between emotionally different tones of voice (Ruffmann and Morris–Trainor 2011), that is, they were slower to take a piece of food when commanded to leave it in an angry tone of voice compared with a 'happy voice'. In contrast, Mills et al. (2005) found no difference in the latencies to obey when the 'sit' and 'come' commands were given in different emotional tones.

It seems that dogs do acquire some information from the human face and voice about our emotional states. However, most of the communicative interactions between owners and dogs involve simultaneous visual and vocal signals, thus investigating only one modality may not be representative of the dogs' general ability to interpret human emotional expressions.

Buttelmann and Tomasello (2013) introduced an experimental paradigm (based on Repacholi 1998) in order to test whether dogs are able to rely on the emotional behaviour of humans in a two–object choice task. They allowed dogs to select one of two boxes after viewing the experimenter's emotional reaction to these boxes (looking into the boxes with different facial expressions accompanied by verbalizations: happy versus neutral, happy versus disgust). Each dog participated in 18 trials of both conditions. The dogs chose the 'happy' box above chance level in the Happy–Disgusted condition, but they failed in the Happy–Neutral condition

(similar to great apes, Buttelmann et al. 2009). Buttelmann and Tomasello (2013) claimed that the dogs' failure in the Happy–Neutral condition could be either due to difficulties in distinguishing between the happy and neutral emotions, or the dogs' assumed negative affective response to the neutral expression.

Merola et al. (2014) addressed the hypotheses that neutral expressions may have negative effects by including a novel negative neutral condition. They used a similar experimental setup as Buttelmann and Tomasello (2013). Dogs could choose between two identical objects marked with different emotional expressions (happy versus neutral, happy versus fearful, neutral versus fearful). Each dog participated in one trial only. Dogs were able to distinguish between the happy and fearful expressions, but only if the owner was the demonstrator (the dogs' choice was random when a stranger demonstrated the same emotions). They also found that dogs distinguished between the happy and neutral expressions of their owner (preferring the happy one, contrary to the results of Buttelmann and Tomasello 2013). However, dogs chose randomly between objects marked with fearful versus neutral expressions. The authors concluded that in such situations, dogs have a tendency to show a 'preference for the positive emotion' (rather than 'avoidance of the negative emotion'). The lack of preference in the neutral–fear condition could be either due to the dogs' inability to recognize the valence of the fearful expression, or due to lack of inhibition of exploratory behaviour in response to human fear.

The latter explanation may reflect a possible difference between the preferences of the owner and dog. In the case of positive emotions, the interest and preference of the owner and dog usually match (i.e. the owners often use happy, excited emotions when trying to get the dogs' attention, e.g. in playing or training situations, so what the owners show preference for is usually also interesting for the dog). However, in the case of negative emotions, the interest of the dog and the owner could be opposite. In everyday life situations (e.g. during walks), what the owner finds negative (e.g. disgusting) could be interesting for some dogs (e.g. garbage,

faeces). If the dogs are able to recognize the valence of the owners' negative emotional expressions, some dogs may have learnt to associate it with a negative outcome and avoid such objects, while for other dogs, the owners' negative emotions may mean a rather interesting object, which elicits an approaching behaviour.

In other words, in a free choice situation (Buttelmann and Tomasello 2013; Merola et al. 2014), dogs may have recognized the valence of the demonstrator's negative emotional display and understood the link between this emotion and the object, but some dogs were willing to ignore this information because it was inconsistent with their own preference, resulting in a random choice at the group level. Based on this reasoning, we suppose that analysing only the dogs' approaching behaviour towards an object does not reliably reflect their ability to recognize the valence of human emotions, as it is influenced by their interest towards these objects. To analyse whether the dogs are able to recognize the negative emotional signals of the owner, as well, the dogs should interpret the demonstration as a task situation. By giving the dog a command used in play situations ('*Fetch!*') the situation of choosing an object became an interactive play task instead of a non-interactive free choice. As the dog can only play fetch-and-carry with a partner, the partner's (here, the owner's) preference became a more relevant factor influencing the dog's choice of object (for example, in an everyday play situation: which toy the owner wants to play with, or which stick the owner had thrown). Accordingly, we hypothesized that the owner's demonstration is more relevant in an interactive task situation than in a non-interactive free choice task. Therefore, if we ask dogs not only to approach a chosen object but to retrieve one to the owner, we can distinguish between the dogs' own preference and the ability to recognize human emotions.

In our experimental setup, dogs had to choose between two similar objects (plastic bottles) which were associated either with a positive, neutral or negative emotional expression. The bottle associated with the more positive emotion contained food, and the other bottle contained

a small stone. We decided to use the owner as the demonstrator because dogs are more familiar with his/her emotional expressions and more prone to rely on it (Merola et al. 2014). As a negative emotion, we used disgust (similar to Buttelmann and Tomesello 2013), because it may be more frequently expressed (even over–emphasised) by the owners in the dogs' everyday life so that the dogs may have more opportunity to learn the association between this expression of the owner and a negative outcome (e.g. scolding) than in the case of fear.

In the present study, each dog participated in eight experimental trials to investigate consistency in choice behaviour. Following the methods used by Merola et al. (2014), each dog in our study received only one pair of emotional displays (happy versus neutral, happy versus disgust, neutral versus disgust or neutral versus neutral), because a pilot study showed that the performance in the first condition strongly affected the dogs' choice in the subsequent conditions. To maintain the dogs' motivation to choose one of the objects, after a bottle was fetched, we opened it and showed its contents (food or stone) to the dog in every trial. If it was the food pellet, the dog was allowed to eat it. We included two control conditions, one to investigate the possible confounding effects of odour cues and another to investigate the possible 'Clever Hans' effect. In these conditions, both the baited and non–baited bottles were associated with neutral facial expressions.

The key important difference in comparison with earlier studies was that dogs were instructed to retrieve an object to the owner, not only to approach it. This protocol allowed the dogs to approach any of the objects presented but then to choose freely which one they preferred to retrieve. In this way, we could obtain a measure of the dogs' own preference (first approach) and their tendency to recognize the valence of the human happiness and disgust emotions (specific bottle fetched).

We hypothesized that dogs will preferentially choose (approach and fetch) the object marked with the happy emotion over the other one marked with a neutral expression since here the

interests/preferences of the owner and dog match. In case of the disgust emotion, we hypothesize that some dogs may display interest towards the object that the owner finds disgusting, while other dogs do not. Thus, we expect a random first approach at the group level in the Happy–Disgusted and Neutral–Disgusted groups. However, as some dogs may also have learnt to associate retrieving 'disgusting' objects to the owners with a negative consequence, we expect that the dogs will avoid retrieving the 'disgusting' object to the owner.

