

Do shelter dogs engage in social referencing with their caregiver in an approach paradigm? An exploratory study



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ABSTRACT

When confronted with an unfamiliar object or person, privately owned pet dogs engage in social referencing, synchronizing their reaction with that of their owners. The question of whether shelter dogs do so when confronted with a stranger has not yet been studied. We tested the reactions of 30 shelter dogs with their principal caregiver when confronted with a stranger approaching them in a neutral manner. The caregivers were instructed to behave in one of three ways toward the stranger: stay still, approach, or retreat. The shelter dogs showed both referential looks and gaze alternations between the stranger and their caregiver. However, the shelter dogs did not modify their reactions towards the stranger in accordance with the behaviour of their caregivers. Thus, when confronted with a stranger, shelter dogs did not show social referencing with their handlers, contrary to privately owned pet dogs with their owners. These findings highlight social deprivation that dogs in shelters are confronted with, and emphasize the importance of the affiliative bond between humans and dogs in creating social referencing.

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1. Introduction

Domestic dog (*Canis familiaris*) was the first species to be domesticated by humans, approximately 15,000–6400 years ago (Frantz, 2016). Over this time, the species developed the abilities to follow human communicative signals (see Duranton and Gaunet, 2015 for a review), making them particularly well integrated in human society.

Nevertheless, a large number of dogs are abandoned every year in shelters (e.g. 15 million dogs in the USA, Tuber et al., 1999; 129,743 dogs in the UK, Clark et al., 2012). Dogs are abandoned often because of behavioural problems such as aggression, disobedience, but also because people lack time to care for the dogs (Diesel et al., 2010; New et al., 2000; Salman et al., 2000). Shelter dogs are prone to experiencing high level of stress, which may be caused by isolation from conspecifics, excessive noise, physical limitations, and a poorly enriched environment (Beerda et al.,

1999; Hennessy et al., 1997; Tuber et al., 1999). These factors can influence the quality of the relationships between shelter dogs and humans (Barrera et al., 2010, 2011). Shelter dogs interact with one or several caregivers at least once a day, and can develop bonds with them (Gácsi et al., 2001). However, shelter dogs still have limited/altered direct contact and interactions with humans (Taylor and Mills, 2007; Stafford, 2007). This reduced exposure to human social contact in everyday life prevents these dogs from forming as positive emotional bonds with people as pet dogs develop with their owners (Barrera et al., 2010, 2015; O'Hara and Reeve, 2011). Privately owned pet dogs have been described as “human-bonded” dogs, engaged in human-bonded relationships; while shelter dogs have been described as “contact-deprived”, lacking human contact or “weakly bonded” with their caregiver (Buttner and Strasser, 2014; O'Hara and Reeve, 2011). Similar to humans, social deprivation impairs social abilities in dogs (Bowlby, 1982; Angermeier and James, 1961). It has been shown that dogs who stayed at least several months in a shelter perform at lower rates than pet dogs in tasks involving communication with humans, suggesting the importance of considering shelter dogs as different from privately owned pet dogs (Barrera et al., 2015; Udell et al., 2011). For this reason, studying behaviour towards humans of dogs with different life experiences with humans is essential to better understand the factors than can influence dogs' social abilities (Duranton and

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Gaunet, 2016). Additionally, a better understanding of shelter dogs' behaviour towards humans is helpful to improve welfare of the animals as well as adoption rates (Hennessy et al., 1997).

To facilitate the adoption of shelter dogs, a paradigm assessing shelter dogs' reactions when they are confronted with a stranger has been designed. Sometimes the unfamiliar person stands still (Barrera et al., 2010; Lore and Eisenberg, 1986); sometimes she is active and approaches the dog (Barrera et al., 2010; Van der Borg et al., 1991). The latter case corresponds to the so-called approach paradigm: the stranger moves towards the dog, mainly either in a friendly or a threatening manner. In the friendly approach shelter dogs initiated more physical contact with the stranger, whereas in the threatening approach they initiated more interactions with their caregivers, who could be considered as a secure base figure in that situation (Van der Borg et al., 1991). Approach paradigms are also widely used in studies on privately owned pet dogs: when approached in a threatening manner, pet dogs show more avoidance behaviours, more barking, and less contact with the stranger than when approached in a friendly manner (Barrera et al., 2010; Gácsi et al., 2013; Györi et al., 2010; Kim et al., 2006; Vas et al., 2005, 2008).

A recent study also investigated dogs' reaction during an approach paradigm when the stranger was neutral (she was walking without looking nor interacting with the dog) in order to test the effect of the handler's behaviour (Duranton et al., 2016). The authors evidenced that the handler's behaviour also influenced dogs' reaction when encountering a stranger, through the social referencing paradigm: one's ability to use a referent's behavioural reaction towards an ambiguous stimulus to guide one's own reaction towards the stimulus (Duranton et al., 2016). Social referencing is characterized by two criteria: gaze alternations between the stimulus and the informant and behavioural regulation based on the informant's reaction (Russell et al., 1997). Evidenced between children and their mothers (De Rosnay et al., 2006), it has been shown that pet dogs also present social referencing with their owners. In a series of studies, Merola et al. (2011), Merola et al. (2012a,b, 2014) showed that when privately owned pet dogs are faced with an unfamiliar stimulus (an unknown and potentially threatening object), they use their owners' reaction to the object to guide their own. If the handler moved close to the object displaying a positive/curious attitude, the dogs spent more time close to the object and engaged in more exploratory behaviours. Conversely, if the handler moved away from the object while exhibiting a negative/frightened reaction, the dogs spent more time as far away as possible from the object (Merola et al., 2012a,b, 2014). Finally, Duranton et al. (2016)¹ showed that when their owner moved away from an approaching stranger, privately owned pet dogs looked more quickly at the stranger and then took more time before initiating contact with her, compared to when their owner walked towards the stranger. This suggested that dogs who observed their handlers moving away from a stranger perceive the stranger as potentially threatening. It was thus concluded that pet dogs engage in social referencing, using human's behaviour to adjust their own reaction towards a stranger.

