DEMONSTRATING OPERANT CONTROL OF GAZING BEHAVIOR IN DOMESTIC DOGS (*CANIS LUPUS FAMILIARIS*) AND GRAY WOLVES (*CANIS LUPUS LUPUS*)

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
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To all who nurtured my intellectual curiosity, academic interests, and sense of scholarship throughout my lifetime, especially my family

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It has been argued that over domestication, dogs developed a genetic predisposition to gaze at a human's face, forming a complex communication system between dogs and humans that exists independently from individual histories. However, Bentosela et al. (2008) demonstrated that gazing behavior in dogs can be increased or decreased by manipulating reinforcement schedules, presenting evidence that the high occurrence of dogs gazing at their owners may result from operant conditioning. The current experiment demonstrates operant control of gazing using differential reinforcement in dogs and wolves. Gazing at targets was reinforced with food and subsequently extinguished and re-established using a reversal design. Dog subjects were placed in one of three conditions where the target was i) the person delivering reinforcement, ii) a person other than the one providing reinforcement, and iii) an inanimate object. Wolf subjects were placed in one of the latter two conditions. The amount of gazing at each target by dog and wolf subjects increased during acquisition, decreased during extinction, and increased again during re-acquisition. The object condition shows that individuals will gaze at any target when that behavior has been followed by food, decreasing the likelihood that a complex communication system

developed between dogs and humans. The demonstrated operant control of the gazing behavior of dogs and wolves suggests that a specially evolved ability is unnecessary to account for dogs' gazing behavior. These experiments encourage the consideration of a more parsimonious explanation for gazing behavior, particularly ontogenetic learning processes.

CHAPTER 1
EXPERIMENT 1: OPERANT CONTROL OF GAZING IN DOGS

Introduction

The last decade has seen a dramatic rise in scientific interest in dog (*Canis lupus familiaris*) behavior, particularly in their interactions with humans (for a review of recent work see Udell & Wynne, 2008; for an historical review see Feuerbacher & Wynne, 2011). Dogs' almost uncanny ability to follow human pointing gestures in an object choice task has led to several hypotheses regarding the effects of domestication, including arguments for an understanding of human actions independent of exposure to humans (Riedel, Schumann, Kaminski, Call, & Tomasello, 2008). Some studies (Hare, Brown, Williamson, & Tomasello, 2002; Miklosi et al., 2003) suggested that dogs are more successful than wolves (*Canis lupus lupus*) at following the difficult momentary distal point, in which the distance between the pointing hand and the object pointed to exceeds 50 cm and the cue is removed before the individual makes a choice (though for more recent evidence to the contrary, see Udell, Dorey, & Wynne, 2008). Viranyi et al. (2008) suggested that the success of dogs in following human momentary distal points is due to their tendency to establish and maintain eye contact readily with humans, giving them a better chance to observe the signal before it is removed. Some researchers (e.g., Gasci et al., 2005, Miklosi et al., 2003) have argued further that this difference in gazing patterns between dogs and wolves formed during the phylogenetic process of domestication. They claim that dogs developed a genetic predisposition to gaze at a human's face independent of their individual histories, creating a complex communication system between dogs and humans. They also assert that wolves, dogs' undomesticated ancestor, lack the ability to look at a human's face and that this behavior cannot be achieved in wolves even after intensive socialization with humans (Miklosi et al., 2003).

In contrast, Bentosela, Barrera, Jakovcevic, Elgier, and Mustaca (2008) have demonstrated that gazing behavior in dogs can be increased or decreased by manipulating reinforcement schedules, presenting empirical evidence that the high occurrence of dogs gazing at their owners may result simply from operant conditioning. During the Acquisition phase, the experimenter delivered a treat to the dog immediately following each gaze toward her face, resulting in an increase in the duration of gazing over three sessions. In the Extinction/Omission phase, treats were either withheld or delivered immediately following gazes away from the experimenter's face, both of which resulted in a decrease in gazing at the experimenter. The speed at which the dogs' gazing behavior changed and the ease with which it could be controlled and manipulated suggest that environmental influences may have more profound effects on this social behavior than previously believed.

The present study replicates and extends that of Bentosela et al. (2008) by adding two further conditions. In one, we control for the subject inadvertently gazing at the human as an unintended consequence of orienting toward the source of food. In the second new condition, we remove the human face altogether by making the target of gazes an inanimate object. This condition will test whether individuals will gaze at an arbitrary target to which gazing has previously resulted in reinforcement, thus reducing the likelihood that gazing has a unique role as part of a complex communication system between dogs and humans. Furthermore, if wolves are able to rapidly learn to gaze at humans, this would suggest that gazing is not a specially evolved ability resulting from domestication. While these experiments would not completely rule out the possibility of a genetic predisposition, they would advocate that the more parsimonious explanation of ontogenetic learning processes accounting for the emission of gazing behavior must also be considered.

Methods

Subjects

Twenty-four pet domestic dogs (Canis lupus familiaris) living in their present owner's home for at least four months were tested at a dog daycare center in Orlando, FL. Dogs varied by breed, size, and age, but were all at least one year old (Table 1-1). Only dogs reported to be in good health were used.

Procedures

Each subject was tested individually and off-leash in an indoor room (8 m by 8 m) at the dog daycare center, which allowed some auditory and olfactory access to other dogs and people outside of the room. Each session began with an approximately five-minute habituation phase to allow the dog to investigate the room and become comfortable with the experimenter. Up to ten pieces of high-quality dog treats were delivered non-contingent on any behavior to assess the dog's motivation to participate in the experiment. A dog was considered motivated if it approached and readily consumed the treat from the hand of the experimenter, as well as following the treat with its eyes as the experimenter picked up each piece from the container. Pieces of Pet Botanics pork or chicken or Pup-Peroni beef treats (approximately 0.3 g each) were used as reinforcers depending on any food allergies reported by the owner, but only one type of treat was used per dog.

A video camera mounted on a tripod recorded the entire experiment. Experimenter 1 looked at the dog and live-coded the onset and offset of its gazes toward the target using J-Watcher software on a laptop computer. Experimenter 1 also delivered reinforcers when appropriate for all conditions.

Phases

All subjects, regardless of condition, experienced the same series of phases. This included Baseline, Acquisition, Test, Extinction, and Re-Acquisition. The inter-session interval between every session and phase was between 15 - 30 seconds. The number and duration of sessions, reinforcement schedules, and interval times were derived from pilot trials.

Baseline*.* Baseline involved one two-minute session of non-contingent reinforcement. The subjects' gazes toward the target were recorded but not marked to the subject. Experimenter 1 delivered one treat on a Variable Time schedule of 15 seconds, meaning that a treat was delivered to the dog on average every 15 seconds. A delay of at least 1.5 seconds was inserted following a gaze at the target before treat delivery to avoid adventitious reinforcement of gazing.

