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Research

Persistence in learned responses: A comparison of Animal Assisted Intervention and pet dogs

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A B S T R A C T

Dogs participating in Animal Assisted Interventions (AAI) are prime candidates to assess how increased interaction with people modulates canine behavior. The aim of this work was to compare the behavior of AAI and pet dogs on three tasks following the same pattern: a) an acquisition phase in which dogs were reinforced for emitting a specific response and b) an extinction phase in which it was no longer reinforced. We evaluated 26 dogs (13 participating in AAI and 13 living as pets) on learning two socio-cognitive tasks (gazing and object choice) and a nonsocial one (problem-solving). As clients do not always respond properly to their communicative interactions, AAI dogs often need to persevere in their communicative responses during their typical activities. Therefore, we hypothesized that AAI dogs would be more persistent than pet dogs, particularly during the extinction phases of the tests. Although no significant main effects of group were observed during the extinction phase of the gazing test, only pet dogs significantly decreased the time spent gazing at the experimenter during this phase, which indicates they gazed less as trials went on. In the object choice task, no differences between these groups were observed. Finally, in the problem-solving task, AAI dogs persisted significantly more in picking up bones even when the apparatus was empty and also spent more time interacting with it during extinction trials than pet dogs. Besides pre-existing behavioral characteristics, the combination of the higher exposure to people and not always being immediately reinforced during their work may affect AAI dogs' persistence on some cognitive tasks. However, factors such as training levels and interaction with the experimenter during the task modulate this response. A deeper understanding about AAI dogs will shed light over the effects of increased social experience on dogs' cognition and is particularly relevant given the popularity of AAIs in the recent years.

Introduction

Dogs have remarkable social skills in their communication with humans, given that they are highly proficient in responding to our communicative cues as well as emitting expressive signals toward us (e.g., Miklósi et al., 2003; Hare & Tomasello, 2005). A topic of debate for years on the field of canine social cognition has been the role of both phylogeny (i.e., evolution, domestication) and ontogeny (i.e., development, life experiences, and learning) on such behaviors. Nowadays, it is widely accepted that both, evolutionary changes and ontogenetic experiences, contribute to the development of dogs' social cognition (Miklósi & Kubinyi, 2016), but debate remains open regarding the relative weight of each factor. One way to account for the role of ontogeny on the display of communication skills is to assess dogs with different levels of daily interaction with humans (Udell et al., 2010a). If experiences during their ontogeny play a major role in the acquisition and expression of dogs' communicative skills, it would be expected that differences in their everyday contact with people would be reflected in their performance on social tasks (Carballo et al., 2017). Therefore, dogs with higher daily contact with people should perform better than those with limited exposure to humans.

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To this end, several studies have focused on shelter dogs, as they have less daily contact with people than dogs living as pets. For instance, these two dog populations were evaluated on a gazing task (Barrera et al., 2011) in which they were reinforced for gazing at the experimenter's face and then received an extinction phase in which no more food was delivered. Results indicate that both groups behaved similarly during the acquisition phase, but shelter dogs gazed significantly less during the extinction one. In another study (Barrera et al., 2015), dogs were confronted with a problem-solving task consisting of two phases of interaction with a dog toy, one which contained food and one which appeared empty. Pet dogs (PD) spent more time interacting with the apparatus in all phases, which suggests a higher persistence than their shelter counterparts. One explanation for these results is that PD have more opportunities in their everyday interactions to learn to persist in their behavior (Barrera et al., 2011). In addition, they are frequently exposed to partial reinforcement during their lives which has been shown to increase resistance to extinction (Amsel, 1992; Barrera et al., 2015).

Finally, when tested on an object choice task, although shelter dogs were able to follow simple cues to find food (Hare et al., 2010), they failed to do so when the cues were complex such as momentary distal pointing (Udell et al., 2008). However, they were able to learn the task with further training (Udell et al., 2010b; Wynne et al., 2008). Taken together, these results suggest that shelter dogs, which are less exposed to people in their daily lives, show less persistence (i.e., less resistance to extinction) and have a poorer performance on their communicative skills during sociocognitive tasks than PD.

Conversely, other studies have focused on dogs with a higher level of exposure to people, such as those participating in Animal Assisted Interventions (AAI) (e.g., Cavalli et al., 2018; Mongillo et al., 2015; 2017; Wanser & Udell, 2018). These interventions incorporate animals in areas like health and education, with the aim of improving people's well-being and obtaining therapeutic gains (IAHAIO, 2018). They can be separated into Animal Assisted Therapy, which is carried out by professionals and are more structured and goal oriented; Animal Assisted Activities (AAA), of a more spontaneous nature and oriented toward motivational or recreational goals; and Animal Assisted Education, overseen by an educator and focused on academic goals, prosocial skills, and cognitive functioning.