Merola et al. (2014) assumed that the previous experience and learning influenced the dogs' choice behaviour in such object choice tests. That is, during their ontogeny, dogs had learnt the association between the owners' happy, enthusiastic display and a positive outcome, and therefore, they show preference for the object marked with the positive (happy) emotional display. On the other hand, the dogs' skills for reading human social communicative behaviour (i.e. recognize certain human emotional displays) might also be the result of the genetic changes caused by the domestication (e.g. Hernádi et al. 2012; Miklósi et al. 2004). However, no study yet investigated the performance of non-adult puppies in emotion-recognition tasks. Here we tested a small number of puppies, as well, to compare their performance with that of the adult dogs.

In sum, the aim of this study was to investigate (1) whether dogs are able to discriminate the human happiness and disgust emotional expressions from each other and from the neutral one and (2) whether they prefer the object eliciting the more positive emotion from the owner in a two–object choice test. Compared with previous studies, the unique aspects of our experiment were that we also took into account the dogs' interest towards the negative, 'disgusting' object by analysing both the object first approached and the one they retrieved to the owner and that we also investigated the performance of puppies.

2. Materials and methods

165

166 *2.1 Subjects*

167 A total of 125 adult (>1 year) pet dogs and 38 puppies (2.5–10 months old) from various
168 breeds were recruited on a voluntary basis from the Family Dog Project database in Budapest,
169 Hungary. The only criterion for inclusion was that dogs had to be familiar with the 'Fetch'
170 command. Fourteen adults and ten puppies were excluded for various reasons (e.g. the dogs
171 lost their interest, or owners failed to follow our instructions), and an additional 12 dogs (11
172 adults, one puppy) were excluded from the analyses due to 100 % side preference (when the
173 dog chose the object placed on one side in all the trials).

174 The remaining 127 dogs (adults: 42 males, 58 females; mean age ± SD = 3.74 ± 2.34 years,
175 puppies: 17 males, 10 females; mean age ± SD = 0.50 ± 0.19 years) belonged to 39 different
176 breeds, and 26 dogs were mixed–breed. Data of all the dogs included in the study are provided
177 in Online Resource 1. The 100 adult dogs were semi–randomly assigned to five groups (three
178 experimental and two control groups, 20 dogs in each) based on the emotion pair they received.
179 As only a small number of puppies were available (N = 27), they were distributed only among
180 the three experimental groups (9 puppies in each). We assumed no difference between puppies
181 and adult dogs in their ability to sniff out the food in the control conditions, and also no
182 difference were expected in their owners' motivation to provide 'Clever Hans' cues.

183

184 *2.2 Objects and testing room*

185 The experimental objects were two identical plastic bottles (standard 0.5 l PET bottles,
186 flattened and tightly closed). The bottles contained a piece of food or a small stone, placed in a
187 2.2 × 1.2 cm semitransparent plastic case inside the bottles (to control for the smell and the
188 sound it makes in the bottle, Fig. 1). The tests took place in a 5 × 2.5 m room. There were

markings on the floor, indicating the locations of the bottles (1.5 m apart from each other and 2.5 m apart from the subjects' starting place) and also a chair for the owner (Fig. 2a).

2.3 Procedure

A video of the protocol can be seen in Online Resource 2 and on the Comparative Mind Database:

http://www.cmdbase.org/web/guest/play/-/videoplayer/223

Dogs were free to explore the room prior to the testing for 5–6 min. The test started with warm–up trials. The aim of these trials was to practice retrieving a bottle to the owner on only a verbal command. The owner sat in a chair and held the dog. When the subject was watching, the experimenter put a piece of food in a plastic bottle (similar to those used in the test trials), closed the bottle then put it down 1 m from the dog. The owner then encouraged the dog to retrieve the bottle; then the owner gave its contents to the dog. This procedure was repeated until the dog retrieved the bottle upon the first command.

Each test trial was executed in exactly the same way:

Baiting phase: The owner sat down on the chair and put the dog on leash. The experimenter turned her back to the subject, baited the bottles, and put them in their predetermined locations one by one, in a random order. Then she returned to the owner, took the leash of the dog, and instructed the owner about the setup of the following demonstration (starting side and the order of the emotions) (Fig. 2a).

Demonstration phase: The owner stood up, attracted the dog's attention if necessary, and walked to the first bottle. Then she/he turned back to the dog, crouched down behind the bottle, touched it, looked at the dog, and gave the appropriate emotional expression (happy, neutral or disgust) for 3–4 s (Fig. 2b). Then the owner put the bottle back in its place, walked to the other object, and repeated this display with the second assigned emotion. During the demonstration,

214 the experimenter stood silently behind the dog, looking towards the middle of the bottles. After
215 the demonstration, the owner walked back to the chair, sat down, and positioned the dog in the
216 middle.

217 *Fetching phase*: If the dog assumed the predetermined body position, then the owner
218 released it, and immediately gave the 'Fetch!' verbal command. The owner was strictly
219 instructed not to use any gestures or directional cues, and they were required to look straight
220 ahead between the bottles while giving the command. If the dog started to move towards the
221 bottles, the owner stopped talking and sat silently and motionless. When the dog retrieved one
222 of the bottles to the owner, it was briefly praised (irrespective of whether the baited or the non–
223 baited bottle was retrieved), and then the owner got the food/stone out of the bottle, and offered
224 it to the dog (allowed it to eat the food or smell the stone). During this phase, the experimenter
225 stood silently next to the owner, looking at a point halfway between the bottles. Next, the
226 experimenter retrieved both bottles, and the next trial started with the hiding phase.

227 Each dog received eight trials, the side of the bottle containing food changed in every trial,
228 and the direction of the demonstration (from left to right or vice versa) changed in every second
229 trial. The owners' starting side in the first trial was counterbalanced among dogs. Each dog was
230 pseudo–randomly assigned to one of the five experimental groups:

231 *Happy–Neutral* group (N = 20 adults, 9 puppies): the owner reacted to one of the bottles with
232 a happy emotional display (this bottle contained the food) and with a neutral display to the other
233 bottle (this one contained the stone).

234 *Happy–Disgusted* group (N = 20 adults, 9 puppies): the owner reacted to one of the bottles
235 with a happy display (contained food) and with a disgusted expression to the other bottle
236 (contained stone).

Neutral–Disgusted group (*N* = 20 adults, 9 puppies): the owner reacted to one of the bottles with a neutral display (contained food) and with a disgusted expression to the other bottle (contained stone).

Neutral–Neutral (control) group (*N* = 20 adults): the owner reacted with a neutral expression to both bottles; one of them contained food (the owner was not aware which) and the other a stone. This condition served as an odour control group, included in order to investigate if the dogs are able to smell the location of food and choose it irrespective of the owners' demonstration.