Acquisition*.* All subjects received five two-minute sessions of Acquisition. Each session consisted of Experimenter 1 delivering reinforcement on a Fixed Ratio 1 schedule immediately following the onset of a gaze toward the target. This means that a treat was delivered to the dog every time it gazed at the target.

Test*.* Test consisted of one two-minute session identical to Baseline. This session was included for comparison to Baseline to determine any changes in gazing following Acquisition.

Extinction*.* Gazes toward the target were recorded but no indication was made to the subject, and no reinforcers were delivered. Each subject received up to five two-minute extinction sessions. However, if the subject did not emit a single gaze toward the target during a session, Extinction was terminated and Re-Acquisition began.

Re-Acquisition*.* Each subject experienced a minimum of two and maximum of five two-minute Re-Acquisition sessions. Re-Acquisition only continued until it was demonstrated that the response had been re-acquired (i.e. response rates were similar to responding before Extinction). The circumstances of Re-Acquisition were identical to those of Acquisition.

Conditions

Three different conditions were included, with each dog only experiencing one condition. There were eight dogs in each condition.

Feeding Person*.* The first condition involved Experimenter 1 calling the subject's name once at the beginning of each session. The face of Experimenter 1 was the target of the subject's gazes.

Other Person*.* In "Other Person," a second person (Experimenter 2) was present standing 1 meter away from Experimenter 1. Experimenter 2 called the dog's name once at the beginning of each session, and Experimenter 2's face was the target of gazes. Experimenter 2 was instructed to look at the dog but otherwise avoid interacting with it throughout the experiment except for calling its name at the beginning.

Object*.* In "Object," an inanimate stuffed animal toy was located inside a crate on the floor so that it was visible to the dog, but it could not access the toy. The stuffed animal was a tan-colored bear approximately 50 cm high and was the target of gazes in this condition. The dog's name was recorded by Experimenter 1 with an audio device prior to the start of the experiment and was placed behind the object before each session. This allowed for the dog's name to be called once at the start of each session, coming from the direction of the object. There was a five second delay between the time the device was placed by the object and the name being called.

Inter-Observer Agreement

The data live-coded during the experiments were compared to those coded from the video recording by one of two trained independent observers. The coders were instructed to code the onset and offset of gazes at the target, the delivery of reinforcers, and any time the subject moved off-screen and returned to view. If the subject moved off-screen during a session, that portion was excluded from the calculations. Twenty percent of the total videos were coded for inter-observer agreement (IOA). Reliability was calculated by dividing the difference of the two scores by the smaller value, with a criterion of < .20 or by an absolute measure of no more than one unit difference (number of gazes for Acquisition and Re-Acquisition sessions and seconds [s] for Baseline, Test, and Extinction sessions). Satisfying either criterion was considered a hit. The IOA percentages were calculated by dividing the number of hits by the total number of sessions coded by the independent observer for each condition. The reliability was 95.7% for Feeding Person, 84.0% for Other Person, and 81.8% for Object.

Statistical Analysis

The frequency of gazing during each two-minute session was analyzed. Additionally, duration of gazing was analyzed for Baseline, Test, and Extinction sessions because frequency alone does not account for the variability in length of individual gazes. For example, a single gaze could last a fraction of a second or 30 seconds. Duration was not analyzed for Acquisition or Re-Acquisition sessions because the immediate presentation of reinforcement interrupted and truncated each gaze, artificially limiting the duration.

We tested whether reinforcement increased the duration of gazing and whether the effect was the same across conditions by conducting a two-way ANOVA with within subjects factor Session (Baseline vs. Test) and between subjects factor Condition (Feeding person; Other person; Object). Furthermore, we ran a two-way ANOVA to assess changes in gaze frequency across the acquisition and extinction sessions with respect to the Condition (Feeding Person; Other Person; Object). Then we conducted a two-way ANOVA with repeated measures to assess if the gaze durations in Extinction decreased. We also assessed re-acquisition of the gazing response following extinction by comparing the frequency of gazing between Acquisition 1 and Re-acquisition 1 with respect to the Condition (Feeding person; Other person; Object).

When necessary follow up tests to ANOVAs were calculated using Tukey's HSD post hoc test. The degrees of freedom for within-subjects comparisons were adjusted for deviance from sphericity (Greenhouse–Geisser) to decrease Type 1 errors. An alpha level of .05 was adopted throughout statistical analyses.

Control Coding

In order to account for the possibility that the presentation of food occasioned gazing in general, gazes toward Experimenter 1's face in the Other Person condition were coded from video. Similar trends (i.e. an increase in gazing during acquisition and a decrease in gazing during extinction) between the Other Person condition and the Control Coding would suggest that the mere presentation of food was responsible for changes in gazing rather than the schedule of reinforcement for gazing at a particular target. If these trends do not occur, this would strengthen the evidence for the argument that the schedule of reinforcement is the controlling factor. Because the camera position was not intended to capture gazing toward Experimenter 1 in this condition, only video from five subjects could be coded in this way. Inter-observer agreement was also obtained for 20% of these videos.

Results

Figure 1-1 shows the durations of gazing at the target for individual dogs across Baseline and Test sessions for Feeding Person, Other Person, and Object conditions. Overall, the dogs in all three groups increased the duration of gazing from Baseline to Test. Also, dogs in the Feeding Person condition appeared to gaze at their respective target longer than dogs in the Object condition.The two-way ANOVA of gaze durations from baseline to the test sessions confirmed a significant main effect of Session, $F(1, 21) = 52.33$, $p < .001$, and a main effect of Condition, $F(2, 21) = 13.86$, $p < .001$. However, there was no interaction between the factors, $F(2, 21) = 3.27$, $p > .05$. Post hoc tests revealed that the only significant differences in Conditions lay between Feeding Person and Object (Tukey's HSD, $Q = 7.44$, $p < .01$).

In all three conditions, the subjects increased the number of gazes across the five Acquisition sessions (Figure 1-2). A two-way ANOVA confirmed the effects of Session, $F(2.13, 44.82) = 20.22$, $p < .001$ with Greenhouse-Geisser adjustment, and Condition, $F(2, 21) = 19.80$, $p < .001$. However, there was no interaction between the factors, $F(4.27, 44.82) = 1.68$, $p > .05$ with Greenhouse-Geisser adjustment. A test for an increasing linear trend across Sessions in the Acquisition phase revealed significant effects for Feeding Person, $t(7) = 2.79$, $p < .05$, Other Person, $t(7) = 4.49$, $p < .01$, and Object, $t(7) = 2.52$, $p < .05$.

