

Social interaction can function as a reinforcer for dogs: Effects of stimulus duration and session parameters

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Abstract

Prior research has produced mixed results on whether human social interaction can function as a reinforcer for dog behavior. However, that research used either short durations of social interaction or rapid, repeated trials such that satiation could have been a factor. We investigated whether two durations of social interaction (30 s or 4 s petting plus vocal praise) would maintain more responding than extinction, than each other, or than food. We limited each session to 10 trials and temporally spaced sessions within and across days. Both durations of social interaction produced more responding than extinction, but there was no difference in responding between the two social interaction durations. When we compared responding in food sessions to 30-s and 4-s social interaction sessions, we could not determine differences in responses emitted per session for two dogs due to ceiling effects, but the third dog doubled her responding when food was provided. Additionally, latencies in food sessions for all dogs were significantly lower than expected from a random sampling of latencies. Our results suggest both durations of social interaction can function as a reinforcer, especially when delivered sporadically, but they are still not as effective as food as a reinforcer for most dogs.

KEYWORDS

domestic dog, food, reinforcement, reinforcer efficacy, social interaction

Identifying effective reinforcers is essential for training and maintaining desirable behaviors across species. In domestic dogs, prior research has identified food as an effective positive reinforcer (Feuerbacher & Wynne, 2012; Fukuzawa & Hayashi, 2013; Okamoto et al., 2009). Despite its utility as a reinforcer, using food requires extra effort on the part of the owner, as it must be prepared and carried during training. Although the use of food as a reinforcer has become more commonplace, some owners are still reluctant to use food as a reinforcer, have dogs with dietary restrictions, or would simply like to have a variety of effective reinforcers. Identifying other positive reinforcers for owners to use is important to ensure they always have a reinforcer available and to potentially increase owners' willingness to use positive reinforcers for training. Social interaction, such as petting and vocal praise, are easily delivered to dogs; however, the research on the utility of social interaction as a reinforcer has shown mixed results. Although there is evidence

for its reinforcing function, it typically does not maintain much responding, especially compared with food.

When comparing brief (4 s) periods of social interaction (petting and vocal praise) to food as a consequence, the brief social interaction maintained less responding with longer latencies to respond than what food produced in both shelter and owned dogs (Feuerbacher & Wynne, 2012). In fact, the brief social interaction often was indistinguishable from extinction. However, one shelter dog did respond as much and as quickly for brief social interaction as for food, leaving open the possibility that it is an effective reinforcer for some dogs. Okamoto et al. (2009) evaluated whether food or petting plus vocal praise affected the frequency of correct responses to the cue "sit." Food produced more correct responses in two of the three experimental dog groups (which were distinguished by the speed at which the dogs ate food) as well as more gazing at the handler. The amount of petting dogs received was not specified, but the

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vocal praise was a single “good,” suggesting that the petting was also brief. Similarly, Fukuzawa and Hayashi (2013) compared dogs receiving food, five strokes of petting, or one praise statement. Especially during the baseline training stages (training “sit” and “stay” behaviors), dogs that received food as the consequence reached criterion faster and were faster to respond to the “come” command that was used in the experimental training sessions than dogs that received petting or praise. Nevertheless, in both studies the dogs did respond in the social interaction conditions, suggesting that it can function as a reinforcer, although weaker than food. However, neither study presented individual dog data or individual session data, so it is not possible to determine individual dog variability or how responding proceeded across sessions, for example if correct responding or latency increased, decreased, or stayed the same.

The research discussed thus far has used relatively short social interaction. It is possible that longer social interaction could function as a more effective reinforcer; dogs have been shown to be sensitive to the magnitude of other reinforcers (food; Feuerbacher et al., 2022), and humans have been found to be sensitive to different magnitudes of social interaction (e.g., Trosclair-Lasserre et al., 2008). Fonberg et al. (1981) evaluated longer social interaction, which was 30 s of petting plus a vocal praise statement (“good dog”) as a reinforcer and reported it was as effective as food in that it produced the same percentage of correct for the dogs’ behavior of placing and holding their foreleg on a food tray. However, an additional contingency (the dog being physically placed into the cued position if it did not respond within 1 min) confounds a clear conclusion about longer social interaction as a reinforcer and its relative value to food. Still, it is possible that 30 s of social interaction is more effective than the brief interaction periods provided in the previously described studies.

Another possibility is that even brief social interaction can function as an effective reinforcer but that dogs satiate on it quickly. In prior research (Feuerbacher & Wynne, 2012), sessions were run back to back all on the same day. In this study, shelter dogs, owned dogs, and hand-reared captive wolves did not show strong evidence that 4 s of social interaction functioned as reinforcer; only one dog showed sustained responding (nose touch) in the social interaction conditions. This lack of effect might be due to satiation from the repeated trials. Similarly, Okamoto et al. (2009) ran repeated trials and sessions: dogs were cued every 5 s for three 5-min sessions, with 5-min sessions separated by only a 3-min break. In the two groups in which the authors detected a statistical difference, the responding in the social interaction sessions was approximately one third of that of the food sessions. In the third group, which did not show a statistical difference, the number of correct responses in the social interaction group was still approximately 20% less than the food group. In both studies, satiation effects from rapid, repeated trials might influence results and social interaction might function as a more effective reinforcer when many trials are not delivered in quick succession.