Clever Hans control group (*N* = 20 adults): similar to the group above, the owner reacted with a neutral expression to both bottles; one of them contained food and the other a stone. In this group, the owners were told that the aim is to test whether the dogs are able to sniff out where the food is. The owners were informed about the location of the baited bottle after each demonstration right before they let the dog go. The experimenter also added comments, which may have elicited some kind of expectation in the owner, like *'I hope the dog will find the food this time'*. This condition served as control group, included in order to investigate if the dogs' choice are influenced by the owners' voluntary or involuntary 'Clever Hans' cues during the fetching phase.

The owners expressed happiness or disgust emotions by displaying facial and body gestures accompanied by verbalizations. The reason behind using the owner as the demonstrator was that dogs are supposedly more familiar with their owners' emotional expressions (Merola et al. 2012; 2014). The owners were instructed that they should try to behave as they usually do while displaying these emotions. For example, they were instructed to act as if they were trying to invite the dog to play in case of the happy emotion and imagine that their dog found something particularly distasteful during walking in the case of disgust. They were also encouraged to use vocalization, but they were not allowed to use any word known as a command for the dog

during the demonstration. The neutral emotion was displayed by only a blank facial expression; here, no vocalization was allowed.

2.4 Data analysis

In the *Demonstration phase*, we evaluated the owners' behaviour at the bottles. We coded the length of the emotional display, the percentage of talking to the dog, looking at the dog and touching the bottle, and the frequency of pushing the bottle away and pulling the bottle closer in one randomly chosen trial for each dog. We compared these variables between the three emotions (happy, disgust and neutral) using one-way ANOVA. Moreover, we also investigated whether the owners demonstrate the same emotion differently in different conditions. For this, we compared the conditions in which a given emotion was demonstrated (e.g. the demonstration of the 'happy' emotion in the Happy-Neutral and Happy-Disgusted conditions) using independent-sample *t* tests. We also investigated whether the owners display the neutral emotion differently at the bottle containing food than at the bottle containing stone in the two control conditions using paired-sample *t* tests.

In the *Fetching phase*, the trials were scored on the spot by the experimenter (B.T. or F.Sz.), but all experiments were recorded on video, as well. We measured two variables in each trial: the first approach (corresponds to the object the dog first touched in a given trial) and the fetched bottle (the object the dog retrieved to the owner). Both variables were categorized as correct (the object contains the food) or incorrect (the object contains the stone). A randomly selected 25 % of the subjects were recoded to assess the inter–observer agreement between the two experimenters. The agreement was perfect between them (*Cohen's Kappa* = 1.00 for both variables).

IBM SPSS Statistics v21 was used for statistical analyses. We analysed whether the dogs' performance was affected by the condition they received, the order of the emotional expression

(demonstrated first or second), the spatial location of the object (left side or right side), the repetition of the trials (first four vs. second four) or the age category (adult or puppy). For these, we used two binary generalized linear mixed models (GLMM), one for the first approach, and one for the fetched bottle variables. In each model, the dogs' choice in each trial (correct or incorrect) was added as the target variable, and the condition, the demonstration order, the side of the baited bottle, the repetition (belongs to the first half or to the second half of the trials) and the age category were added as fixed effects. Two–way interactions between the condition and order, condition and side, and condition and repetition were also investigated. Non–significant effects were removed from the models. If the condition the dogs received was found as a significant predictor of their performance, we compared the performance in each group to chance level (50 %) using one–sample Wilcoxon Signed Rank tests.

We also analysed the effect of learning during the trials by analysing the dogs' performance in the first trial (which is free of any possible learning effect) using one–tailed Binomial tests.

3. Results

3.1 Demonstration phase

The descriptive statistics of the owner's emotional display are presented in Table 1. The owners talked to the dog the longest during demonstration of the happy emotion, followed by the disgusted and neutral displays (in the latter, no talk was allowed) (all conditions differ from each other at $P < 0.001$). The owners also looked at the dog significantly longer in the case of happy, than in the other two emotions ($P < 0.001$ for both). The owners touched the bottle the least in the case of the disgusted emotion, and the most during the happy demonstration (disgusted versus neutral and happy: $P < 0.001$ for both, happy versus neutral: $P = 0.034$). The owners demonstrated the happy emotion longer than the neutral emotion ($P < 0.001$). Pushing

312 the bottle away happened only during the demonstration of the disgusted emotion, whereas
313 pulling the bottle closer was characteristic to the happy emotion.
314 We also compared the demonstration of a given emotion between the conditions it emerged.
315 No difference was found in the owners' demonstration of the happy emotion between the
316 Happy–Neutral and Happy–Disgusted conditions. In the case of disgust, the owners looked
317 more at the dog in the Happy–Disgusted condition than in the Neutral–Disgusted condition (P
318 = 0.018), no other difference was found between the two conditions. In the case of the neutral
319 demonstration, no difference was found between the Happy–Neutral and Neutral–Disgusted
320 conditions. Similarly, no difference was found in either of the control conditions (Neutral–
321 Neutral and Clever Hans) between the demonstration at the baited bottle and the demonstration
322 at the bottle containing stone.
323
324 *3.2 Fetching phase*: *the effect of the condition, the order of the emotional expressions and the*
325 *location of the object*
326 The parameter estimates of the fixed effects are presented in Table 2.
327 Neither the demonstration order, nor the side on which the object was placed, nor the
328 repetition (first half vs. second half of the trials), nor the age category had a significant effect
329 on the dogs' performance (first approach and fetched bottle; $P > 0.355$ for all). No significant
330 interaction with the condition was found, either. The condition itself had a significant main
331 effect on both the dogs' first approach ($F_{4,982} = 2.433$, $P = 0.046$) and on which bottle the dogs
332 retrieved to the owner ($F_{4,982} = 3.482$, $P = 0.008$). Pairwise contrasts revealed differences
333 between the control groups (*Neutral–Neutral* and *Clever Hans*) versus the three experimental
334 groups in both variables.
335 *Neutral–Neutral (control)* group: In the first approach, the performance in this group differed
336 significantly from the *Happy–Neutral* group ($P = 0.035$) and a nearly significantly from the

Neutral–Disgusted group (P = 0.083). In the fetched bottle variable, all three groups had significantly higher performance than this group (*Happy–Neutral* P = 0.002; *Happy–Disgusted* P = 0.036; *Neutral–Disgusted* P = 0.046).

Clever Hans control group: In the first approach, the performance in this group differed significantly from the *Happy–Neutral* and *Neutral–Disgusted* groups (P = 0.009; P = 0.027, respectively) and tended to differ from the *Happy–Disgusted* group (P = 0.095). In the fetched bottle variable, this group had significantly lower performance than the *Happy–Neutral* and *Happy–Disgusted* groups (P = 0.004; P = 0.049, respectively), the *Neutral–Disgusted* group had only a marginally higher performance than this group (P = 0.060).