Duration of gazing decreased during the Extinction phase for subjects in all three conditions, particularly in Feeding Person and Other Person (Figure 1-3). A two-way ANOVA with within subjects factor Session (Extinction 1-5) and between subjects factor Condition (Feeding Person; Other Person; Object) was conducted. Zeroes were used for sessions that were not conducted because the subject met the criterion of no gazes during a full session (two subjects, two sessions each). There were significant main effects of Session, $F(2.85, 59.82) = 6.64$, $p = .001$ with Greenhouse-Geisser adjustment, and Condition, $F(2, 21) = 12.43$, $p < .001$. However, there was no interaction between the factors, $F(5.7, 59.82) = 1.31$, $p > .05$ with Greenhouse-Geisser adjustment. A test for a decreasing linear trend across Sessions in the Extinction phase revealed significant effects for Feeding Person , $t(7) = -2.78$, $p < .05$, and Other Person, $t(7) = -2.53$, $p < .05$. However, there was no significant linear trend for Object, $t(7) = -1.64$, $p > .05$.

Overall, gazing in all conditions was re-acquired following the Extinction phase as demonstrated by the increase in frequency of gazing from Acquisition 1 to Re-acquisition 1 (Figure 1-2). The two-way ANOVA with within subjects factor Session (Acquisition 1 vs. Re-acquisition 1) and between subjects factor Condition (Feeding person; Other person; Object)confirmed significant main effects of Session, $F(1, 21) = 28.18$, $p < .001$, and Condition, $F(2, 21) = 9.66$, $p = .001$. There was no interaction between the factors, $F(2, 21) = 1.51$, $p > .05$.

Control Coding Results. Figure 1-4 displays the duration of gazing toward Experimenter 1during the Other Person condition. A visual analysis reveals that there was not an increase in gazing during Acquisition, rather, there was a decrease. If the presence of food occasioned gazing in general by causing an increase in all activity, then high rates of gazing toward Experimenter 1 would have maintained. Additionally, there was an increase of gazing activity during Extinction, when no food was presented. This further illustrates that the occurrence of gazing was not merely controlled by the presentation of food.

Discussion

This experiment was designed to demonstrate that manipulating reinforcement could impact the gazing behavior of dogs. As hypothesized, the results show that the duration of gazing toward targets increased for subjects in all three conditions from Baseline to the Test session as a consequence of the intervening Acquisition phase. The rate of gazing also increased during Acquisition. When reinforcement was removed in the Extinction phase, the duration of gazing decreased. Finally, the reintroduction of the reinforcement schedule in the Re-acquisition phase resulted in another increase in the rate of gazing.

Differences in gaze durations between the groups highlight some important points. The duration of gazing for subjects in the Feeding Person group was higher than for the Object group in both Baseline and Test sessions. However, because this could be attributed to the dogs simply orienting toward the source of the reinforcers in the Feeding Person condition a comparison of Object and Other Person groups may be more illuminating. At the group level, there was no significant difference between the two conditions, but visual inspection highlights that although durations were generally similar in Baseline, half of the Other Person subjects gazed longer in Test than any of the subjects in the Object group.

The potential difference in gazing durations in Test between Other Person and Object groups may have several possible causes. As argued in Miklosi et al. (2003), there could be an evolved cognitive mechanism in dogs selected for during domestication that increases the likelihood of gazing interactions with humans. Although this is possible, a more parsimonious explanation lies in the conditioning experiences of each individual subject throughout its lifetime. Because only ten minutes of explicit reinforcement for gazing can significantly alter the rate and duration of gazing at either a person or an object, it is possible that extensive informal conditioning experience on a daily basis before the experiment could have affected the rate of gazing at a particular target.

Another alternative explanation for these results is that they could be an artifact of the experimental setting. For example, the object was kept inside a crate with the dog on the outside, restricting tactile access and constructing a partial visible barrier to the object. This was done to ensure that the dog could not remove the object and damage it. Other research (Udell, Dorey, & Wynne, 2008) has shown that dog responsiveness to a human cue when viewed through a fence is greatly reduced. Meanwhile, the human in the Other Person condition had no such barrier and could be clearly seen and touched, which may have led to higher rates of gazing. Furthermore, the inanimate object was completely motionless, but the human in the Other Person condition did exhibit some subtle movements, such as breathing and yawning, for example, despite efforts to remain still for long periods of time. These movements may have attracted the subjects' attention and increased the chances of subjects contacting the contingency of reinforcement.

The sample of subjects used in this experiment consisted of pet dogs obtained from a dog daycare facility in the Orlando, Florida area. The generality of these results to other populations may be limited. Past research (Udell, Dorey, & Wynne, 2010) has demonstrated that behavior of dogs living in homes as pets compared to those in shelters can differ significantly during their interactions with humans. In a comparison of the gazing behavior of shelter dogs and pet dogs, Barrera, Mustaca, and Bentosela (2011) observed shorter durations in Extinction for shelter dogs, suggesting that the different living conditions and learning experiences through everyday interactions can contribute to differences in social behavior. Future research could investigate the factors affecting this behavior in animals from other populations.

Another limitation of this study is that breeds were not systematically analyzed for differences due to a limited number of subjects per breed type. Jakovcevic, Elgier, Mustaca, & Bentosela (2010) compared Retrievers, Shepherds, and Poodles using the Bentosela et al. paradigm and discovered no differences in acquisition but a slower rate of extinction in Retrievers. They also found a higher duration of gazing in Retrievers during a baseline assessment with no prior gaze training. The major mechanism behind this breed difference has not yet been identified (i.e. genetic or environmental), so future research could try to tease apart this difference and include the new conditions of the present study.

Furthermore, this particular daycare center provides its dogs with intra-specific socialization and obedience training onsite, which may have also impacted the behavior of the dogs in this setting. For example, if the subjects previously received obedience training using positive reinforcement methods in the testing room, the setting of the room itself could serve as a discriminative stimulus for attending to the human as a source of treats. This may have inflated baseline gazing durations. Likewise, if any subjects experienced aversive training techniques in the testing room, the room itself may illicit avoidance responses, decreasing baseline rates of gazing.

Future research should investigate the rates of reinforcement in interactions between dogs and humans in natural settings. If it could be shown that owners are more likely to deliver reinforcement in the form of treats or attention when their dog is looking at them than when it is not, more evidence for the argument of operant control would be provided. In addition, a functional analysis, a procedure used by applied behavior analysts to determine which stimulus in the environment is maintaining a particular behavior in humans (e.g. Iwata, Dorsey, Slifer, Bauman, & Richman, 1982) or non-human individuals (e.g. Dorey, Rosales-Ruiz, Smith, & Lovelace, 2009), could be conducted. For example, potential conditions to be arranged could include tangible reinforcers (e.g. treats), attention (e.g. verbal or tactile), play, escape from a demand, and an ignore condition.