Dogs are one of the most common animals used for these interventions (Bert et al., 2016), but few studies have focused on the characteristics of this population. Those dogs participating on AAI are prime candidates to assess how increased interaction with people modulates social behavior, as they experience a greater quantity and a deeper quality of interaction, with numerous people of different ages and varying characteristics. One study focusing on AAI dogs was carried out by Mongillo et al. (2017), who found that dogs trained for AAI gazed more frequently and sustained their attention on their owners more than PD. The authors conclude that this increased attention toward their owners could be due to AAI dogs relying on them for support when faced with unpredictable situations, such as those that could arise during their work. Furthermore, Cavalli et al. (2018) compared dogs participating on AAA (a particular type of AAI) and PD on a battery of sociocognitive tasks. Although there were no differences in sociability and impulsivity tasks, AAA dogs gazed significantly more toward an unfamiliar experimenter both on the baseline and when they were no longer reinforced for doing so (i.e., extinction). Therefore, they exhibited an increased tendency to gaze at humans and persisted on this response even when it was not successful. It is possible that AAA dogs have learned to gaze longer during their working sessions, as they often need to persist on their communication attempts given that participants do not always respond properly to their cues. For instance, clients may be afraid of the dog, unable or reluctant to engage with it (for case examples of AAI work see VanFleet et al., 2015). The type of activities carried out during a visit focuses on varied skills and is quite diverse according to the goals of each intervention. For instance, if the emphasis is on motor skills, they may include petting, brushing, walking, or playing with the dog. Other visits may be dedicated to social interaction and thus include activities featuring being gentle, appropriate touch, connection with a living being, and reduction of anxiety or loneliness (Nimer & Lundahl, 2007).

All in all, results in AAI dogs indicate that their work experience influences their behavior on some sociocognitive tasks, in which they differ from PD in their communicational patterns and persistence.

Taking these results into account, the aim of this study was to assess the performance of AAI dogs on different tasks following a similar pattern as in Cavalli et al. (2018) (i.e., acquisition of a response followed by an extinction phase in which it was no longer reinforced), to test their persistence. To this end, dogs were evaluated on three tasks (two social: gazing and object choice; and one nonsocial: problem-solving). It was predicted that AAI dogs would be more persistent on social tasks (i.e., gazing and object choice), whereas predictions were unclear for the nonsocial one (problem-solving). On the one hand, if AAI work affects cognition broadly and causes dogs to be more persistent in general, we would expect AAI dogs to persist more on the nonsocial task as well. Alternatively, if AAI work preferentially affects dogs' social cognition, no difference between the persistence of AAI and PD would be expected on this task.

This work contributes to a better understanding of how life experiences modulate dog behavior. Furthermore, knowing more about the characteristic of dogs participating in AAI helps to determine some of the factors that may be at play in their differences with dogs not participating in such activities, and may aid in the selection and training of these animals.

Methodology

Subjects

We assessed 28 domestic dogs (*Canis familiaris*); two dogs were excluded because of fear toward the experimenters. The final sample consisted of 26 adult dogs, between 1 and 11 years of age of various breeds and mixes (see Table 1). Of the three tasks, 25 dogs completed gazing, 23 completed object choice, and 16 completed problem-solving because of the owner being unavailable for further visits or the dog not engaging with the activity (i.e., during the first trial, the dog did not gaze at the experimenter, did not follow the pointing cue, or did not remove any bones, respectively).

The AAI group ($N = 13$: 9 females, 4 males; mean age = 5.15 SD ± 2.9) consisted of dogs working in hospital units (psychiatry and physical rehabilitation), special education groups and psychotherapeutic private practice with their owners. Frequency of AAI entailed weekly visits and, in all cases, involved interactions with unfamiliar people. All dogs had participated in AAI for at least one year. Most ($N = 11$) started carrying out these activities as puppies (<1 year of age) and continued into the present. Two exceptions were one dog which was adopted as an adult and another which had stopped participating in AAI at the time of the testing. These dogs were recruited from AAI groups in our city which were invited to participate.

The PD group ($N = 13$: 10 females, 3 males; mean age = 3.6 SD ± 2.3) consisted of dogs living with families and not participating in AAI. They were selected to match, as close as possible, the

Table 1
Subject's details

Group	Age (years)	Sex	Breed	Completed tasks
AAI	2	F	Toy poodle	G, OC, PS
AAI	3	F	Border collie	G, OC, PS
AAI	10	F	White shepherd	G, OC
AAI	4	F	Labrador retriever	G, PS
AAI	4.5	F	Toy poodle	G, OC, PS
AAI	6	F	Maltese	G, OC, PS
AAI	5	F	Golden retriever	G, OC
AAI	4	M	Mixed	G
AAI	3.5	M	Mixed	G, OC, PS
AAI	3.5	M	Golden retriever	G, OC, PS
AAI	2	F	Labradoodle	G, OC
AAI	11	F	Mixed	G, OC
AAI	8.5	M	Jack Russell terrier	G, OC, PS
PD	3	F	Golden retriever	G, OC, PS
PD	7	F	Catalan shepherd	G, OC, PS
PD	1	F	Labrador retriever	G, OC, PS
PD	6	M	Mixed	G, OC, PS
PD	2	F	Mixed	OC, PS
PD	7	M	Toy poodle	G, OC, PS
PD	1	F	Labradoodle	G, OC, PS
PD	1.5	F	Mixed	G
PD	5	M	Toy poodle	G, OC
PD	3	F	Golden retriever	G, OC
PD	3	F	Border collie	G, OC
PD	1.5	F	Jack Russell terrier	G, OC, PS
PD	7	F	Mixed	G, OC