Given that dogs' relationship with the person providing communicative cues in a task influences their performance (Elgier et al., 2009; Merola et al., 2012b), we investigated whether shelter dogs would also exhibit social referencing with their caregiver, in an

approach paradigm. Do social deprivation or type of relationship between the dog and the human influence dogs' ability to perform social referencing?

In light of the findings from previous studies, we hypothesized that shelter dogs would adjust their behaviour in response to their caregiver's reaction: if the caregiver approached the stranger, shelter dogs would initiate more visual and/or physical contact with the stranger; conversely if the caregiver walked away from the stranger, dogs would show more avoidance behaviours and initiate less visual/physical contact with the stranger. However, we hypothesized that behavioural differences across conditions should be less marked in shelter dogs than what was previously found in privately owned pet dogs. Finally, we investigated possible effects of other factors such as the dog's sex, breed, and age.

2. Methods

2.1. Participants

The study took place at the AVA Animal Rescue Center, Cuy-Saint-Fiacre, France. The facilities of the shelter are made to reduce the stress of the dogs as much as possible. Dogs are kept in outside large enclosures, with natural vegetation. Dogs are kept in groups, except a few exceptions (e.g. if they cannot live with other dogs, if they need temporary isolation for a medical treatment – which did not concern the participants of the present study); they are walked on a weekly basis according to the staff availability, and they are regularly given food enrichment (such as occupation toys like Kongs[®], Kibble Nibbles[®], or ice cubes with food inside).

The dogs who participated in the study were chosen on the basis of their age (more than 1-year-old), breed label (shepherds or molossers types, according to their official book health), length of time at the shelter (i.e. more than 6 months) and good socialization with humans (based on the shelter official dog trainer's expertise). Thirty-two shelter dogs were tested with their favourite caregivers (determined according to the staff shelter reports). Two were excluded due to caregiver's errors during the tests. 30 shelter dogs, seven molossers (three females) and 23 shepherds (six females), were thus included in analyses. The proportions of dogs per breed, sex or conditions are unequal but were dictated by the particular dogs that were available in the rescue center when the study was conducted. Dogs were aged between 2 and 13.5 years old (mean = 9.1 ± 3.4 years old) and did not show any obvious signs of ageing (e.g., eye or joint problems) or behavioural problems that could negatively impact the study (according to the veterinarians at the shelter). All of the selected dogs were naïve to the testing room. All of the caregivers (four women, two men) were employees or volunteers at the AVA Animal Rescue Center who had taken care of the dogs for at least 6 months. Each dog was tested in only one of the testing conditions.

2.2. Ethical note

The shelter dogs were not physically or psychologically harmed in the course of our study. All of the dogs were free to move in the room without physical constraints. The dogs did not undergo any physical intervention (such as blood or saliva sampling). After the test, they all returned to the shelter enclosure with their caregivers.

2.3. Procedure

The shelter dogs were tested in an unfamiliar, empty, quiet room (5.92 m × 5.80 m) in the AVA Animal Rescue Center (Cuy-St-Fiacre, France). The same procedure was followed as in Duranton et al. (2016), except that dogs were tested with their favourite caregiver as the social informant. At the beginning of the experiment the dog

¹ Duranton et al. (2016) focused on the effect of the owner's displacement as they considered it as carrying emotional value, even if not accompanied by vocal cues. However, note that Merola et al. (2011) proposed using movement alone as implying observational conditioning more than strictly social referencing, i.e. learning the positive or negative value of an object or event by observing another individuals' behaviour.

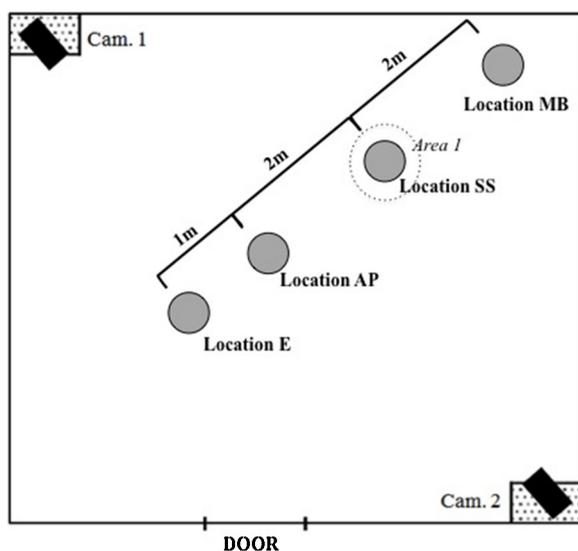


Fig. 1. Experimental setting. Location of the experimenter (E) and different locations of the handlers according to condition (approach (AP), stand-still (SS), or retreat (MB)).