No differences between the *Neutral–Neutral (control)* group and *Clever Hans control* groups were found (first approach: P = 0.654; fetched bottle: P = 0.911).

These results showed that the condition seems to be a significant predictor of the dogs' choice behaviour, so the performance in each group was also assessed separately. Since there were no significant differences in performance of puppies and adult dogs, their data were combined for these analyses.

3.3 Fetching phase: *performance in each group*

In the *Neutral–Neutral (control)* group, the dogs approached the bottle containing food in 48.8 % of the trials and retrieved it to the owner in 51.3 % of the trials. This performance did not differ from chance level (one–sample Wilcoxon Signed Rank test, first approach: $T+$ = 36.00, N = 12 (8 ties), P = 0.850; fetched bottle: $T+$ = 66.00, N = 15 (5 ties), P = 0.762) (Fig. 3).

In the *Clever Hans control* group the dogs' approached the baited bottle in 46.3 % of the trials, and retrieved this bottle to the owner in 51.9 % of the trials. Again, no difference from

361 the chance level was found (first approach: $T+ = 24.00$, $N = 12$ (8 ties), $P = 0.266$; fetched
362 bottle: $T+ = 46.00$, $N = 12$ (8 ties), $P = 0.622$).

363 In the *Happy–Neutral* group the dogs' performance differed from chance level regarding
364 both variables. They approached the 'happy' object first in 59.8 % of the trials ($T+ = 228.50$,
365 $N = 23$ (6 ties), $P = 0.004$) and retrieved this bottle to the owner in 66.6 % of the trials ($T+ =$
366 293.00, $N = 24$ (5 ties), $P < 0.001$).

367 In the *Happy–Disgusted* group the dogs' first approach did not differ significantly from
368 chance level, only a nearly significant effect was found. In 55.6 % of the trials the dogs
369 approached the 'happy' bottle ($T+ = 130.00$, $N = 18$ (11 ties), $P = 0.054$). However, they
370 retrieved the 'happy' bottle significantly above chance level (62.2 % of the trials, $T+ = 242.50$,
371 $N = 24$ (5 ties), $P = 0.007$).

372 The same pattern emerged in the *Neutral–Disgusted* group, the dogs' first approach only
373 nearly significant: in 57.5 % of the trials, the dogs approached the 'neutral' bottle ($T+ = 231.50$,
374 $N = 25$ (4 ties), $P = 0.063$), but they retrieved the 'neutral' bottle to the owner significantly
375 above chance level (62.3 % of the trials, $T+ = 252.00$, $N = 23$ (6 ties), $P < 0.001$) (Fig. 3).

376

377 *3.4 Fetching phase*: *performance in the first trial (effect of learning during the trials)*

378 We also analysed the performance in the first trial. In the *Neutral–Neutral* (*control)* group,
379 the dogs' performance was random regarding both variables (Binominal test, $N = 20$, first
380 approach: $P = 0.120$; fetched bottle: $P = 0.160$) (Fig. 4). In the *Clever Hans control* group, the
381 dogs' performance was similarly random ($N = 20$, first approach: $P = 0.120$; fetched bottle: P
382 $= 0.160$). In the *Happy–Neutral* group, the dogs' first approach was random (14 of 29 dogs (48
383 %) approached the 'happy' object, $P = 0.144$), but they fetched this bottle significantly above
384 chance level (19 of 29 dogs (66 %), $P = 0.037$). In the *Happy–Disgusted* group, both the dogs'
385 first approach and fetched bottle were random (first approach: 14 of 29 dogs (48 %) $P = 0.144$;

386 fetched bottle: 17 of 29 dogs (59 %) $P = 0.097$). In the *Neutral–Disgusted* group, the dogs' first
387 approach was, again, random (16 of 29 dogs (55 %) approached the 'neutral' object, $P = 0.115$),
388 but they retrieved this bottle to the owner significantly above chance level (20 of 29 dogs (69
389 %), $P = 0.019$).
390
391 **4. Discussion**
392
393 Our study aimed to investigate whether dogs recognize and rely on the owners' emotional
394 expression of happiness and disgust in a two–object choice test, taking into account the dogs'
395 curiosity and interest towards the objects. We hypothesized that dogs do recognize both the
396 positive and negative valence of owners' emotions, but that the object first approached is
397 strongly influenced by their interest towards these objects, whereas the object they retrieve to
398 the owner is also influenced by the owners' preference. Therefore, the object which is first
399 approached by the dog could be different than the one which is retrieved to the owner. We
400 expected that in a task–situation, dogs would retrieve the 'positive' object and avoid retrieving
401 the 'negative' object to the owner.
402 Our results showed that dogs recognized the valence of the owners' positive and negative
403 emotional displays and similar to other human communicative cues (e.g. pointing, gazing); they
404 are able to use it as a source of information. However, the mean performance in the three
405 experimental groups (57.6 % in first approach, 63.7 % in fetched bottle) was lower than in other
406 two–object choice tasks (e.g. distal pointing: ~80 % in Lakatos et al. 2009). The reason behind
407 the lower performance in this experiment might be attributed to the 5–10 s delay between the
408 demonstration and the choosing phase. Previous studies (e.g. Fiset et al. 2003; Topál et al. 2005)
409 found that delay before the choice can cause a decline in the dogs' performance in object choice
410 tasks. Another, not mutually exclusive explanation could be the effect of the local enhancement.

411 In most of the two–object choice tasks (e.g. pointing, gazing), only one object is marked with
412 cueing, while in our experiment, the owners provided highly salient social cues at both objects
413 (e.g. touched it while looked at the dog). Since dogs are sensitive to such cues (e.g. Téglás et
414 al. 2012), demonstrating them at both objects could slightly mask the difference in the content
415 of the demonstration and also make the two objects more similar in memory.

416 Dogs in the Happy–Neutral group approached and retrieved the 'happy' object to the owner
417 above chance level, and the performance (both the first approach and the fetched bottle) in this
418 condition differed from that in the Neutral–Neutral (control) and Clever Hans control groups.
419 These results support previous findings (Merola et al. 2014) that dogs recognize the valence of
420 the happy emotion, and they preferentially choose the indicated object over the other one
421 marked by a neutral behavioural expression. However, our result contradicts findings reported
422 by Buttelmann and Tomasello (2013) where the dogs chose randomly when the experimenter
423 displays happy and neutral emotions. One reason behind this contradiction could be that the
424 dogs were familiar with the owners' emotional displays, but not with that of the experimenter
425 (as suggested by Merola et al. 2014). Alternatively, the discrepancy can be attributed to
426 differences in the design of the studies. Both the present study and the study by Merola et al.
427 (2014) exposed each dog to only one pair of emotional displays, whereas Buttelmann and
428 Tomasello (2013) used a within–subject design. The lack of preference in the latter study could
429 be explained by the fact that half of the dogs participated in the Happy–Neutral condition after
430 the Happy–Disgusted condition. These dogs might be more inclined to investigate the 'neutral'
431 object, because in this case, they were not firmly discouraged (i.e. with the disgusted emotional
432 expression in the Happy–Disgusted condition) to do so.