AAI, Animal Assisted Intervention dogs; PD, pet dogs; F, female; M, male; G, gazing; OC, object choice; PS, problem-solving.

characteristics of the AAI sample (see Table 1). In three cases, the same household had both a dog participating in AAI and one not doing so. Dogs from this group were recruited through social media flyers and personal contacts.

All dogs lived (and worked, in the case of AAI dogs) with their owners. They were asked to refrain from feeding their dogs for 3 hours before the testing to increase their interest in food; water was available *ad libitum*.

General procedure

Dogs were administered three behavioral tasks: gazing, object choice, and problem-solving. The tests were carried out on three different visits, separated by approximately one month each, and task order was counterbalanced across subjects.

Before the first task, the owners filled out a basic demographic questionnaire including age, sex, breed, and training level of their dog. Owners of AAI dogs were also asked about the kind of facilities they visited and the populations they worked with.

All dogs were tested in a quiet room within their homes, away from distractions. The sessions were videotaped with a SONY DCR 308 video camera placed on a tripod in a corner of the room for the object choice task and handheld by an experimenter for the other two. The experimenters (Es) were females, unknown to the animals. The food rewards were small pieces of cooked liver.

Communicative learning task: gazing test

Materials. Pieces of liver were placed in a container inaccessible to the animals, so they could see the food but not reach it (see Figure 1). Two Es were present; one stood next to the container and administered the rewards when needed. The other recorded the situation, capturing the direction of the dog's head and gaze.

Procedure. The procedure was similar to the study by Bentosela et al. (2008). It comprised four consecutive phases: baseline, acquisition, extinction, and reacquisition. Each trial lasted 2 min with an intertrial interval of 2 min. After each trial, the E left the training area and stood in a corner of the room with her back turned, taking the food container with her. Before beginning the test, the dog received a warm up to assess its interest in food. The E called its name and sought physical contact, while giving it three pieces of liver.

Baseline. Directly after warm up, the dog received 1 baseline trial. This trial started when E, who was standing next to the container, called its name and gave it one single piece of liver. Then, she stood still while gazing at the dog's face, trying to maintain eye contact.

Acquisition. Afterward, the dog received 3 trials of reinforcement of the gazing response toward the E. These trials began with E calling the dog's name and giving it a piece of liver. From then on, the dog received a piece of food each time it gazed at E's face.

Extinction. Next there were 3 extinction trials, in which the gazing response was no longer reinforced. This phase was identical to the baseline.

Reacquisition. Finally, the dog received 1 trial of reacquisition, identical to the acquisition phase. The aim of this phase was to discard satiety or fatigue effects.

The dependent variable was gaze duration (s), which consisted of dog's visual contact with the E and was scored continuously on all trials.

Object choice task

Materials. The setting consisted of two chairs placed 1 m apart from each other, in between which E stood during the trials. The starting point was set facing the chairs, 1.5 m from where the E stood. During the test two opaque bowls (base diameter 9 cm, diameter of the opening 23 cm, depth 10 cm) were used. The bowls were spread with liver and fitted with a double bottom containing pieces of liver to control for odor cues. Two Es were present, one who gave the pointing cues and another who acted as handler, holding the dog at the starting point by the leash. The situation was filmed with a camera on a tripod.

Procedure. The procedure was the same as in the study of Elgier et al. (2009a). The test consisted of an object choice task, in which the dog had to choose between two opaque bowls following cues given by the experimenter (see Figure 1). To control for odor cues, each bowl was fitted with a double bottom in which five pieces of liver were hidden. The bowls were baited out of the dog's

Figure 1. Image of the experimental set. (A) Communicative learning task: gazing test, (B) object choice task, (C) problem-solving task.

view. All pointing gestures were proximal and static (i.e., the E was at a distance of 10 cm from each bowl, and continued to give the cue until the dog chose or time ran out). The pointed side was counterbalanced across trials. There were three phases:

Pretraining. This phase aimed to show the dog that the bowls could contain food. The E showed a piece of liver, placed it in one bowl and pointed toward it. If the dog did not approach on its own, the handler gently guided it to the baited bowl and encouraged it to eat. This was repeated twice per side.