was allowed 10 min to roam freely in the room with Experimenter 1 and the caregiver present, allowing them to become familiar with the space while Experimenter 1 explained the procedure to the caregiver. Instructions were given on how to behave during the single condition that was randomly attributed to each dyad (Approach, Stay-still or Retreat condition). The humans and the dog then left the room. The test lasted for a maximum of two minutes, and was divided into a series of phases. First, the caregiver entered the room with the shelter dog off leash, and walked to a predefined location (Location SS; see Fig. 1). After 15 s, the caregiver gently called the dog towards him (in Area 1, see Fig. 1). If the dog was distracted or disengaged from the interaction, the caregiver waited for the dog to come back, and if it did not, the caregiver was allowed to gently call the dog again. As soon as the dog entered Area 1 (determined by Experimenter 1 viewing the dog's location through a window whilst hidden from the dog's view), the stranger (Experimenter 2), who was unfamiliar to the shelter dog, entered the room. Looking only at the caregiver, she took three regular steps towards her predefined location (Location E; see Fig. 1). As soon as the stranger started to walk, the caregiver moved to (or remained in) the second predefined location, still facing the stranger, according to the assigned condition. In the approach condition, the caregiver took three regular steps towards the stranger (Location AP); in the stay-still condition, the caregiver remained in the same place (Location SS); and in the Retreat condition, the caregiver took three regular steps away from the stranger (Location MB). The stranger and the caregiver then remained in these locations for one minute and 30 s, while the dog's reaction was observed. Each dog was tested in only one of the condition. All locations were visually marked and easily identifiable by the caregiver and experimenters.

2.4. Behavioural analysis and inter-observer agreement

All trials were recorded by two video cameras. The different locations were marked on the floor, and the room was marked out in 1 m squares. Behaviours were then recorded with Actogram Kronos 2. The variables studied in all conditions are defined in Table 1.

Reliability coding was conducted for the behavioural analysis: a blind coder who was unaware of the aim of the study was trained to use Actogram Kronos and then coded a randomly chosen 40% of the data for both the occurrence and duration variables. The resulting Pearson correlation coefficients were good (first gaze at handler:

99% of agreement, $P < 0.001$; first contact with stranger: 99% of agreement, $P < 0.001$; first contact with handler: 99% of agreement, $P < 0.001$; time spent gazing at the handler: 98% of agreement, $P < 0.001$; time spent gazing at the stranger: 97% of agreement, $P < 0.001$; time spent in contact with the stranger: 98% of agreement, $P < 0.001$; number of stress associated behaviours: 96% of agreement, $P < 0.001$; and number of urinations: 100% agreement).

2.5. Statistical analysis

Statistical analyses to test the effects of experimental condition (stay-still, approach, retreat), sex, age, and breed and their potential interactions on dogs' behavioural responses, were conducted using R statistical software (version 3.2.0, The R Foundation for Statistical Computing, Vienna, Austria, <http://www.r-project.org>). We considered the whole test (the three phases) continuously. To test whether the numbers of referential looks and gaze alternation differed significantly from zero, we performed permutation tests. For variables that were found to be normally distributed and to have homogeneous variance (referential looks, gaze alternations, latencies, gazes, contacts, indices, duration of stress-associated behaviours, proximity), we used multivariate analyses of variance (ANOVA) and covariance (ANCOVA); where needed, we carried out post hoc comparisons with Holm-Bonferroni correction. Correlations were calculated to test for effects of age. Standard errors are presented on the graphs.

3. Results

All descriptive data are provided in Table 2.

3.1. Referential looks and gaze alternations

One of the main aims of this study was to assess whether shelter dogs engage in referential looks and gaze alternations between a stranger and their handlers, one of the two essential criteria which is indicative of social referencing. Among the 30 shelter dogs, 60% showed at least one referential look and one gaze alternation between the stranger and their handler. Table 3 shows that the shelter dogs' number of referential looks and gaze alternations was significantly greater than zero for all dogs pooled together, and for each value of the three factors tested, apart from the stay-still condition and for molosser dogs with both referential looks and gaze duration.

There was no significant effect of condition, breed, or sex on the number of referential looks. There was, however, a significant effect of age, with younger dogs making more referential looks than older ones (see Table 4).

There was no significant effect of condition or age on the number of gaze alternations. There was, however, a significant effect of sex, with females performing more gaze alternations than males (see Table 4). There was also a significant effect of breed, with shepherd dogs performing more gaze alternations than molosser dogs (see Table 4).

3.2. Behavioural regulation

3.2.1. Towards the handler

There was no significant effect of condition, breed, or sex on the latency before the dogs' first movement towards the handler. There was, however, a significant effect of age, with younger dogs waiting for a shorter time before first moving towards the handler than older dogs (see Table 5).

Table 1
Variables used in the study.