Future experiments could also study dogs from infancy, manipulating rates of reinforcement for gazing at various targets. This would test the hypothesis that reinforcement histories before the experiment are contributing to the patterns we obtained in our data. If dogs raised without receiving reinforcement for interacting with humans were shown to have reduced gazing toward humans, there would be further evidence that the individual conditioning experiences are the most important factors.

In the current study, the experimenters looked at the subject during the experiment, which may serve as a discriminative stimulus or predictor of reinforcement.

On the other hand, prolonged gaze from the experimenter may be perceived as a threat and elicit avoidance of eye contact or escape behaviors in the subjects, as had been found in humans (Greenbaum & Rosenfeld, 1978, cited in Kleinke, 1986). Future studies could compare the current study’s set-up to one where the experimenter does not look at the dog and avoids eye contact.

Table 1-1. Dog Subject Characteristics

Name	Breed	Age	Sex	Condition
Simone	Australian Shepherd mix	2 yrs	F	Feeding Person
T-Bear	Laborador Retriever	3 yrs	M	Feeding Person
Dixon	Laborador Retriever	2 yrs	M	Feeding Person
Bella	Border Collie	2 yrs	F	Feeding Person
Heidi	Laborador Retriever mix	3 yrs	F	Feeding Person
Datz	German Shepherd	4 yrs	M	Feeding Person
Court	Weimaraner	3 yrs	M	Feeding Person
Linus	Australian Shepherd	5 yrs	M	Feeding Person
Stash	Australian Shepherd	2 yrs	M	Other Person
Maya	Boxer	2 yrs	F	Other Person
Sparkle	Australian Shepherd	4 yrs	F	Other Person
Scamper	Australian Shepherd	4 yrs	M	Other Person
Laila B	Boxer	2 yrs	F	Other Person
Hudson	Laborador Retriever	2 yrs	M	Other Person
Scout	German S.H.Pointer	7 yrs	M	Other Person
Sam	Laborador Retriever mix	3 yrs	M	Other Person
Laila C	Boxer	4 yrs	F	Object
Sage	Hound mix	5 yrs	F	Object
Rainey	German Shepherd mix	2 yrs	F	Object
Bo	Laborador Retriever	5 yrs	M	Object
Belle	Laborador Retriever	3 yrs	F	Object
Sam C	German Shepherd	3 yrs	F	Object

Table 1-1. Continued

Name	Breed	Age	Sex	Condition
Jag	American Bulldog mix	2 yrs	M	Object
Kepa	Pitbull Terrier mix	4 yrs	M	Object

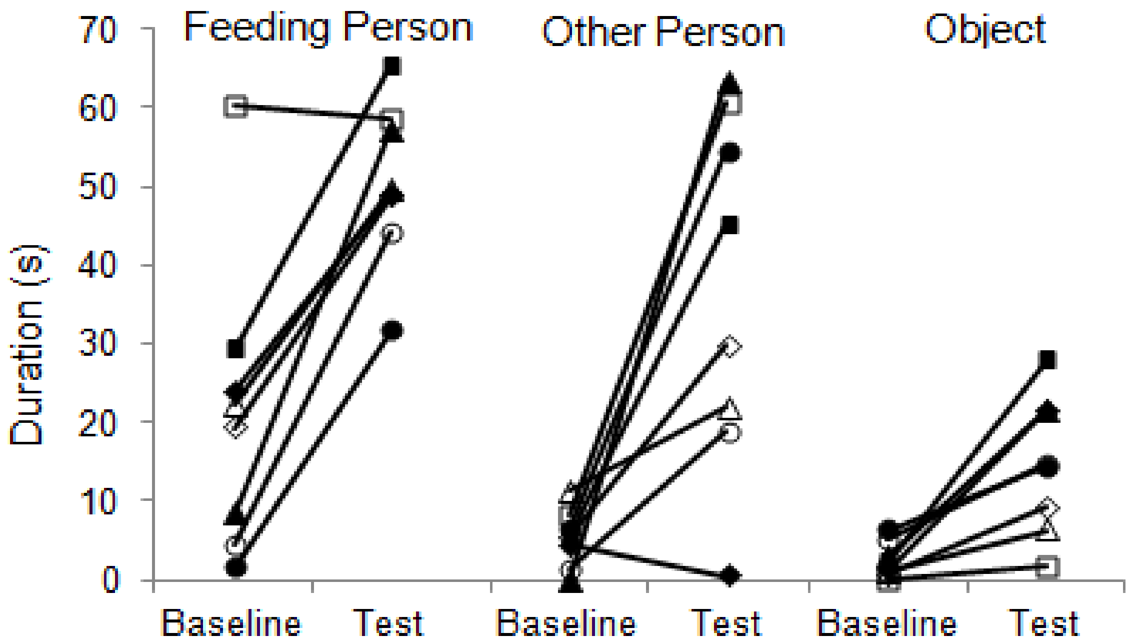

Figure 1-1. Gazing durations for individual dog subjects in Baseline and Test sessions for the Feeding Person, Other Person, and Object conditions.