Acquisition. This phase was divided into two sessions of 10 trials, with an intertrial interval of 20 seconds (s) and an intersession interval of 2 minutes (min). Each trial began with E calling the dog's name and, once visual contact was achieved, E pointed toward the bowl containing a piece of liver. Then the handler released the dog, letting it free to choose. A choice was scored when the dog approached a bowl with its muzzle at less than 10 cm. If it was the correct one, the dog was allowed to eat and the handler congratulated it (saying "very well!") while returning to the starting point. If the dog chose incorrectly, the handler said "no", while the E showed that the bowl was empty and that food was in the other one, allowing the dog to see but not eat it. If the dog did not make a choice within 15s from the moment the pointing gesture started, it was registered as a no choice and the next trial began.

Extinction. Two min after the acquisition phase, an extinction phase began. The procedure was exactly the same, except that no bowl contained food. In this phase, the handler remained silent. This phase consisted of two sessions of 10 trials, but the test was stopped earlier if the dogs reached an extinction criterion of 4 consecutive no choices.

To assess whether dogs stop responding because of satiety or lack of motivation, the E offered them 4 pieces of liver once the task ended, which all dogs consumed.

The dependent variables were the number of correct choices during the acquisition phase, and the trials needed to reach the extinction criterion (if it was reached, otherwise the maximum number of trials was 20) and the number of no choices during the extinction phase.

Problem-solving task

Materials. For this test a commercial toy for dogs, "Dog Magic, Nina Ottosson interactive toys", was used (see Figure 1). It consisted of a round disk of 36 cm in diameter, which had 9 bone-shaped depressions in which nine plastic bones could be fitted (eight arranged in a circle, and the ninth located in the middle). All bones had a small hole to release the smell of food hidden underneath. The bone-shaped spaces were spread with liver, to help distribute the smell and control for odor cues. The device was placed on a carpet (75 × 45 cm) to prevent it from slipping. One E was present recording the situation, avoiding the dogs' gaze and ignoring them if they approached her, while other E waited in an adjacent room and took the apparatus away to refill it after each trial.

Procedure. The procedure was the same as in the study of Barrera et al. (2015). It consisted of a problem-solving task in which the dogs had to dislodge the plastic bones from the apparatus to obtain the piece of liver hiding under each bone. It comprised three phases:

Acquisition. This phase consisted of 3 trials, with an intertrial interval of 1 min. Each trial began when E brought the device containing one piece of liver under each plastic bone. She placed it on the carpet and started her stopwatch once the dog was in contact with the apparatus, then left the room. During the first of these trials, 3 of the bones were partially removed to encourage the dogs to find the food hidden underneath. Each trial went on for a maximum of three min or until the dog picked up all the 9 bones and ate the rewards underneath.

Extinction. After the acquisition, there were 3 trials in which procedure was similar, but none of the plastic bones were baited. In this phase, trials had a fixed duration of 3 minutes.

Reacquisition. Finally, there was one trial similar to the acquisition ones, with the device containing a piece of liver under each plastic bone.

Intertrial interval was of 1 min, in which the toy was taken away and refilled in another room out of the dog's view.

The dependent variables were the number of plastic bones the dog picked up on each trial and the time (s) spent interacting with the apparatus (i.e., sniffing, licking, paw touching, and trying to dislodge the bones with the paw or the nose).

Data analysis

The performance of each group (AAI and PD) was compared for each test.

A second observer, blind to the dogs' group, measured 100% of the videos from the gazing test, and 30% of the videos from the problem-solving task. Pearson's coefficients of correlation were calculated to assess interobserver reliability for gaze duration ($r_s > 0.95$, $P < 0.001$) and time spent interacting with the toy ($r_s > 0.99$, $P < 0.001$). Number of picked up bones in the problem-solving task and the choices during the object choice task were scored live after each trial by two experimenters. Agreement between them was excellent as the measures were unequivocal.

For the gazing test, the time dogs spent gazing at the E was compared across phases (baseline, acquisition, extinction, and reacquisition) and between groups. A GLM with gaze as dependent variable was run, with group (AAI and PD) and phase (baseline, acquisition, extinction, and reacquisition) as fixed factors as well as their interactions. Trial number was added as a repeated factor nested within each phase and the interaction of group by trial within phase was included. Subject identification was added as random factor to assess the variance between subjects. Given that the data were normally distributed (Shapiro Wilk, $P > 0.05$), a normal probability distribution with an identity linking function was used.

For the object choice task, the measures included the number of correct choices during acquisition, and the trials needed to reach criterion (or 20 if it was not reached) and a no choice rate (calculated dividing the number of no choice trials by the number of trials until criterion) during the extinction phase. Mann–Whitney U was used to compare group effects of correct choices during acquisition and trials until extinction criterion, as these data were not normally distributed (Shapiro Wilk, $P < 0.05$). Conversely, the no choice rate followed a normal distribution (Shapiro Wilk, $P > 0.05$) and was analyzed with a t test. Finally, Fisher exact test was used to compare the frequency of dogs reaching the extinction criterion between groups.