433 In case of the disgust, we hypothesized that some dogs may be predisposed to display interest
434 towards the object that the owner finds disgusting. Thus, we expected random performance in
435 the dogs' first approach in the Happy–Disgusted and Neutral–Disgusted groups at the group

436 level. However, by putting the dogs in a task situation, we predicted that they would avoid
437 retrieving the 'disgusting' object to the owner in both conditions.

438 The results confirmed these predictions. In the Happy–Disgusted and Neutral–Disgusted
439 groups, the first approach of the dogs did not reached the significant level, suggesting that the
440 dogs at the group level seem to be nearly as interested in investigating the object eliciting
441 disgust from the owner as the object eliciting neutral or happy displays. However, contrary to
442 their first approach, the dogs retrieved the bottle marked with the more positive emotion (happy
443 or neutral in contrast to disgusted) significantly above chance level. The performance in the
444 fetched bottle variable in both groups differed from that in the Neutral–Neutral (control) and
445 Clever Hans control groups. It seems therefore that dogs are able to distinguish between the
446 disgusted and neutral emotional expressions of their owners and are able to recognize the
447 valence of the disgust, as well. Importantly, significant avoidance of the 'disgusting' object
448 emerges only in a task–driven situation.

449 As a simple explanation, during everyday life, family dogs may have learnt to associate
450 fetching objects the owners find disgusting with a negative outcome, and as a consequence,
451 they avoided retrieving the 'disgusting' bottle to the owner. However, we found no difference
452 in the performance between the adults and puppies. Thus, one can argue that the ability of
453 recognize human emotional signals could have also evolved during the process of
454 domestication, similar to dogs' other specific social skills (Miklósi et al. 2004), as it might be
455 a very useful tool for dogs to adapt to the human society.

456 Our findings are similar to those reported for human infants and great apes. In the study of
457 Repacholi and Gopnik (1997), 14- and 18–month–old infants viewed the experimenter's
458 emotional reactions (happy versus disgusted) to two types of food, one of which was preferred
459 by the infants. Then they were asked to give the experimenter a piece of food from the two
460 bowls. Infants at the age of 18 months offered the food type the experimenter preferred both

when it matched their own preference (76 %) and when it did not (69 %). In the experiment of Buttelmann et al. (2009), apes viewed the experimenter's emotional reaction (happy versus disgusted) to two containers (containing different types of food) and then watched the experimenter eating something from a container. Then they were allowed to select a container for themselves. If the apes did not know about the contents of the containers (so their choice was not influenced by their own preference), then they showed a slight preference (56 % of the trials) for the cup still containing food (i.e. the cup which elicited disgust from the experimenter). Based on these studies, one might speculate that dogs are also able to differentiate between what they themselves find interesting and what their owners prefer. The dogs first approach what they themselves prefer, but they infer the owner's desire and then retrieve the object which the owner showed preference for during the demonstration.

The highest performance was found in the Happy–Neutral group in both variables. It suggests that the susceptibility to recognize human emotions might be emotion specific. The dogs may be more predisposed to recognize those human emotional displays, which show more generality across species (like joy–happiness e.g. Ekman 1992; Morris et al. 2008), while they need more time to learn to recognize emotions, which are more human specific (such as disgust, Rozin et al. 1999) (although, no difference between the adults and puppies performance was found). Second, dogs might be generally more exposed to the owners' happy displays in everyday life situations, since it may occur more frequently than disgust when interacting with the dog (e.g. during playing, training, or just petting). Therefore, dogs have had more opportunities to learn to associate the human happy expression with a certain outcome (although, again, no difference between the adults and puppies performance was found). Third, as mentioned in the introduction, the interests of the owner and dog are more likely to match in the case of positive emotions, resulting in a higher performance (both in first approach and fetch) in conditions where only the happy emotion is involved. Fourth, one may argue that

differences in the salience of the demonstrations can also emerge as an alternative explanation for the higher performance in the Happy–Neutral group (i.e., more salient cues in the happy emotional display than in the neutral one, see Table 1). However, in the Neutral–Disgusted group, the dogs showed a preference for retrieving the neutral object, which was actually less salient than the alternative one. Dogs' performance in this group indicates that they do not base their choices (solely) on the salience of the demonstration (although we do not exclude that this factor can play a part in the dogs' choice).

The preference for retrieving the object with the more positive emotional display cannot be the result of the dogs' ability to sniff out the object containing food, since in the Neutral–Neutral (control) group (the same two baits, both paired with neutral expressions), both the dogs' first approach and their success in retrieving the baited bottle were at chance level. Moreover, similar to Schmidjell et al. (2012) and Hegedüs et al. (2013), we also did not find significant Clever Hans effect. Random performance was found in both variables in the control group designed to investigate the potential effect of owners' voluntary/involuntary cues while the dogs were selecting an object. We also investigated whether the dogs' performance in any of the conditions was influenced by simpler effects like preference for one side or for the object manipulated last by the owner, but none of these factors was found to have a significant effect on either of the measured variables. Learning during the experimental trials also did not explain the dogs' performance, because repetition had no significant effect on either of the variables. Moreover, dogs already preferentially retrieved the bottle eliciting the more positive emotional display from the owner in the first trial in all except the Happy–Disgusted condition (which was only nearly significant). In the latter group, dogs were exposed to two highly salient emotional expressions, and their random choice in the first trial could indicate some limitation of their capacity to attend to these emotional messages within a short time frame (e.g. Range et al. 2009).

As a limitation of the study, we should mention that for some dogs, the fetching of the objects itself could provide a greater reward than food that makes the human emotional displays less relevant for making their choice (for parallel findings, see Sümegi et al. 2014). Since no reliable means was found to exclude the extremely motivated subjects, their performance might have biased our results.

In sum, we demonstrated that dogs are able to recognize the human emotional expressions of happiness and disgust. Their interest towards a 'disgusting' object may influence which object they approach first, but dogs are able to control their own preference and retrieve the object which is marked by the relatively more positive emotion of the owner. Based on these results, we conclude that both positive and negative emotions guide dogs' behaviour in a two–object choice situation. Dogs demonstrate a preference for positive human emotions while also show avoidance of the negative ones.

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Ethics statement

The experiment complies with the current laws of Hungary. According to the corresponding definition by law (‘1998. évi XXVIII. Törvény’ 3. §/9. – the Animal Protection Act), non-invasive studies on dogs are currently allowed to be done without any special permission in Hungary.

Conflict of interest

The authors declare that they have no conflict of interest.