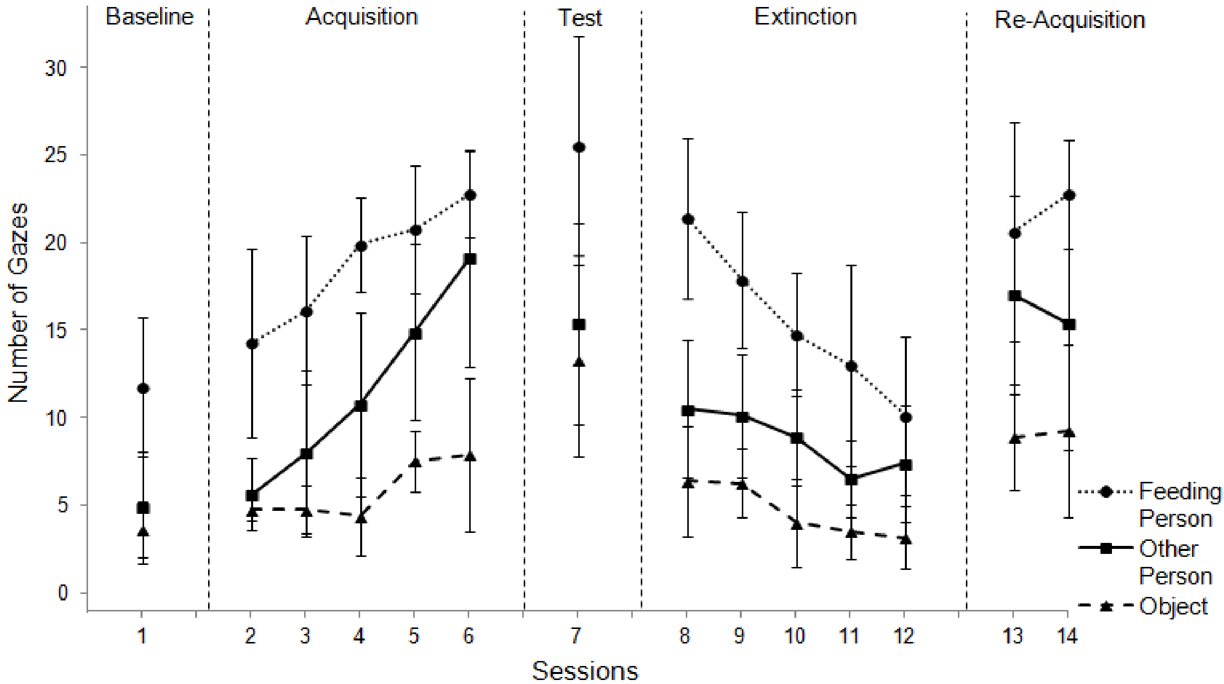

Figure 1-2. Mean number of gazes in each session for dogs in Feeding Person, Other Person, and Object conditions. Error bars indicate 95% Confidence Intervals.

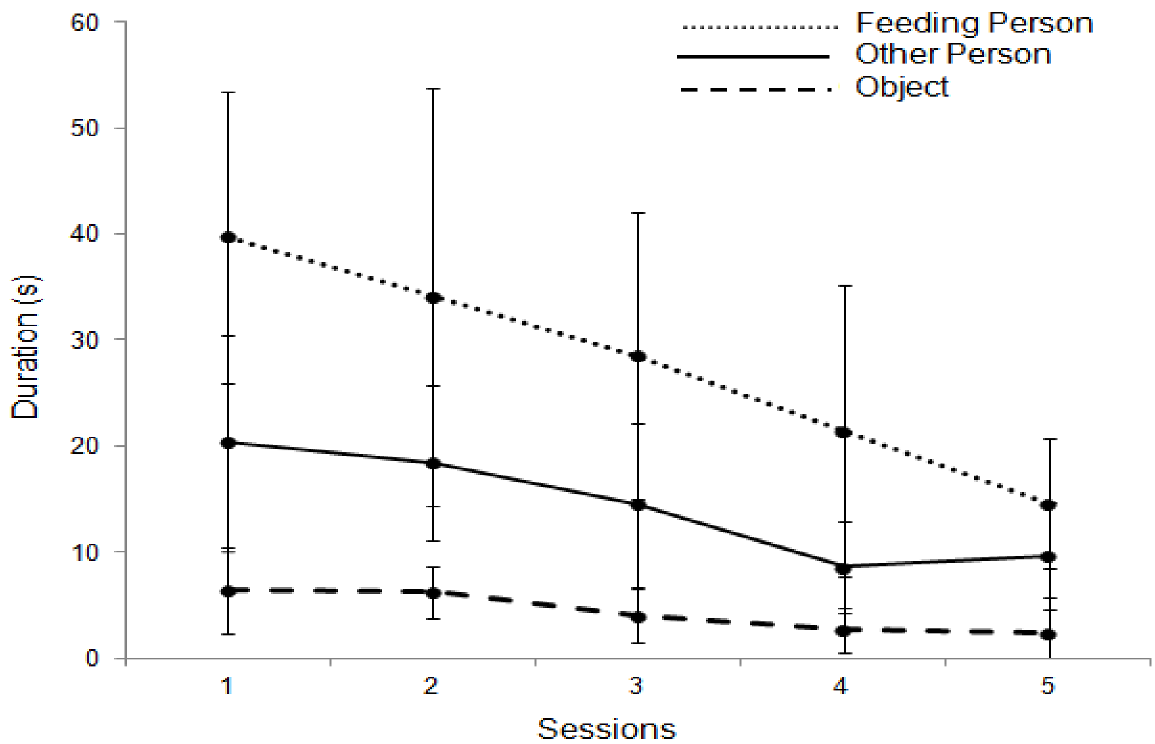

Figure 1-3. Mean durations of gazing during the Extinction phase for dog subjects in the Feeding Person, Other Person, and Object Conditions. Error bars indicate 95% Confidence Intervals.

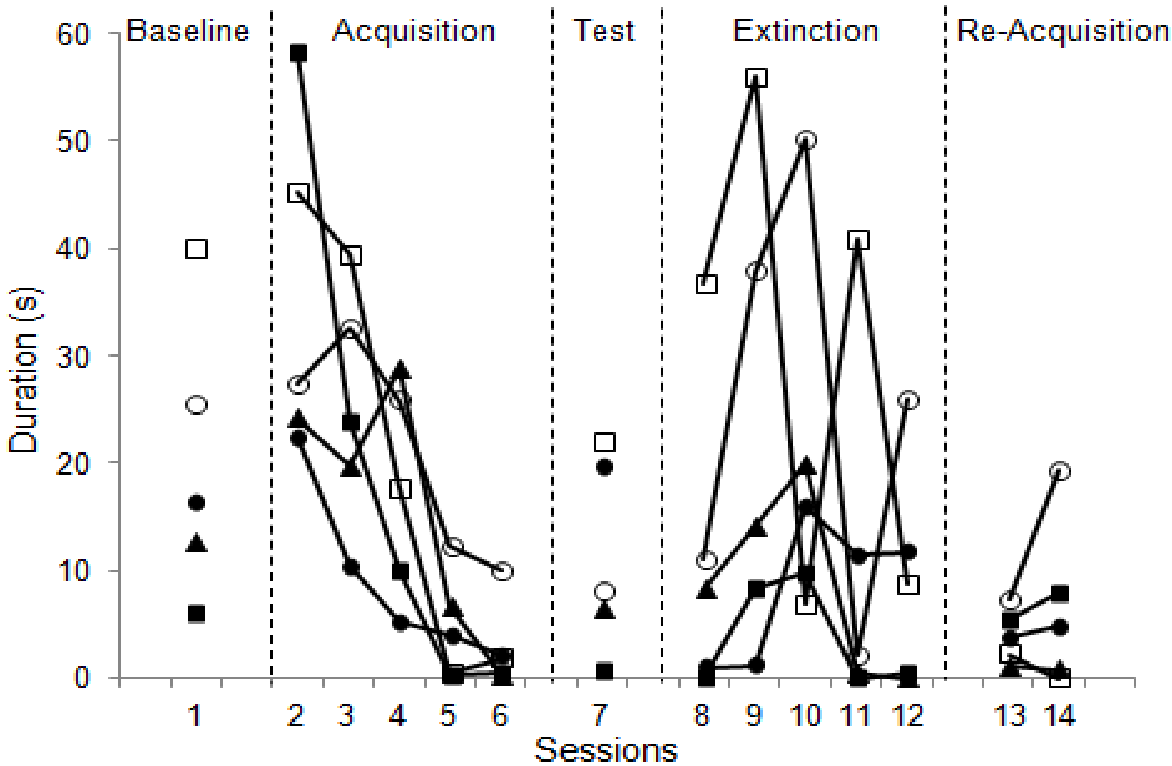

Figure 1-4. Individual subjects' duration of gazing toward Experimenter 1 in each session in Control Coding of Other Person condition.