Measures for the problem-solving task included the number of picked up bones and the time (s) the dog spent interacting with the toy during each trial. As most measures were not normally distributed, nonparametric statistics were used in the analysis (Shapiro–Wilk, $P < 0.05$). Regarding the time interacting with the apparatus, as trial duration was variable, rates were calculated dividing the time the animal spent interacting with the apparatus by the total time of the trial. Mann–Whitney U test was used to compare group effects on the number of picked up bones and the interaction time in each trial for all phases (acquisition, extinction, and reacquisition). Friedman test was used to analyze trial effects on the acquisition and extinction phases.

All tests were two tailed ($\alpha = 0.05$). The data were analyzed with the statistics program SPSS (v20).

Table 2
Mean and SD of the gazing time for each group

Group	BL	AC1	AC2	AC3	EXT1	EXT2	EXT3	RA
AAI	49.28 (±24.91)	17.68 (±8.59)	19.42 (±7.80)	21.17 (±9.12)	72.69 (±27.64)	60.48 (±33.21)	62.90 (±30.90)	21.26 (±7.05)
PD	36.18 (±18.48)	18.58 (±11.17)	16.32 (±8.00)	14.11 (±6.15)	63.40 (±27.35)	59.83 (±28.06)	44.37 (±32.57)	13.80 (±7.64)

AAI, Animal Assisted Intervention dogs; PD, pet dogs; BL, baseline, AC, acquisition, EXT, extinction, RA, reacquisition.
All measures are expressed in seconds.

Results

Communicative learning task: gazing test

Mean and standard deviation of gazing time for each group across trials is reported in Table 2.

Main effects of phase (F (3,184) = 98.49, P < 0.001) and trial within phase (F (4,184) = 2.42, P = 0.05) were found. On the contrary, there were no significant main effects of group (F (1,184) = 1.90, P = 0.15), phase by group (F (3,184) = 0.78, P = 0.50) and group by trial within phase interaction (F (4,184) = 1.11, P = 0.35). Comparing the mean time dogs spent gazing at the experimenter in the different phases of the test, we observed that dogs gazed significantly more at the experimenter during the extinction phase than in all the other phases, independently of the group (baseline: T (184) = 4.72, P < 0.001; acquisition: T (184) = 15.95, P < 0.001; reacquisition: T (184) = 11.37, P < 0.001). Dogs also looked less at the experimenter in the acquisition (T (184) = −6.55, P < 0.001) and reacquisition phases (T (184) = −5.43, P < 0.001) than in the baseline. Importantly, there were no differences between the acquisition and reacquisition phases (T (184) = −0.09, P = 0.92).

When comparing the time dogs spent gazing at the experimenter in each trial within the acquisition and extinction phases, it was observed that dogs gazed significantly less at the experimenter on the third extinction trial compared with the first (T (184) = 3.10, P = 0.002).

Moreover, PD significantly decreased the time they spent gazing at the experimenter during the extinction phase, as they gazed less during the third trial compared with the first (T (184) = −2.84, P = 0.005) and the second (T (184) = −2.31, P = 0.02). However, this difference was not found in AAI dogs (3rd vs. 1st trial: T (184) = −1.52, P = 0.12; 3rd vs. 2nd trial: T (184) = 0.37, P = 0.70). No other differences were found (P > 0.05).

All in all, taking both group of dogs together, we found that dogs gazed longer at the E in the extinction than in the acquisition phase. Nevertheless, the behavior along trials in each phase differed between groups. Specifically, in the extinction phase, the amount of time PD spent looking at E decreased along trials while it remained relatively constant in the AAI group.

Object choice task

During the acquisition phase, there was no difference between AAI and PD on the number of correct choices (AAI: 17.81 ± 2.22, PD: 17.83 ± 2.79; U = 60 P = 0.70).

Regarding the extinction phase, there was no significant group differences on the number of trials needed to reach criterion (AAI: 18.63 ± 2.73, PD: 17.16 ± 3.66; U = 51.5 P = 0.32), nor the rate of no choices (AAI: 0.24 ± 0.14, PD: 0.30 ± 0.21; T (21) = −0.82, P = 0.41). Regarding the frequency of dogs reaching the extinction criterion for each group, only 36% of dogs in the AAI reached it, while 66% of PD did so. Nevertheless, this difference between groups was not statistically significant (Fisher exact test: n = 23, $\chi^2(1)$ = 0.22, P = 0.22).

Problem-solving task

Number of picked up bones

Figure 2 shows the mean number of bones the dogs picked up across trials. During the acquisition phase, there was no significant differences between groups (U < 32, P > 0.654). However, there was a significant difference between trials ($\chi^2(2)$ = 10, P = 0.007), as dogs picked up more bones in the second and third acquisition trial compared with the first (ac1 vs. ac2: Z = −2.41, P = 0.041; ac1 vs. ac3: Z = −2.41, P = 0.041). No differences were found between ac2 and ac3 (Z = 0, P = 1).