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603 Figure Captions

604 **Fig. 1** Flattened plastic bottle used as the experimental object. Inside the bottle, a small case
605 (*shown*) contained the baiting (food or stone)

606

607 **Fig. 2 a** The room and experimental set–up. **b** The two possible routes of the owner during the
608 demonstration indicated by black and white arrows. These routes were counterbalanced across
609 the eight trials

610

611 **Fig. 3** Dogs' overall performance in the five groups regarding the object they approached and
612 the object they retrieved to the owner. In each condition, one emotional expression was paired
613 with food (in *bold*) and another with the stone. Data from puppies and adult dogs have been
614 combined in the experimental conditions (leftmost 6 *bars*). Dotted line represents chance level.
615 Symbols above the columns indicate significant differences from chance level (50 %) (one–
616 sample Wilcoxon Signed Rank test, *** $P < 0.001$, ** $P < 0.01$, † $P < 0.1$). Different letters in
617 the boxes indicate significant differences between the conditions (GLMM pairwise contrast)

618

619 **Fig. 4** The percent of dogs approaching and fetching the object baited with food in the first trial.
620 In each condition, one emotional expression was paired with food (in *bold*) and another with
621 the stone. Data from puppies and adult dogs have been combined in the experimental conditions
622 (leftmost 6 *bars*). Dotted line represents chance level. Asterisks indicate significant differences
623 from chance level (Binomial test, $P < 0.05$)

624

625 Table 1 Descriptive statistics of the emotional displays of the owner during demonstration.

	Variables (mean ± SD)					
Emotional display	Talk (time %)	Look at dog (time %)	Touch bottle (time %)	Push away bottle (*N*)	Pull close bottle (*N*)	Length of display (sec)
Happy (in *N* = 58 trials)						
Happy–Neutral	75.5±11.1	43.7±24.9	85.6±8.7	0	0.4±0.5	7.8±2.9
Happy–Disgusted	75.2±16.3	48.6±26.3	88.0±9.0	0	0.4±0.8	7.2±2.5
Disgust (in *N* = 58 trials)						
Happy–Disgusted	62.0±22.1	37.0±31.3	72.2±25.8	0.5±0.6	0.1±0.4	6.7±2.5
Neutral–Disgusted	53.5±23.7	19.4±19.1	65.7±26.1	0.4±0.6	0.1±0.3	6.4±2.5
Neutral (in *N* = 98 trials, 138 displays)						
Happy–Neutral	0	26.3±24.2	83.2±13.4	0	0	5.7±2.0
Neutral–Disgusted	0	28.1±25.1	82.2±18.7	0	0.04±0.2	6.6±3.0
Neutral–Neutral (food)	0	26.8±21.2	76.8±9.7	0	0.1±0.5	5.5±1.8
Neutral–Neutral (stone)	0	26.8±18.9	76.1±13.4	0	0.1±0.2	5.7±1.7
Clever Hans (food)	0	20.8±22.7	81.3±7.2	0	0.1±0.3	5.3±2.7
Clever Hans (stone)	0	14.0±17.7	81.5±6.6	0	0.1±0.3	4.8±2.1

626 For each dog, one trial was randomly chosen for coding

627

Table 2 Parameter estimates of each fixed effects in a) first approach and b) fetched bottle variables.

Fixed effects	*Coefficient*	SE	*t*	*P*
a) First approach				
Condition (reference category: Neutral-Neutral (control) group)				
Happy-Neutral group	0.437	0.208	2.105	0.036
Happy-Disgusted group	0.245	0.207	1.184	0.237
Neutral-Disgusted group	0.365	0.211	1.731	0.084
Clever Hans control group	-0.100	0.244	-0.448	0.655
Demonstration order (reference category: firstly demonstrated)				
Secondly demonstrated bottle	0.119	0.129	0.926	0.355
Side of the baited bottle (reference category: left side)				
Right side bottle	0.080	0.129	-0.622	0.534
Repetition (reference category: first half of the trials)				
Second half of the trials	0.031	0.129	0.237	0.812
Age-group (reference category: adults)				
Puppies	-0.087	0.171	-0.510	0.610
b) Fetched bottle				
Condition (reference category: Neutral-Neutral (control) group)				
Happy-Neutral group	0.637	0.211	3.017	0.003
Happy-Disgusted group	0.437	0.209	2.090	0.037
Neutral-Disgusted group	0.423	0.212	1.993	0.047
Clever Hans control group	0.025	0.224	0.112	0.911
Demonstration order (reference category: firstly demonstrated)				
Secondly demonstrated bottle	0.035	0.131	0.268	0.789
Side of the baited bottle (reference category: left side)				
Right side bottle	0.014	0.132	0.109	0.913
Repetition (reference category: first half of the trials)				
Second half of the trials	-0.012	0.131	-0.095	0.924
Age-group (reference category: adults)				
Puppies	0.099	0.177	0.563	0.574

For non-significant effects, the parameter estimates at removal are presented. This coefficient is the expected change in test score relative to the reference category of the categorical field