CHAPTER 2

EXPERIMENT 2: OPERANT CONTROL OF GAZING IN WOLVES

Methods

Subjects

Eight captive wolves (*C l lupus*) were studied at Wolf Park, Battle Ground, IN. They ranged in age from 11 months to 12 years at the time of data collection (Table 2), and were hand-reared from 10-14 days of age and extensively socialized by experienced human caretakers using the methods described in Klinghammer & Goodman (1987). All subjects had varying amounts of experience with unrelated behavioral tests.

Procedures

Only Other Person and Object conditions were tested with wolves due to the limited number of available subjects. “Feeding Person” condition was excluded because “Other Person” was an improvement on the former by controlling for the subjects’ orienting toward the source of reinforcement. Also, seven of the eight wolf subjects had some pilot experimental experience with a paradigm similar to the “Feeding Person” condition a year prior to data collection.

The procedures were as identical as possible to those used with the dogs with exceptions due to the practicalities of the facilities and necessary safety precautions. Tests were conducted outdoors in physical isolation from other wolves but with visual, auditory, and olfactory access to the other wolves and people at the park. For five subjects, the experiment was conducted in a holding pen adjacent to the wolves’ resident enclosure, which consisted of a long, narrow space measuring 3 m wide and 10 m long. For the other three subjects, the experiment took place in their individual resident enclosures measuring approximately 15 m by 15 m where they were housed alone. The individuals acting as Experimenter 1 and 2 were familiar to the wolves and stood inside the testing enclosure against a fence, while the first author remained outside the enclosure and live-coded responses. Two video cameras mounted on tripods outside the enclosure were used for recording the experiment. Pieces of summer sausage (about 0.5 g each) were used as the reinforcers, and they were contained out of sight within Experimenter 1's pockets.

In the "Object" condition, a second familiar individual stood at least 10 meters away from Experimenter 1 but inside the testing enclosure in case of an emergency situation and did not interact with the subject during the experiment. The stuffed animal used in the "Object" condition was located on the ground outside the enclosure, approximately 15 cm from the fence.

Inter-Observer Agreement

As in the previous experiment, 20% of the videos were coded by an independent observer to calculate inter-observer agreement. The reliability was 100% for Other Person and 87.5% for Object.

Statistical Analysis

We performed the same tests that were used to analyze the dog data from Experiment 1.

Results

Figure 2-1 shows the gazing durations for individual wolf subjects in Baseline and Test sessions for Other Person and Object conditions. The gazing durations increased from Baseline to Test for both groups, and the data for three of the four wolves in Object condition appear similar to the data for the wolves in Other Person. A two-way ANOVA with repeated measures on factor Session (Baseline vs. Test) and between subjects factor Condition (Other person vs. Object) confirmed a significant main effect of session, $F(1, 6) = 40.70$, $p < .001$. There was no significant effect of condition, $F(1, 6) = 4.03$, $p > .05$, nor any interaction between the factors, $F(1, 6) = 0.81$, $p > .05$.

The frequency of gazing increased during the Acquisition phase for subjects in both conditions (Figure 2-2). A two-way ANOVA with within subjects factor Session (Acquisition 1-5) and between subjects factor Condition (Other Person vs. Object) confirmed significant main effects of Session, $F(3.28, 19.67) = 8.35$, $p = .001$ with Greenhouse-Geisser adjustment, and Condition, $F(1, 6) = 12.51$, $p < .05$. However, there was no interaction between the factors, $F(3.28, 19.67) = 0.54$, $p > .05$ with Greenhouse-Geisser adjustment. A test for linear trend across Sessions in the Acquisition phase revealed significant effects for Other Person, $t(3) = 3.56$, $p < .05$, and Object, $t(3) = 3.70$, $p < .05$.

The duration of gazing decreased during the Extinction phase for subjects in the Object condition. The subjects in Other Person decreased their duration of gazing across the first four sessions but showed a small increase in Extinction 5, although the mean of the final session remained below that of the first session of Extinction (Figure 2-3). A two-way ANOVA with within subjects factor Session (Extinction 1-5) and between subjects factor Condition (Other Person vs. Object) was conducted to assess changes in gazing duration during the Extinction phase. There was a significant main effect of Session, $F(2.13, 12.77) = 15.47$, $p < .001$ with Greenhouse-Geisser adjustment. However, there was no effect of Condition, $F(1, 6) = 2.66$, $p > .05$. There was an interaction between the factors, $F(2.13, 12.77) = 4.15$, $p < .05$ with Greenhouse-

Geisser adjustment. A test for trend across Sessions in the Extinction phase revealed significant effects for linear trend in Object, $t(3) = -4.31$, $p < .05$, and a significant cubic trend for Other Person, $t(3) = 6.72$, $p < .01$.

Following Extinction, gazing was re-acquired during the Re-acquisition phase for subjects in both conditions (Figure 2-2). A two-way ANOVA with within subjects factor Session (Acquisition 1 vs. Re-acquisition 1) and between subjects factor Condition (Other person vs. Object) confirmed significant main effects of Session, $F(1, 6) = 10.64$, $p < .05$, and Condition, $F(1, 6) = 53.59$, $p < .001$. There was no interaction between the factors, $F(1, 6) = 5.43$, $p > .05$.

Discussion

Similar to the results in Experiment 1, the gazing durations and frequencies for the wolf subjects increased and decreased in the appropriate phases as predicted. Acquisition and Re-acquisition showed an effect of condition, with the frequency of gazing in Object condition remaining higher than that of Other Person condition. The individual data are shown for the Baseline-Test comparison to demonstrate that the durations of gazing were similar among the subjects in both conditions except for one individual wolf in Object condition, who gazed considerably longer than the other subjects in either condition.