Category	Variable	Description of behaviour
Referencing	Number of referential looks	The dog gazed consecutively at stranger and handler (or vice versa) within 2 s.
	Number of gaze alternations	The dog gazed first at handler, then at stranger, then back to handler; or first at stranger, then at handler, then at stranger.
Behavioural Modification	Gaze at handler (duration and latency, in seconds)	The dog looked at the handler (i.e., head directed towards the handler).
	Gaze at stranger (duration and latency, in seconds)	The dog looked at the stranger (i.e., head directed toward the stranger).
	Contact with handler (duration and latency, in seconds)	At least one part of the dog's body touched one part of the handler's body.
	Contact with stranger (duration and latency, in seconds)	At least one part of the dog's body touched one part of the stranger's body.
	Proximity (duration in seconds)	The dog was 1 m or less away from the handler.
Stress-related behaviours	Index for behaviours towards handler	The index of behaviours of dogs towards handler = ((duration + occurrences) of moving towards the handler)/2.
	Index for behaviours towards stranger	The index of behaviours of dogs towards stranger = ((duration + occurrences) of moving towards the stranger)/2.
	Dog movements (duration in seconds)	The dog moved, i.e., walked, trotted, or ran in the room without interacting with its environment.
Vocalizations	Urination (yes/no)	The dog urinated at least once in the room.
	Stress-related behaviours (duration in seconds)	The dog performed at least one of the following behaviours: body shake, self-grooming, yawn, licking lips.
Vocalizations	Whine (duration in seconds)	The dog whined.
	Growl (duration in seconds)	The dog growled.
	Bark (duration in seconds)	The dog barked.

Defined following [Beerda et al. \(1998\)](#); [Deidalle and Gaunet \(2014\)](#); [Duranton et al. \(2016\)](#); [Gaunet and Deputte \(2011\)](#); [Savalli et al. \(2014\)](#); [Merola et al. \(2012a,b\)](#).

Table 2
Descriptive data for all variables.

Variable	Approach (N = 11)	Stay-still (N = 7)	Retreat (N = 12)	Male (N = 21)	Female (N = 9)	Molosser (N = 7)	Shepherd (N = 23)
Referential looks	3.18 ± 0.81	1.57 ± 0.75	2.00 ± 0.65	2.14 ± 0.57	2.78 ± 0.55	2.28 ± 1.20	2.45 ± 0.48
Gaze alternations	1.73 ± 0.47	1.14 ± 0.50	1.50 ± 0.74	1.00 ± 0.29	2.67 ± 0.87	0.86 ± 0.46	1.77 ± 0.45
Latency gaze at handler	16.47 ± 5.19	22.96 ± 12.58	13.35 ± 3.07	19.80 ± 4.87	9.6 ± 2.96	10.71 ± 3.38	18.57 ± 4.54
Gaze at handler	11.43 ± 2.47	9.87 ± 3.17	15.47 ± 3.06	10.53 ± 1.57	17.70 ± 3.97	12.51 ± 2.55	12.73 ± 2.10
Latency move towards handler	25.50 ± 9.06	43.20 ± 15.37	27.90 ± 9.83	33.16 ± 7.66	24.54 ± 10.60	25.80 ± 13.03	32.03 ± 7.04
Index: handler	4.27 ± 0.85	3.26 ± 1.41	5.13 ± 1.14	3.69 ± 0.64	5.98 ± 1.41	4.07 ± 1.02	4.47 ± 0.78
Latency contact handler	54.09 ± 11.46	74.16 ± 14.60	54.93 ± 11.16	63.41 ± 8.34	49.07 ± 12.60	60.10 ± 17.39	58.80 ± 7.60
Contact with handler	2.17 ± 0.85	0.30 ± 0.20	6.25 ± 3.85	3.01 ± 2.04	4.19 ± 2.54	0.63 ± 0.41	4.20 ± 2.06
Proximity with handler	45.92 ± 6.10	19.74 ± 6.80	18.90 ± 6.04	29.97 ± 5.41	26.77 ± 6.93	21.74 ± 6.56	31.22 ± 5.17
Latency gaze at stranger	1.34 ± 0.06	1.16 ± 0.05	1.39 ± 0.07	1.30 ± 0.04	1.37 ± 0.09	1.28 ± 0.01	1.33 ± 0.05
Gaze at stranger	19.47 ± 3.06	17.70 ± 3.88	21.98 ± 2.66	20.08 ± 2.30	20.01 ± 2.51	14.93 ± 2.60	21.62 ± 2.07
Latency move towards stranger	25.50 ± 9.06	43.20 ± 15.37	27.87 ± 9.83	33.16 ± 7.66	24.54 ± 10.60	25.80 ± 13.71	32.03 ± 7.04
Index: stranger	3.90 ± 0.57	4.47 ± 0.71	5.25 ± 1.06	4.16 ± 0.32	5.34 ± 1.49	4.39 ± 0.77	4.63 ± 0.61
Latency contact stranger	4.24 ± 0.62	17.13 ± 12.20	4.96 ± 0.6	9.02 ± 4.41	5.50 ± 0.81	4.32 ± 1.04	9.08 ± 4.01
Contact with stranger	9.73 ± 2.17	6.87 ± 2.90	10.19 ± 1.83	9.96 ± 1.59	7.58 ± 1.92	7.14 ± 2.24	9.89 ± 1.49
Stress-related behaviours	2.98 ± 1.19	2.29 ± 1.05	2.50 ± 1.19	3.07 ± 0.90	1.59 ± 0.67	2.47 ± 1.40	2.67 ± 0.78
Dog's movements	31.08 ± 4.38	31.90 ± 6.77	33.57 ± 5.53	30.70 ± 3.27	35.90 ± 6.92	38.07 ± 8.07	30.50 ± 3.16
Whines	1.73 ± 0.92	0	0.08 ± 0.08	0.57 ± 0.36	0.89 ± 0.89	0	0.87 ± 0.46
Urinate	0.18 ± 0.12	0.29 ± 0.18	0.08 ± 0.08	0.24 ± 0.09	0	0.14 ± 0.14	0.17 ± 0.08

Data presented in the table are: mean ± standard error.