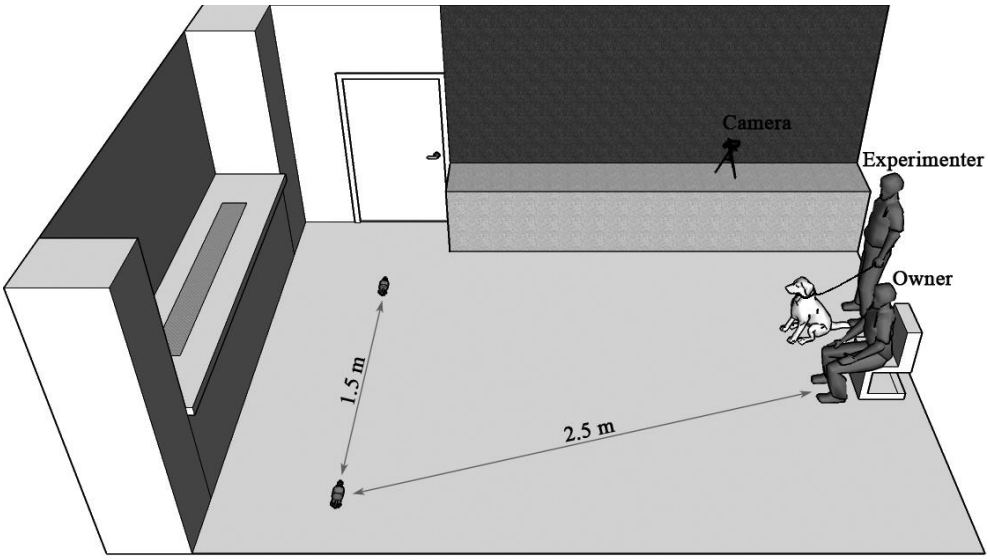
633 Fig 1

634

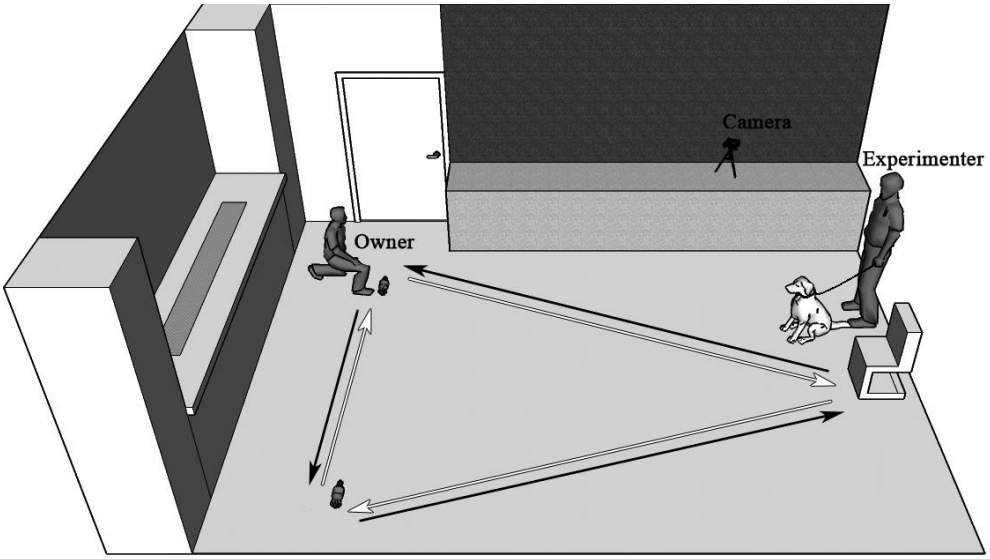
635

Fig. 2

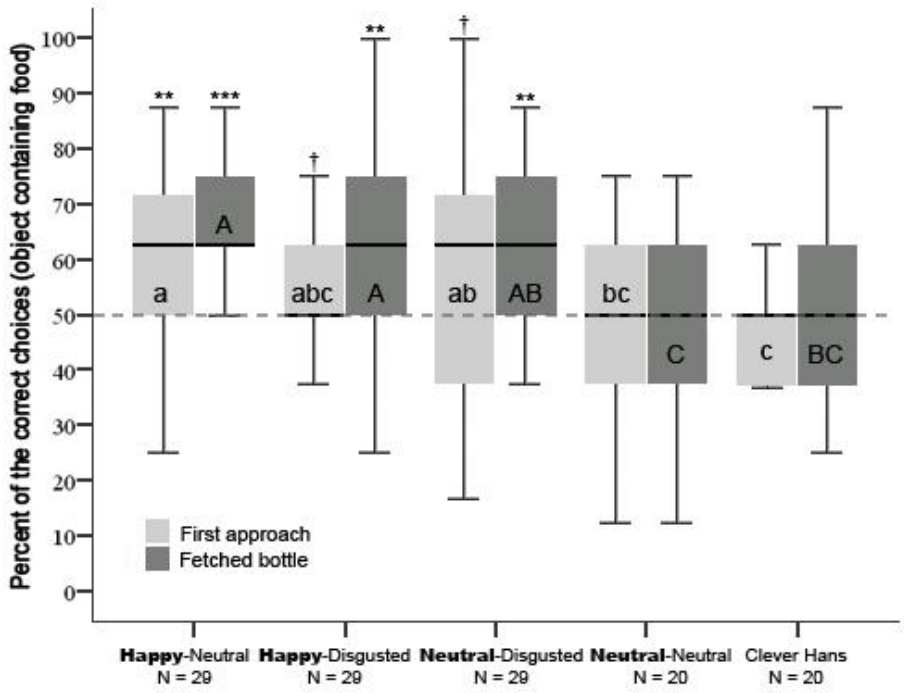
(a)


Camera
Experimenter
Owner
1.5 m
2.5 m

(b)


Camera
Experimenter
Owner

642 Fig. 3



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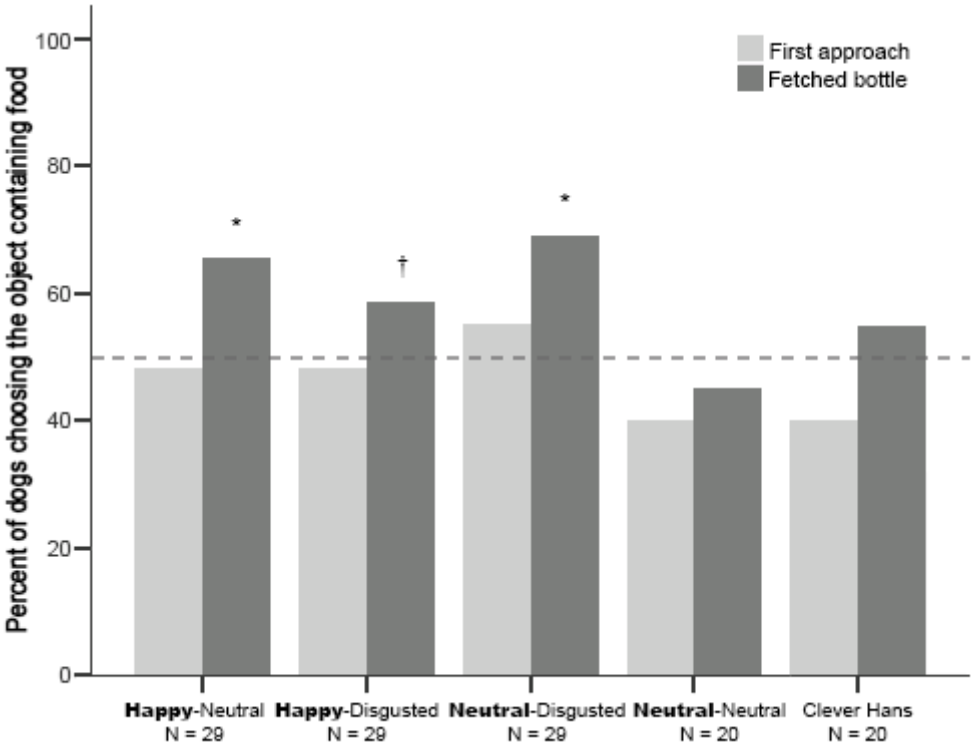
646 Fig. 4