Regarding the extinction phase, there was a significant difference between groups in trials ext2 (U = 10.5, P = 0.02) and ext3 (U = 7, P = 0.007) but not in ext1 (U = 15, P = 0.08). Specifically, AAI dogs picked up significantly more bones than PD in ext2 (mean ± SD: AAI = 5.8 (±3.56), PD = 1.5 (±2.44)) and ext3 (mean ± SD:

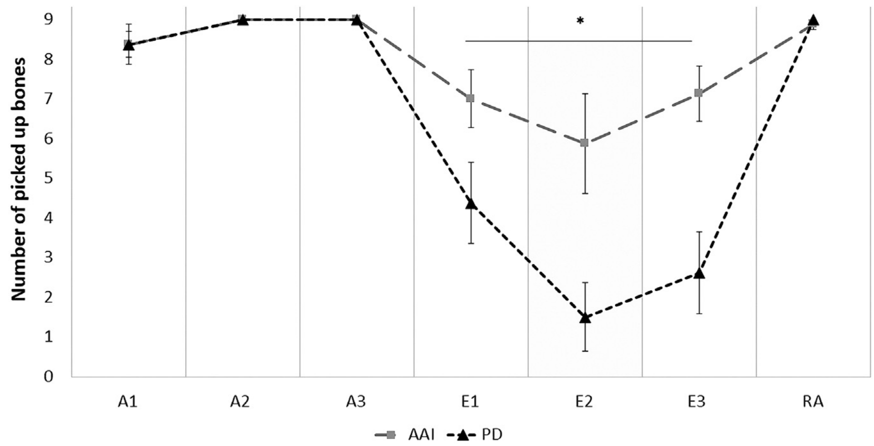

Figure 2. Mean and SEM of the number of removed bones across trials for each group in the problem-solving task. AAI = Animal Assisted Intervention dogs; PD = pet dogs. Lines indicate the different trials (A, acquisition 1, 2, 3; E, extinction 1, 2, 3; RA, reacquisition). * P < 0.05.

Table 3
Mean and SD of the rate of time spent interacting with the apparatus for each group

Group	AC1	AC2	AC3	EXT1	EXT2	EXT3	RA
AAI	0.92 (±0.09)	0.96 (±0.04)	0.98 (±0.02)	0.48 (±0.26)	0.28 (±0.20)	0.37 (±0.21)	0.88 (±0.33)
PD	0.84 (±0.26)	0.94 (±0.10)	0.92 (±0.15)	0.15 (±0.12)	0.05 (±0.06)	0.14 (±0.20)	0.99 (±0.02)

AAI, Animal Assisted Intervention dogs; PD, pet dogs; AC, acquisition, EXT, extinction, RA, reacquisition.
Interaction rates were calculated dividing the time the dog spent interacting with the apparatus by the total time of the trial.

AAI = 7.1 (±1.95), PD = 2.6 (±2.92)), but not in ext1 (mean ± SD: AAI = 7 (±2.07), PD = 4.3 (±2.87)). In addition, there were significant differences between trials ($\chi^2(2) = 6.9$, $P = 0.03$), as dogs picked up fewer bones in ext2 compared with ext1 ($Z = -2.78$, $P = 0.005$), but there were no differences between trial 1 and 3 ($Z = -1.23$, $P = 0.21$) and between trial 2 and 3 ($Z = -1.69$, $P = 0.09$).

During the reacquisition phase, there was no significant differences between groups ($U = 28$, $P = 0.31$).

Time spent interacting with the apparatus

Regarding time spent interacting with apparatus (see Table 3), during the acquisition phase, there was no significant differences between groups ($U < 30$, $P > 0.50$) or trials ($\chi^2(2) = 5.67$, $P = 0.059$).

During the extinction phase, there was a significant difference between groups for each trial (ext1: $U = 6$, $P = 0.006$; ext2: $U = 8$, $P = 0.012$; ext3: $U = 9$, $P = 0.016$), as AAI dogs spent more time interacting with the apparatus than PD in all trials. In addition, there was a significant trial effect ($\chi^2(2) = 10.50$, $P = 0.005$), dogs interacted less with the apparatus in ext2 compared with ext1 ($Z = -3.2$, $P = 0.001$) and ext3 ($Z = -2.17$, $P = 0.03$), no differences were found between ext1 and ext3 ($Z = -1.13$, $P = 0.25$).

During the reacquisition phase there was no significant group differences ($U = 32$, $P = 1$).

Dogs' demographic information

Dogs' demographic information was extracted from the questionnaires filled by the owners. Age, sex, and breed are detailed in Table 1.

Regarding their training levels, dogs in the AAI group could be divided into trained (N = 7) and untrained (N = 6). Conversely, none of the dogs in the PD group were trained (N = 13).