The apparently higher rate of gazing for the Object group is clearly caused by the elevated level of one subject, highlighting the problem with analyzing group averages using small numbers of subjects. In spite of this, there was consistency in the data in terms of the trend followed by all subjects across sessions, suggesting tight experimental control. Furthermore, because each individual subject served as its own control in a reversal design (i.e. Acquisition, Extinction, Re-Acquisition), the data could be visually analyzed for individual subjects in addition to statistical analysis by group. Regardless, the generality of these results can only be established via replication with more subjects.

Another limitation of this study is that some of the changes to the experimental set-up due to the nature of working with wolves versus dogs prevent a fair direct comparison between the two canid types. For example, the wolves may have had more environmental distractions during the experiment than the dogs because they were tested outdoors, with birds flying overhead, other wolves in sight, extra humans present, and occasional bouts of howling by all animals in the park. This being said, both canid types were tested in settings to which they were more accustomed, so testing the dogs outdoors in an attempt to equalize the distraction factor would have put them at an unfair advantage since they typically spend more time indoors.

General Discussion

Every interaction an individual has with its environment has the potential to reinforce or punish some behavior (Skinner, 1953). If a dog looks at a human and subsequently receives reinforcement in the form of a treat, a scratch behind the ears, or verbal attention (which previously could have been paired with a primary reinforcer such as treats), then the dog will be more likely to look at the human again in the future. Because pet dogs experience extensive interactions with humans starting at birth, they are likely to have a long history of reinforcement for paying attention to humans throughout their lives. At the same time, dogs could have a weaker history of reinforcement for looking at an inanimate object if reinforcement seldom follows this behavior. Even though the wolves used in this study are socialized to humans, their individual experiences undoubtedly differ from those of pet dogs, resulting in potentially different gazing patterns.

In 2005, Gasci et al. conducted a test similar to the current experiment on wolf and dog pups at five and nine weeks of age, where a plate of meat was placed in sight but out of reach, and gazes to the experimenter were reinforced with food. During the four-minute session, the dog pups increased their rate of gazing, but the wolf pups did not. This stands in stark contrast to the results of the current study, which demonstrated clearly that wolves can learn to gaze at humans and other targets. This difference may be because adult wolves were studied rather than pups. Another possibility is that the wolf pups may have required more time and chances to contact the contingency of reinforcement than the dog pups, which would have resulted in acquisition of gazing but at a slower rate. This seems unlikely to be the only factor because the dog and wolf subjects in the current study show similar rates of acquisition for the first two session (i.e. duration of training session in Gasci et al. study).

Using a paradigm designed to compare the gazing behavior of dogs and wolves, Miklosi et al. (2003) presented subjects with physical tasks that at first they could solve, but subsequently were made unsolvable. The behavior of interest was turning and looking back at the owner, which was interpreted as soliciting help. They found that dogs had a shorter latency and a higher duration of looking at the owner compared to wolves, which led the authors to conclude that there is a genetic difference in dogs and wolves' ability to initiate communication with humans. The problem with this interpretation is that the effects of environmental influences preceding the experiment were not considered. If the dogs in the study had extensive experience with their owners solving difficult tasks for them, such as opening food containers, while the wolves had more experience destroying containers and obtaining food on their own, then these results would not be surprising. The dogs would have learned that looking to the owner results in reinforcement, while the wolves learned that persistence pays off. Furthermore, Marshall-Pescini, Passalacqua, Barnard, Valsecchi, and Prato-Previde (2009) replicated Miklosi et al.'s experiment comparing dogs trained in agility, search-and-rescue, and no training and found that those trained in agility, which relies heavily on watching human cues, gazed at the human longer in the unsolvable task.

Viranyi et al. (2008) measured latency to establish eye contact in dog and wolf subjects being tested on an object choice task. When tested at four months old, dogs had a shorter latency to gaze than wolves of the same age, even though the authors report that the dog subjects were reared under similar conditions of socialization. However, it is not necessarily only the intensive socialization that impacts the animals' behavior; rather, it is also the specific experience each individual encounters. For example, caretakers dropping food or toys or playing fetch with dogs but not with wolves could account for some wolves' failure on following distal points. The same wolves then received formal training on following point types and were tested again at 11 months old. Following this training on the object choice task, the wolves' latencies to make eye contact were the same as for the dogs, suggesting that experience does matter.

The current study is not suggesting that dogs are explicitly trained to gaze at humans. Instead, gazing may arise if owners (consciously or not) are more likely to provide reinforcers to the dog following gazes. Recent evidence has demonstrated that a dogs gaze releases oxytocin in the owner (Nagasawa, Kikusui, Onaka, & Ohta, 2009), and therefore could be reinforcing to an owner. Another possibility is that gazing could be adventitiously reinforced, merely coinciding temporally with the delivery of food or attention. Dogs may simply learn that paying attention to humans often results in something rewarding for them. The fact that the dogs in the Feeding Person group exhibited a higher baseline of gazing than those in the Other Person group shows that the presence of food will necessarily result in more gazing at the nearest person, supporting the idea that reinforcement is an important factor.

Previous research has demonstrated that experiences within an individual's life are sufficient to account for other types of social behaviors in dogs, such as point following (Elgier, Jakovcevic, Barrera, Mustaca, & Bentosela, 2009; Udell, et al., 2010) and preferential begging from humans of varied attentional states (Udell, Dorey, & Wynne, 2011). Because gazing has been clearly shown to be an operant behavior and easily manipulable in a short period of time, the possibility that it is also shaped during an individual's lifetime must be considered. The frequent interactions that dogs have with humans on a daily basis are most likely sufficient to account for gazing behavior, as they have with the other social behaviors mentioned above, though future research should investigate this directly.

The results of this study demonstrate that gazing responds to operant manipulations, suggesting that claims about the innate tendencies of dogs to gaze at humans may be premature. The fact that we can control gazing not only toward humans but also inanimate objects supports the idea that gazing is just as subject to contingencies of reinforcement as any other behavior, and dogs do not require a specially evolved connection with humans to exhibit high rates of gazing at them.

Furthermore, the finding that wolves similarly show operant control of gazing casts doubt upon the assumption that gaze differences between dogs and wolves result solely from domestication. Attempts to explain behavior in any organism must consider individual histories as well as genetic influences if we are to gain a better understanding of the effects of domestication in general and the dynamic interactions between humans and dogs.

Table 2-1. Wolf Subject Characteristics

Name	Age	Sex	Condition
Wolfgang	6 yrs	M	Other Person
Erin	13 yrs	F	Other Person
Dharma	1 yrs	F	Other Person
Ruedi	7 yrs	M	Other Person
Renki	7 yrs	M	Object
Kailani	7 yrs	F	Object
Ayla	7 yrs	F	Object
Wotan	6 yrs	M	Object

Figure 2-1. Gazing durations for individual wolf subjects in Baseline and Test sessions for Other Person and Object conditions.