Table 3
Mean numbers and comparisons with zero for referential looks and gaze alternations.

Group	N	Referential looks			Gaze alternations		
		Mean ± SE	Z	P	Mean ± SE	Z	P
Retreat condition	12	2 ± 0.65	-2.63	<0.05	1.5 ± 0.74	-1.89	<0.05
Approach condition	11	3.18 ± 0.81	-3.01	<0.01	1.73 ± 0.47	-2.91	<0.01
Stay-still condition	7	1.57 ± 0.75	-1.86	>0.05	1.14 ± 0.5	-1.96	>0.05
Male	21	2.14 ± 0.57	-3.27	<0.01	1 ± 0.29	-3.04	<0.01
Female	9	2.78 ± 0.62	-3.08	<0.01	2.67 ± 0.88	-2.49	<0.01
Molosser	7	2.28 ± 1.2	-1.73	>0.05	0.86 ± 0.46	-1.71	>0.05
Shepherd	23	2.35 ± 0.46	-4.11	<0.01	1.7 ± 0.44	-3.38	<0.01
All dogs	30	2.33 ± 0.44	-4.4	<0.01	1.5 ± 0.35	-3.73	<0.01

Data are provided for all dogs and for each modality of the three factors tested (permutation tests for all). SE = standard error.

There was no significant effect of breed, sex, or age on the latency before first contact with the handler. There was, however, a global significant effect of condition, but pairwise comparisons revealed no significant effects (approach vs. retreat, $F_{1,21} < 0.01$, $P < 0.96$, Cohen's $d = 0.02$, 95% CI = [-34.12–32.43]; approach vs. stay-still,

$F_{1,16} = 3.50$, $P = 0.06$, Cohen's $d = 0.52$, 95% CI = [-60.23–20.09]; retreat vs. stay-still, $F_{1,17} = 3.66$, $P = 0.07$, Cohen's $d = 0.50$, 95% CI = [20.56–59.02]; see [Table 5](#)).

There was no significant effect of breed, sex, or age on the proximity with the handler. There was, however, a significant effect

Table 4
Referential looks and gaze alternations.

Dependent variables	Independent variables	<i>F</i>	<i>df</i>	<i>P</i>	ES	95% CI
Referential looks	Condition	1.93	2, 24	0.17	0.29	–
	Sex	0.43	1, 24	0.51	0.52	–1.11 to 2.38
	Breed	1.54	1, 24	0.22	0.05	–2.93 to 3.05
	Age	7.67	1, 24	0.01	0.44	–0.69 to –0.09
Gaze alternations	Condition	0.93	2, 24	0.41	0.16	–
	Sex	6.24	1, 24	0.02	0.94	–0.40 to 3.74
	Breed	4.98	1, 24	0.03	0.44	–0.48 to 2.16
	Age	4.09	1, 24	0.054	0.31	–0.60 to 0.05

ANOVAs were conducted. Bold type indicates significant results. When condition had a significant effect, details of the post hoc comparisons with 95%CI are provided in the text. ES = effect sizes, corresponding to Cohen's *f* for condition, Cohen's *d* for sex and breed and Pearson's *r* coefficient for age.

Table 5
Behaviours of shelter dogs towards their caregivers.

Dependent variables	Independent variables	<i>F</i>	<i>df</i>	<i>P</i>	ES	95% CI
Latency gaze at caregiver	Condition	0.72	2, 24	0.79	0.19	–
	Sex	0.77	1, 24	0.39	0.52	–21.87 to 1.48
	Breed	0.02	1, 24	0.87	0.39	–3.81 to 19.53
	Age	2.03	1, 24	0.17	0.28	–0.09 to 0.58
Gaze at caregiver	Condition	0.75	2, 24	0.48	0.27	–
	Sex	2.86	1, 24	0.10	0.81	–2.27 to 16.60
	Breed	0.33	1, 24	0.57	0.02	–6.81 to 7.25
	Age	0.29	1, 24	0.59	0.07	–0.42 to 0.29
Latency move towards caregiver	Condition	1.78	2, 24	0.19	0.21	–
	Sex	0.05	1, 24	0.83	0.25	–36.25 to 19.01
	Breed	0.62	1, 24	0.44	0.18	–28.40 to 40.86
	Age	9.96	1, 24	<0.01	0.48	0.14 to 0.71
Index: caregiver	Condition	0.90	2, 24	0.42	0.21	–
	Sex	0.33	1, 24	0.57	0.67	–1.11 to 5.69
	Breed	0.47	1, 24	0.50	0.11	–2.37 to 3.17
	Age	3.25	1, 24	0.08	0.30	–0.59 to 0.06
Latency contact with caregiver	Condition	3.47	2, 24	0.04	0.22	see text
	Sex	1.15	1, 24	0.29	0.37	–46.46 to 17.77
	Breed	0.98	1, 24	0.33	0.03	–44.68 to 42.09
	Age	1.67	1, 24	0.10	0.34	–0.06 to 0.60
Proximity with caregiver	Condition	6.31	2, 24	<0.01	0.68	see text
	Sex	0.15	1, 24	0.70	0.13	–21.67 to 15.27
	Breed	2.60	1, 24	0.12	0.40	–8.40 to 27.35
	Age	0.78	1, 24	0.39	0.11	–0.45 to 0.25
Contact with caregiver	Condition	0.93	2, 24	0.40	0.29	–
	Sex	0.08	1, 24	0.78	0.13	–5.65 to 8.00
	Breed	0.83	1, 24	0.37	0.41	–0.76 to 7.91
	Age	0.07	1, 24	0.78	0.17	–0.20 to 0.50