Dogs in the AAI group weekly visited different kind of facilities such as hospitals (specifically psychiatry and physical rehabilitation units) and participated in special education groups and psychotherapeutic private practice with their owners. They all interacted with unfamiliar people, mostly adults, but also children in some cases. The activities carried out during the visits included a wide array of interactions, from complex and active (performing tricks, training, agility-like circuits) to simple and passive (cuddling, being petted).

Discussion

The aim of this study was to compare the performance of AAI and PD which do not participate in such work, using a battery comprising three tasks. Two of them were social (gazing and object choice) and one was nonsocial (problem-solving). We focused on dogs' persistence when a learned response was no longer reinforced. It was predicted that AAI dogs would be more persistent than PD dogs on social tasks, while no predictions were made for the nonsocial one.

Regarding the gazing test, contrary to our predictions and previous results (Cavalli et al., 2018), no significant main effects of group were observed, as this was similar for both AAI and PD. However, PD significantly decreased the time spent gazing at the experimenter during the extinction phase, gazing less as trials went on. This difference was not observed in AAI dogs, which indicates they took longer to extinguish their gazing behavior and suggests an increased level of persistence in this population. A higher number of extinction trials may have been needed for main group effects to be observed.

One possible explanation for the lack of main differences between groups on gaze duration, may be the disparity in training levels within the AAI group (about half the sample was trained and the other half was not). When taking this into account, a marginal effect was found on the extinction phase ($F(1,11) = 4.26$, $P = 0.063$). Specifically, untrained AAI dogs gazed longer than their trained counterparts during this phase (untrained dogs = ext1: 86.74 ± 18, 26, ext2: 78.70 ± 26.48, ext3: 77.81 ± 28.08; trained dogs = ext1: 60.65 ± 29.72, ext2: 44.86 ± 31.71, ext3: 50.11 ± 28.99). This may account for the difference with our previous study (Cavalli et al., 2018), as the AAI dogs included in that sample were not trained. Moreover, no PD were trained. It must be taken into account that the difference between AAI and PD was meant to be in their differential exposure to people and not due to specific training, as not all AAI dogs were trained. Past training experiences have been suggested to influence dogs' communicative behaviors toward people, including gazing (e.g., Marshall-Pescini et al., 2009; Mongillo et al., 2017). Furthermore, this effect appears to be highly dependent on the type of training the animal received, instead of comprising a generic "training effect" that modulates gazing behavior in an unspecific way across dogs (Mongillo et al., 2017). Taking this into account, it would be of interest to assess highly trained dogs that do not participate in AAI on the gazing test, to disentangle the effects of training and experience (i.e., higher exposure to people during their lives) on this task.

However, a difference between AAI and PD was found regarding their persistence levels during the extinction phase. In particular, PD decreased their gazing as trials went on and AAI dogs did not. This is in line with what would be expected for AAI dogs, as the clients may not always respond properly to their communication attempts and they may need to persist in behaviors such as gazing during their working sessions (Cavalli et al., 2018). This becomes particularly relevant, as partial reinforcement schedules are known to increase the persistence of learned responses (Amsel, 1962).

Finally, significant effects of phase were found, indicating that dogs gazed longer during the extinction phase than in the acquisition one. This was expected, as instrumental responses briefly increase when they are not rewarded any more (Domjan, 2014). However, it is also possible that dogs gazed less during the acquisition phase because they spent relatively more time eating the rewards and thus had less time to gaze at the human face.

Regarding the object choice task, no differences between AAI and PD were found during the acquisition phase, as both groups exhibited a good performance indicated by the high number of correct choices. During the extinction phase, only 36% (n = 4) of dogs in the AAI group reached the extinction criterion defined by four consecutive no choices, whereas 66% (n = 8) of PD did so. However, this difference was not statistically significant, which could have been due to the sample size. Likewise, no differences between AAI and PD were found on the number of trials needed to reach criterion or on the rate of no choices.

It must be noted that this task was relatively easy and dogs from both groups may have continued to respond although they were not being reinforced anymore. Previous studies using object choice tasks observed that dogs may prefer to follow social cues to guide their choices, even when they prove to be incorrect. For instance, Szetei et al. (2003) found that dogs efficiently used both olfactory and visual cues to choose a baited bowl when no person was present, but if there was a person pointing to a bowl, they tended to pick that one even if they knew that it was empty. In another study, Elgier et al. (2009) trained dogs to follow a nonsocial cue (i.e., color of the bowl) to choose a baited recipient. However, when it was presented simultaneously with a social cue (proximal pointing), their performance did not differ from chance levels (i.e., they did not follow the previously trained color cue). The authors carried out a second study with an unusual and less salient social cue (elbow pointing) and found that dogs showed a significant preference for the color cue in that case. They concluded that proximal pointing may be a signal too salient for dogs and thus interfere with their performance. Dogs' preference for following proximal pointing may depend, at least in part, on its repeated association of the human hand with different reinforcers across their life experience. Furthermore, Pongrácz et al. (2013) found that dogs followed pointing cues even when the reward was of minimal value, and the nonindicated bowl contained a high-value alternative. They also continued to respond when they were downshifted from a preferred food to a nonpreferred one. The authors suggest that following human signals may have overridden the effects of incentive changes and highlight that social interaction may play a larger role in dog behavior during tasks such as this one. Taken together these findings suggest that dogs may be inclined to follow pointing cues even when they get no reward, which could have led to a ceiling effect that masked differences between the AAI and PD groups in the present study.