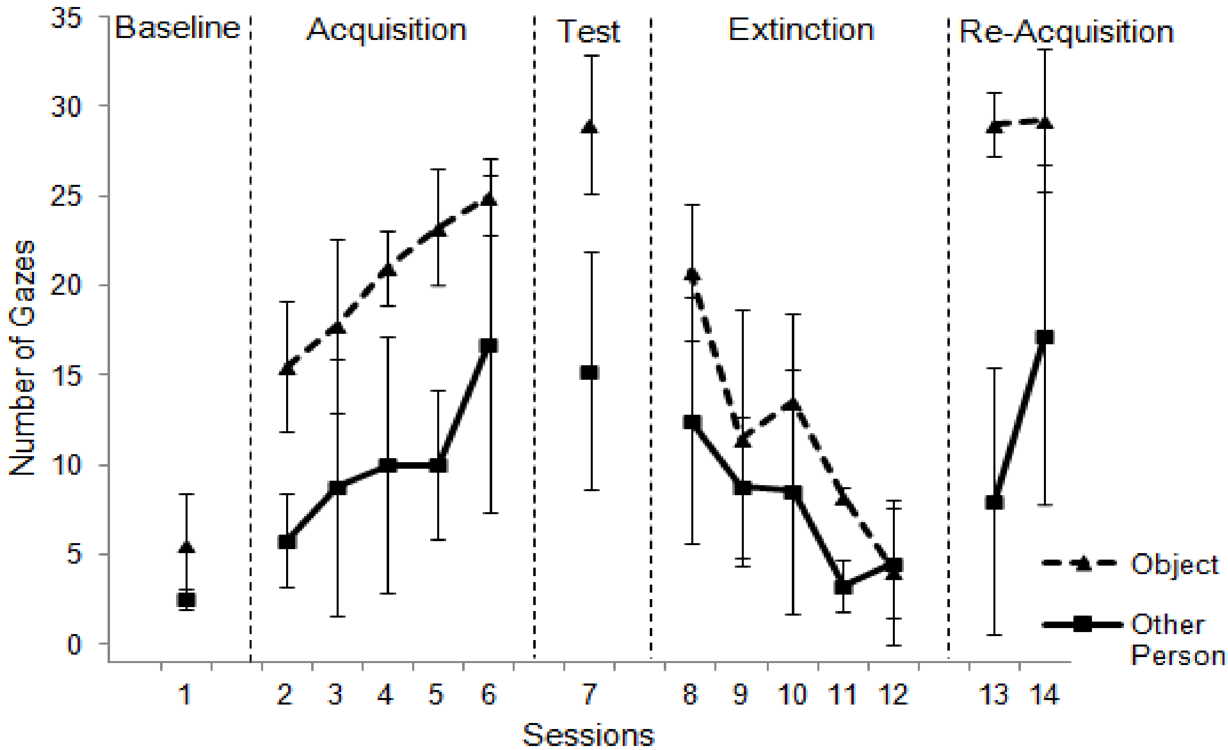

Figure 2-2. Mean number of gazes in each session for wolves in Other Person and Object conditions. Error bars indicate 95% Confidence Intervals.

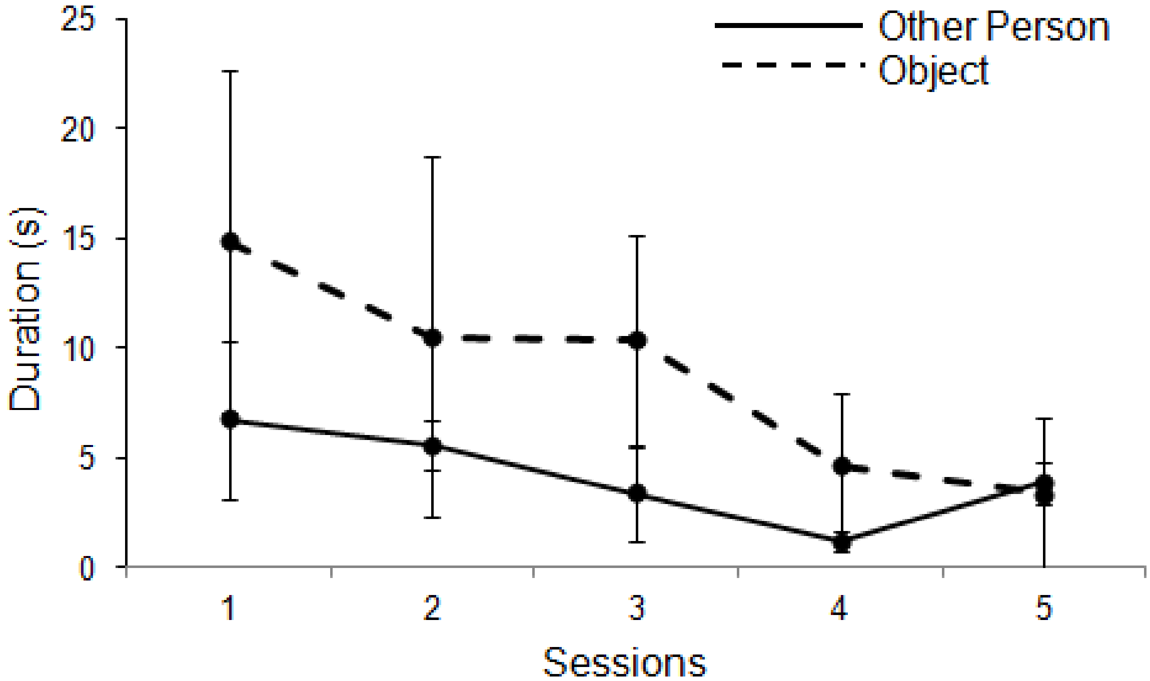

Figure 2-3. Mean duration of gazing during the Extinction phase for wolf subjects in the Other Person and Object conditions. Error bars indicate 95% Confidence Intervals.

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BIOGRAPHICAL SKETCH

Jessica Marie Spencer was born in Granbury, Texas, as the youngest of six children. She grew up mostly in Pennsylvania, but graduated from Watkins Mill High School in Gaithersburg, Maryland, in 2004. She received her Bachelor of Science degree in psychology at Stetson University of Deland, Florida, in 2008, graduating Magna cum Laude. During her time at Stetson, she also spent a semester at the University of Edinburgh in the study abroad program. She received her Master of Science degree from the Department of Psychology in the behavior analysis area at the University of Florida in 2012.