Results of the ANOVAs are provided, with bold type indicating significant results. When condition had a significant effect, details of the post hoc comparisons with 95%CI are provided in the text. ES = effect sizes, corresponding to Cohen's *f* for condition, Cohen's *d* for sex and breed and Pearson's *r* coefficient for age.

of condition, with dogs spending more time in proximity with the handler in the approach condition than in the stay-still and retreat conditions (approach vs. retreat, $F_{1,21} = 09.86$, $P < 0.01$, still significant after correction for multiple tests, Cohen's $d = 1.31$, 95% CI = [9.14–44.88]; approach vs. stay-still, $F_{1,16} = 7.76$, $P = 0.01$, still significant after correction for multiple tests, Cohen's $d = 1.35$, 95% CI = [6.59–45.76]; retreat vs. stay-still, $F_{1,17} < 0.01$, $P = 0.93$, Cohen's $d = 0.04$, 95% CI = [–18.62–20.29]; see Table 5).

There was no significant effect of condition, breed, sex or age on any other variables regarding behaviour towards the handler (see Table 5).

3.2.2. Towards the stranger

There was no significant effect of condition, breed, sex, or age on any variable reflecting behaviour towards the experimenter (see Table 6).

3.2.3. Stress-related behaviours and vocalizations

There was no significant effect of breed, sex, or age on the time spent whining. There was, however, a global significant effect of condition, but no significant effects were found in pairwise comparisons (approach vs. retreat, $F_{1,21} = 3.50$, $P = 0.07$, Cohen's

$d = 0.78$, 95% CI = [–0.40–3.69]; approach vs. stay-still, $F_{1,16} = 2.21$, $P = 0.15$, Cohen's $d = 0.15$, 95% CI = [–0.31–3.77]; retreat vs. stay-still, $F_{1,17} = 0.57$, $P = 0.46$, Cohen's $d = 0.36$, 95% CI = [–0.31–3.77]; see Table 7).

There was no significant effect of condition, breed, sex, or age on the other stress-associated variables (see Table 7). As only one dog barked and no dogs growled during the test, we did not use these variables for the statistical analysis.

4. Discussion

This study investigated the presence of social referencing in shelter dogs when confronted with a stranger: i.e., the modification and synchronization of shelter dogs' behaviour in response to their caregivers' reaction. Although shelter dogs exhibited a pattern of referential looks towards their handler and gaze alternations between the stranger and their handler, no difference across conditions was found in their reactions to the stranger. Shelter dogs' behaviour towards the stranger did not show that they made use of their handler's behaviour to guide their own. The present experimental study thus cannot confirm the existence of social

Table 6
Behaviours of shelter dogs towards the stranger.

Dependent variables	Independent variables	F	df	P	ES	95% CI
Latency gaze at stranger	Condition	2.14	2, 24	0.14	0.42	–
	Sex	0.77	1, 24	0.39	0.33	–0.14–0.29
	Breed	0.57	1, 24	0.46	0.21	–0.06 to 0.16
	Age	0.05	1, 24	0.82	0.14	–0.23 to 0.47
Gaze at stranger	Condition	0.38	2, 24	0.68	0.18	–
	Sex	0.03	1, 24	0.86	<0.01	–7.15 to 7.01
	Breed	2.00	1, 24	0.17	0.71	–0.40 to 13.79
	Age	0.27	1, 24	0.61	0.23	–0.14 to 0.54
Latency move towards stranger	Condition	0.14	2, 24	0.87	0.12	–
	Sex	0.25	1, 24	0.62	0.23	–1.03 to 1.76
	Breed	0.09	1, 24	0.76	0.06	–1.87 to 1.67
	Age	0.37	1, 24	0.54	0.09	–0.27 to 0.44
Index: stranger	Condition	0.83	2, 24	0.44	0.22	–
	Sex	0.86	1, 24	0.36	0.51	–2.07 to 4.82
	Breed	0.34	1, 24	0.57	0.08	–1.86 to 13.24
	Age	0.12	1, 24	0.72	0.13	–0.47 to 0.23
Latency contact with stranger	Condition	1.64	2, 24	0.21	0.39	–
	Sex	0.24	1, 24	0.63	0.20	–12.84 to 5.80
	Breed	0.15	1, 24	0.70	0.28	–3.78 to 13.29
	Age	0.06	1, 24	0.80	0.06	–0.41 to 0.30
Contact with stranger	Condition	0.54	2, 24	0.59	0.20	–
	Sex	0.49	1, 24	0.49	0.34	–7.61 to 2.84
	Breed	0.54	1, 24	0.47	0.40	–3.11 to 8.60
	Age	0.09	1, 24	0.76	0.17	–0.19 to 0.50

Results of the ANOVAs are provided. When condition had a significant effect, details of the post hoc comparisons with 95%CI are provided in the text. ES=effect sizes, corresponding to Cohen's *f* for condition, Cohen's *d* for sex and breed and Pearson's *r* coefficient for age.

Table 7
Stress-related behaviours and vocalizations.