Finally, significant differences between AAI and PD dogs were found on the problem-solving task, as PD dogs picked up less bones and spent less time interacting with the apparatus once it was empty (i.e., they were not reinforced anymore) compared with AAI ones. Unexpected shifts in the reward (including its omission) are known to elicit a reduction in operant behavior (Flaherty, 1996) as well as aversive emotional state known as frustration (Amsel, 1992). One possible explanation is that AAI dogs may be more resistant to frustration effects, as they are used to completing tasks in which they are not immediately reinforced. Likewise, Barrera et al. (2015) concluded that PD may have had a longer partial reinforcement history during their daily life than shelter dogs, leading to a higher persistence during the extinction phase. It would be expected for this effect to be even more pronounced in AAI dogs, giving them an advantage during certain tasks in which they may need to perform long or complex behaviors without immediate reward.

Another possible explanation is that AAI dogs are not only exposed to an increased number of people during their work, but also to complex environments rich in sights, sounds and smells than PD do not often experience. Therefore, they may experience situations such as visiting novel places, interacting with different objects and riding cars more frequently than PD do.

Some authors suggest that the richness of the environment itself may influence behavior such as persistence and enhance learning during cognitive tasks (e.g, Burman et al. 2008; Riemer, 2018; Rosenzweig & Bennett, 1996). Taking this into account, AAI dogs may be more resistant to frustration effects as they are exposed to a highly enriched environment through their work. However, this interpretation must be taken with caution, as other studies revealed that animals living in enriched environments were faster to extinguish learned responses (e.g., Gauthier et al., 2017; Stairs, Klein & Bardo, 2006).

Regarding the acquisition and reacquisition trials, no group differences were found as most dogs picked up all the available bones during these trials. Therefore, a ceiling effect of the task made it impossible to assess group differences on these phases.

In line with this, it is interesting to note that in this case, the task was of a nonsocial nature as there was no direct interaction with the experimenter, and predictions regarding the dogs' performance had been unclear. During social tasks (such as gazing or object choice), one explanation for the lack of differences between groups is that the mere presence of the experimenter may act as a source of reinforcement as animals continue to respond despite not receiving any food. Conversely, there was no social reinforcement in this case, which may have helped to observe clearer group differences during the extinction phase.

One point that must be highlighted when studying working dog populations is that the animals may have been selected for that type of work based on certain pre-existing characteristics which could have influenced their performance on the tests, regardless of their work experience or training regimen (e.g., Bray et al., 2017). Unfortunately, it was not possible to obtain a baseline measure of these dogs' abilities before they started working.

Another limitation of this study is the heterogeneity of the activities carried out by the AAI dogs. They worked in various settings (hospitals, special education groups, and private psychotherapeutic practice) and also did different activities during their visits according to their owner's descriptions of a typical workday. For instance, some were expected to complete complex tasks (showing off tricks, being trained by the client, participating in agility-like circuits), whereas others were expected to lie down, be petted, or cuddle. Different activities may entail different requirements in the sociocognitive abilities of the participating dogs and thus affect their results on the tasks evaluated in this study. Given the size of the available sample and the fact that some varied their type of activities according to the client's health and mood, it was not possible to properly analyze this variable. Future research would benefit from comparing different populations of AAI dogs.

All in all, these results indicate that a higher exposure to people during the life of a dog, such as it occurs in those participating in AAI, may influence their behavior during some cognitive tasks. Moreover, the partial reinforcement that may occur during AAI sessions may also modulate their responses. However, the nature of the task and factors such as the interaction with an experimenter and their level of training appear to play a significant role in their performance.

An increased level of persistence may be relevant during some aspects of their work, as they may need to complete assignments without accessing to immediate reinforcement. A deeper knowledge of the characteristics of these dogs is vital to broaden our understanding of this population, as well as facilitate their training and selection. This is of particular relevance, taking into account the benefits attributed to AAIs and the positive effect these animals can have on people's lives (e.g., Friedmann et al., 2015).

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Ethical considerations

This study complies with the current Argentinean law of animal protection (Law 14.346) and was developed with the approval of the CICUAL (Institutional Commission for the Care and Use of Laboratory Animals) from the Medical Research Institute IDIM CONICET (Res. Nro. N 081-18). All owners expressed their consent for the participation of their dogs in this study.

Conflict of interest

The authors declare no conflict of interest.

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