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649 Supplemental material

650

651 Table S1 Descriptive information of the dogs that were included in the study

dog group / dog number	breed	dog gender	dog age (months)	owner gender	owner age (years)
Happy–Neutral group					
1	Mixed breed	male	84.9	woman	25
2	Miniature Poodle	male	15.2	woman	31
3	Mixed breed	female	76.6	woman	26
4	Mixed breed	female	98.7	woman	50
5	Golden Retriever	female	28.0	woman	24
6	Hungarian Vizsla	female	72.9	woman	28
7	Mixed breed	male	22.6	woman	23
8	Golden Retriever	female	48.1	man	39
9	American Staffordshire Terrier	female	22.8	woman	49
10	Border Collie	male	66.6	woman	34
11	Golden Retriever	female	14.1	woman	26
12	Australian Kelpie	male	109.8	man	38
13	Border Collie	female	105.8	woman	41
14	Labrador	male	48.0	man	43
15	Labrador	male	32.0	woman	32
16	Pit Bull Terrier	female	16.4	woman	27
17	Mudi	female	16.5	woman	32
18	Mixed breed	female	15.1	woman	32
19	Foxterrier	female	21.3	woman	19
20	Border Collie	male	85.5	man	44
21	Hungarian Vizsla	female	4.9	woman	38
22	Border Collie	female	3.8	woman	27
23	Boxer	female	3.4	woman	28
24	Hungarian Vizsla	male	6.0	woman	36
25	Belgian Shepherd/Malinois	male	5.7	woman	33
26	Irish Terrier	male	6.0	woman	28
27	Border Collie	female	7.0	woman	31
28	Beauceron	female	3.0	woman	29
29	Border Collie	male	8.5	woman	27
Happy–Disgusted group					
1	Mudi	female	18.0	woman	25
2	Cairn Terrier	male	60.0	woman	49
3	Border Collie	male	24.0	man	49
4	Golden Retriever	male	44.7	woman	36
5	Beauceron	male	30.9	woman	28
6	Hungarian Vizsla	male	30.0	woman	29
7	Cairn Terrier	female	17.2	woman	14
8	Border Collie	male	20.1	woman	14
9	Hungarian Vizsla	male	42.6	woman	29
10	Border Collie	male	46.4	woman	31
11	Shiba Inu	female	25.6	man	16

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Table S1 Descriptive information of the dogs that were included in the study *(Continued)*

dog group / dog number	breed	dog gender	dog age (months)	owner gender	owner age (years)
12	Mixed breed	female	52.2	woman	41
13	English Cocker Spaniel	female	43.0	woman	32
14	Mixed breed	female	71.5	woman	45
15	Puli	female	42.2	woman	37
16	Hungarian Vizsla	female	14.8	woman	38
17	Mixed breed	female	30.7	woman	22
18	German Shepherd	female	108.0	woman	31
19	Rottweiler	female	96.0	woman	48
20	Labrador	female	44.9	woman	37
21	Mixed breed	female	7.2	man	50
22	Shetland Sheepdog	male	2.7	woman	39
23	Miniature Dachshund	male	3.2	woman	22
24	Middle Poodle	male	8.3	woman	30
25	Labrador	male	6.1	woman	29
26	Labrador	male	9.1	woman	33
27	Mixed breed	male	8.8	woman	32
28	Bullmastiff	male	4.0	woman	35
29	Australian Cattle Dog	male	6.0	woman	19
Neutral–Disgusted group					
1	Labrador	male	12.2	woman	54
2	Hungarian Vizsla	male	60.3	woman	45
3	Border Collie	male	12.0	woman	34
4	Mixed breed	female	18.7	woman	49
5	German Shepherd	male	78.5	woman	23
6	Mudi	female	90.5	woman	31
7	Mixed breed	female	24.3	woman	34
8	Mixed breed	female	39.3	woman	30
9	Mixed breed	female	34.2	woman	25
10	English Cocker Spaniel	female	36.0	woman	32
11	Belgian Shepherd/Groenendael	female	50.9	woman	38
12	Mixed breed	male	83.6	woman	52
13	Mixed breed	female	18.8	woman	35
14	Hungarian Vizsla	female	36.0	woman	29
15	Border Collie	female	20.2	woman	48
16	Border Collie	female	72.0	woman	21
17	Nova Scotia Duck Tolling Retriever	female	67.0	woman	24
18	Border Collie	male	73.1	man	28
19	Mixed breed	male	26.8	woman	41
20	Golden Retriever	male	12.0	woman	26
21	Golden Retriever	male	10.0	woman	26
22	Border Collie	male	8.6	woman	26
23	Mixed breed	female	5.2	woman	24
24	Mudi	male	3.7	woman	28
25	German Pointer	female	9.6	woman	26
26	German Shepherd	male	6.0	woman	27
27	Norwich Terrier	male	4.9	woman	52
28	Labrador	female	9.0	woman	30
29	Giant Poodle	female	4.0	woman	57

Table S1 Descriptive information of the dogs that were included in the study *(Continued)*

dog group / dog number	breed	dog gender	dog age (months)	owner gender	owner age (years)
Neutral–Neutral (control) group					
1	Mixed breed	female	48.5	woman	47
2	Mudi	male	68.2	woman	20
3	Schapendoes	female	30.8	woman	45
4	Boston Terrier	male	13.5	woman	27
5	Golden Retriever	male	14.7	woman	43
6	Foxterrier	female	16.5	woman	29
7	Mixed breed	male	22.9	woman	49
8	Foxterrier	female	56.7	woman	38
9	Miniature Schnauzer	male	60.9	woman	38
10	Border Collie	female	19.0	woman	23
11	Golden Retriever	male	55.2	woman	35
12	Labrador	female	28.4	man	37
13	Bull Terrier	female	24.0	woman	39
14	Labrador	female	27.1	woman	25
15	Border Collie	male	133.8	woman	36
16	Hungarian Vizsla	female	68.9	woman	39
17	Hungarian Vizsla	female	47.4	woman	17
18	Mixed breed	female	28.3	man	31
19	Miniature Poodle	male	48.0	woman	31
20	Mixed breed	male	56.2	woman	36
Clever Hans control group					
1	White Swiss Shepherd Dog	female	24.4	woman	20
2	Black Russian Terrier	female	24.3	woman	29
3	Jack Russell Terrier	male	41.1	woman	38
4	Labrador	male	21.1	woman	35
5	Beagle	male	48.0	woman	35
6	Hungarian Vizsla	female	33.4	woman	25
7	Labrador	female	54.0	woman	26
8	Hungarian Vizsla	male	124.1	woman	28
9	Beagle	male	67.1	woman	28
10	Mixed breed	male	42.1	woman	29
11	Nova Scotia Duck Tolling Retriever	male	83.3	woman	35
12	Siberian Husky	female	24.0	woman	24
13	Mixed breed	male	23.0	woman	32
14	Mixed breed	female	24.0	woman	18
15	German Shepherd	female	54.0	woman	35
16	Labrador	female	80.7	woman	38
17	Hungarian Vizsla	female	30.0	man	38
18	German Shepherd	female	14.3	woman	32
19	Labrador	female	14.2	woman	22
20	Mixed breed	male	56.6	woman	37