Dependent variables	Independent variables	F	df	P	ES	95% CI
Time moving	Condition	0.17	2, 24	0.84	0.06	–
	Sex	0.09	1, 24	0.76	0.30	–11.50 to 21.92
	Breed	0.17	1, 24	0.68	0.45	–27.58 to 12.44
	Age	2.29	1, 24	0.14	0.32	–0.61 to 0.04
Whines	Condition	3.74	2, 24	0.04	0.46	see text
	Sex	1.56	1, 24	0.22	0.16	–1.80 to 2.43
	Breed	1.29	1, 24	0.27	0.44	–0.09 to 1.83
	Age	0.62	1, 24	0.44	0.14	–0.23 to 0.48
Stress-related behaviours ^a	Condition	0.14	2, 24	0.86	0.08	–
	Sex	0.76	1, 24	0.39	0.40	–3.80 to 0.83
	Breed	0.49	1, 24	0.49	0.05	–3.38 to 3.78
	Age	4.47	1, 24	0.06	0.30	–0.59 to 0.06
Urinate	Condition	0.24	2, 24	0.78	0.12	–
	Sex	1.78	1, 24	0.19	0.43	–1.18 to 0.13
	Breed	0.05	1, 24	0.83	0.16	–0.53 to 0.93
	Age	0.37	1, 24	0.55	0.04	–0.40 to 0.32

Results of the ANOVAs are provided, with bold type indicates significant results. When condition had a significant effect, details of the post hoc comparisons with 95% CI are provided in the text. ES = effect sizes, corresponding to Cohen's *f* for condition, Cohen's *d* for sex and breed and Pearson's *r* coefficient for age.

^a To make the variable "stress-related behaviours" heteroscedastic, the data was transformed using the following equation: $\text{data}^{0.5} + 1$.

referencing between shelter dogs and their caregivers in an approach paradigm.

A number of factors aside from lifetime exposure to human contact might nevertheless influence the performance of dogs living in a shelter environment, including stress and the possibility of an underlying wariness of the situation. However, in the present study, stress due to the living immediate environment of the shelter dogs was reduced to the minimum; as they were kept in large outside enclosures, with other dogs, they were weekly walked and they were provided daily environmental enrichments. Dogs tested were all evaluated by the shelter's staff member as comfortable in unfamiliar situations and with unfamiliar people, as we wanted to avoid any behavioural modification due to stress. Finally, during the experiment, shelter dogs exhibited very few stress-related behaviours, and at similar rates than privately owned pet dogs (Duranton et al., 2016), disregarding the explanation that behavioural reaction in shelter dogs was due to stress level. We ensured as much as possible that we were testing the impact of a lack of human exposure.

Our findings that shelter dogs show referential looks and gaze alternations similarly to those of privately owned pet dogs (Duranton et al., 2016) is in line with Merola et al.'s (2012b) results that when confronted with an unfamiliar stimulus, privately owned pet dogs alternated their gaze between the object and the human informant even when the informant was not their owner. The relationship between the dogs and the human referent does not influence the presence of gaze alternations. Additionally, various studies have found no difference between shelter dogs and privately owned pet dogs' in spontaneous gazing towards humans (Barrera et al., 2011, 2012). However, in the present study shelter dogs' referential looks and gaze alternations did not differ from zero in the stay-still condition. It is possible that as the caregivers did not move in this condition, contrary to the two others, shelter dogs were less inclined to look at them to gain information on how to behave. This hypothesis is supported by studies which have revealed that individuals were more attentive to, and synchronized with others when a switch of activity occurred than when there was none (Dostáková and Špinková, 2007; Kerepesi et al., 2005; Lakin

et al., 2003; Pays et al., 2008). Another possibility is that our sample size was too small to show an effect in the stay-still condition. This could be clarified in further studies with more dogs. The results also failed to show referential looks or gaze alternations in molosser dogs. Two different, mutually compatible hypotheses can explain that. It is possible that our sample size was not big enough compared to that of shepherds. It is also possible that these dogs did not actually need to search for information by gazing at their handlers because molosser breeds are known to be bolder and more autonomous than shepherd dogs (Duffy et al., 2008; Duranton et al., 2016; Svartberg, 2006).

Contrary to our hypothesis, our results failed to show that shelter dogs modulate their behaviours according to the reaction of their caregivers. We did not find any effect of condition on shelter dogs' behavioural reactions towards a stranger. These results differed to the findings of Duranton et al. (2016) in privately owned pet dogs undertaking the same protocol. In their study, Duranton et al. (2016) found that the dogs used their owners as social references. There are various non-mutually exclusive explanations for the contrasting finding in shelter dogs. First, it is possible that the shelter dogs may have been more stressed in the experimental environment and paid less attention to the social situation. Dogs living in a shelter situation are less likely to be taken outside to encounter novel stimuli and different environment compared with pet dogs. Therefore, it is possible that shelter dogs were more sensitive to new surroundings and situations and as a consequence more stressed in the testing room than privately owned pet dogs (as also found by Barrera et al., 2010), paying less attention to the procedure/the stranger. This 'inattentive' explanation is however unlikely as the living conditions of these shelters are little stressful overall and that the shelter dogs showed levels of referential looks, gaze alternations, and caregiver-directed behaviours equivalent to those of privately owned pet dogs (Duranton et al., 2016). It is thus more likely that both populations of dogs looked at their handler for information about their reaction; but then only privately owned pet dogs adjusted their behaviour to the handlers' reaction, whereas shelter dogs did not. Specifically, in the retreat condition, privately owned pet dogs adjusted their behaviour to their owners' reaction by looking more quickly at the stranger, and taking longer to first make contact with the stranger (Duranton et al., 2016), whereas shelter dogs did not in the present study. As the bond between shelter dogs and their caregivers is weaker than the bond between pet dogs and their owners (Barrera et al., 2010; O'Hara and Reeve, 2011), it is plausible that shelter dogs did not use their caregiver's reaction as a behavioural cue in the testing situation. In the present study, the stranger was always moving in a neutral way, and did not walk directly in the dogs' direction. It may be, then, that our test situation was not considered as threatening/ambiguous enough for the shelter to use their caregivers as informants. A more parsimonious hypothesis for the present results may be that shelter dogs, because of their living conditions, and particularly the social deprivation (i.e. lack of regular interactions with humans) have lost the habit of using human behaviour as a reference/cue, or may have learn to ignore it. In short, they saw their caregivers' reaction, but they did not use it to react accordingly. This hypothesis is consistent with the fact that social isolation impairs dogs' ability to use others' behaviour (Angermeier and James, 1961). It is also in line with the fact that dogs are able to learn to change the way they use human communicative signals, or even to stop using them altogether (Bentosela et al., 2008; Elgier et al., 2009). One study that examined shelter dogs' ability to use human communicative signals showed that shelter dogs needed more trials to succeed in a human-guided task than pet dogs (Udell et al., 2010). When the shelter dogs were given additional familiarization time with the caregiver and tested again, they succeeded in the task at the same performance level than pet dogs. The authors proposed that due

to the shelter dogs' lack of interaction with humans, they needed additional time to be able to use the specific communicative signals provided by the demonstrator. The same phenomenon could be at play in the present study. Finally, it is also possible that the lack of a significant effect of condition was due to our unbalanced groups. We thus encourage further studies with more shelter dogs and balanced groups.

Nevertheless, experimental condition did have a significant effect on shelter dogs' proximity with their caregiver. In the approach condition, the shelter dogs spent more time close to the caregiver than in the stay-still and retreat conditions. Given that condition did not influence any of the shelter dogs' other behaviours, this may simply be due to a position effect. Our results suggest that in all three conditions, the shelter dogs behaved in the same way towards the stranger, remaining in contact with her for the same amount of time. In the approach condition the caregiver was closer to the stranger, and the shelter dogs were investigating the stranger; so by a simple position effect the dogs were closer to the caregiver. More generally, our results revealed that shelter dogs do not spend a lot of time in proximity with their caregiver, contrary to privately owned pet dogs who stayed in great proximity with their owners (Duranton et al., 2016). The quality of the relationship between the dogs and the handlers likely played a role in this observation. In the present study shelter dogs were tested with their principal caregiver. Although they regularly interacted with this person, the circumstances within the shelter environment are not likely to have allowed them to develop a bond comparable to those found between pet dogs and their owners.

Finally, our results showed that age, sex, and breed all influenced the shelter dogs' referential looks and gaze alternations. Younger shelter dogs made significantly more referential looks than older ones, as was found with privately owned pet dogs by Duranton et al. (2016). One possible explanation for this difference is that older dogs are more experienced and do not need to seek additional information on how to behave (Duranton et al., 2016; Starling et al., 2013). It is also in line with the fact that older dogs returned to their handler later than did younger dogs. It is also plausible that older dogs simply become less interested in what happens in their surroundings (Duranton et al., 2016; Starling et al., 2013), and/or that they are less active than younger dogs (Soffié et al., 1992; Starling et al., 2013). Secondly, we found that female dogs exhibited more gaze alternations than male dogs: female dogs may have looked to their caregiver for information and/or social support more than male dogs, as found in privately owned pet dogs (Duranton et al., 2016; Horn et al., 2013). A number of studies have shown that female dogs are less bold than male dogs when facing an unfamiliar stimulus (Beerda et al., 1998; Duranton et al., 2015; Kubinyi et al., 2009; Starling et al., 2013; Svartberg and Forkman, 2002) and exhibit more gaze alternations (Merola et al., 2012a). The fact that we did not find an effect of sex on any other variable is probably due to our unbalanced groups, and we recommend further studies in this direction with a larger, more diverse population of shelter dogs. Finally, our results revealed that shepherd dogs performed more gaze alternations than molosser dogs, as previously found in privately owned pet dogs (Duranton et al., 2016). Shepherd dogs are selected for herding in active cooperation with their handlers, who provide instructions (Mehrkam and Wynne, 2014). It is thus unsurprising that shepherd dogs are more focused on their human referents, gazing more at them. Pongrácz et al. (2005) presented similar findings, observing that shepherd dogs looked back at their owners more often than other breeds. Additionally, molosser dogs are considered bolder than other breeds, which could explain that they did not need to look at the caregiver for information or support social in such a situation (Duranton et al., 2016; Starling et al., 2013; Turcsán et al., 2011). The fact that we did not find a breed

effect on other variables, could be due to our unbalanced groups, and we recommend further studies in that direction.

To conclude, we found that, like privately owned pet dogs, shelter dogs' behavioural responses to an unfamiliar person were influenced by sex, breed and age. However, contrary to our main hypothesis, we did not find evidence of social referencing between shelter dogs and their caregivers in an approach paradigm, unlike privately owned pet dogs. This may be explained by the shelter dogs' living conditions and, relatedly, their relatively weak bond with their caregivers.

Conflict of interest

The authors declare that there is no conflict of interest.

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