The study by Fukuzawa and Hayashi (2013) addressed this issue with sessions limited to 10 trials, and sessions were temporally spaced with at least 90 min between them. However, the social interaction used (five strokes or one praise statement) was still brief. It is possible that longer social interaction, combined with limited trials and spaced sessions, could successfully maintain responding in dogs and show a strong reinforcing effect. To this point, Fonberg et al. (1981), who suggested petting and praise was as effective as food as reinforcer, used sessions with only eight trials. Although they did not explicitly state how many sessions a day were conducted, other statements seem to suggest that only one session was run per day. Thus, their results that social interaction was as effective as food might stem from the longer duration of social interaction they delivered combined with their use of sessions with limited trials and spaced out across time. Nevertheless, confounding contingencies in their research limit the strength of those conclusions.

In this study we took a translational research approach to evaluate whether different durations of social interaction could function as a reinforcer for owned dog behavior when we limited the number of trials in a session and temporally spaced sessions to reduce the likelihood of satiation. In Experiment 1, we tested whether a 30-s social interaction would maintain more responding than extinction. In Experiment 2, we tested whether a 4-s social interaction would maintain more responding than extinction to elucidate whether it was the trial and session parameters or the length of social interaction that was the critical factor in producing consistent responding. Finally, in Experiment 3 we directly tested whether 30- or 4-s social interactions would maintain more responding (Phase 1) and compared both of these to food as a consequence (Phase 2). In all three experiments, dogs alternated between conditions in a multielement design.

METHODS

Subjects

We tested owned dogs, all of which were at least 6 months of age and had lived in their current home for

TABLE 1 Dog demographics

Dog	Breed	Age	Sex
Cosmo	Standard poodle	1y	UM
Iorek	German shepherd	7y	NM
Leica	Belgian malinois	2y 6 m	SF
Lucky	Yorkshire terrier	2y	UM
Ninja	Pit bull x	10y	SF
Nintendo	German shepherd x	2y	NM
Shelby	Yorkshire terrier	6y	SF
Zaki	Golden retriever	8y	NM

Note. Age is reported in years (y) and months (m). Sex: F is female, M is male, S is spayed, N is neutered, U is unaltered. Under breeds the predominant breed type is listed, and an x indicates the dog is a mix.

at least 4 months. Table 1 shows the dogs' demographic information as reported by the owners. Ethical animal use was approved by the Virginia Tech Institutional Animal Care and Use Committee (Protocol #20–023).

Sessions

We tested the dogs in a quiet room in their own homes. They were tested on leash (approximately 2 m long) to parallel prior research (Feuerbacher & Wynne, 2012). The owner acted as experimenter in all sessions. Sessions began with the experimenter standing with their back to a wall to limit the dog from moving behind the experimenter and placing one hand at the dog's nose level. If the dog touched the experimenter's hand with any part of its muzzle, the experimenter delivered the programmed interaction. If the dog did not touch the experimenter's hand within 30 s, the experimenter raised their hand and then re-presented their hand for the next trial. This continued until 10 trials were provided.

In social interaction sessions, if the dog emitted a nose touch, the experimenter immediately began praising the dog in a high-pitched voice while petting the dog with both hands such that the skin moved over the underlying muscle (Feuerbacher & Wynne, 2014; Hennessy et al., 1998) and the experimenter's fingertips moved along the dog's skin. We petted the dog on the part of the body closest to the experimenter so that the dog could position itself to receive petting on the preferred area. This social interaction lasted for 30 s or 4 s, depending on the condition. After the social interaction ended, the experimenter presented their hand again for the next trial. In extinction sessions, if the dog emitted a nose touch, the experimenter raised their arm, waited 4 s, and then re-presented their hand for the next trial. In the food sessions, if the dog emitted a nose touch, the experimenter said “yip” and delivered one small treat (PetBotanics, Azusa, CA) to the dog using the hand not used for the nose touches. The treats were chicken-flavored and approximately $1 \times 1 \times 0.5$ cm, and kept on a small table to the side of the experimenter. We chose to use a short vocal cue such as “yip” so that the stimulus change was delivered as rapidly as it was in the social interaction phases in which the experimenter immediately began praising the dog while reaching toward the dog to pet it. We did not preestablish “yip” as a stimulus that predicted treats; thus, if “yip” took on conditioned reinforcing functions, it occurred as the experiment progressed.

After completing a session, the dog was allowed to resume its normal activities for the day before participating in another session after a break of at least 30 min. Sessions took place across multiple days. No more than 3 days elapsed between sessions except for an approximately 1-month delay between Session 10 and 11 for Ninja in Experiment 2, and Experiment 3 was conducted two months after Experiment 2. On a given day, a dog

experienced at least one session of each condition in that experiment, with a maximum of four sessions per day (Experiments 1 and 2, and Phase 1 of Experiment 3) or six sessions per day (Phase 2 of Experiment 3).

The recruited dogs differed in their prior history with the experimental response (nose touch). Two dogs (Iorek and Ninja) had extensive training with emitting a nose touch to their owner's hand to receive food and have been subjects in prior research using nose touch as a response that produced food (Feuerbacher et al., 2022). Nintendo and Leica had some but little training by their owner to emit a nose touch to the owner's hand for food, and the owner had not been engaged in any specific training of this response for at least 2 months prior to the experiment. All other dogs had no history of emitting a nose touch to the owner's hand to receive any specific consequence. Additionally, for the dogs that had not been previously trained to emit a nose touch to their owner's hand, we did not provide any pretraining for these dogs prior to the start of the study and instead captured the response during the experiment (Feuerbacher & Wynne, 2012).

Experiments 1 and 2

Sessions alternated between 30 s of social interaction and extinction (Experiment 1) and 4 s social of interaction and extinction (Experiment 2). In these experiments, the first session of the experiment was always a social interaction session to increase the likelihood that dogs contacted the putative reinforcer rather than contacting no consequence and possibly extinguishing the response by having an extinction session as the first session.

Experiment 3

Experiment 3 had two phases: in Phase 1 dogs alternated between 30 s of social interaction and 4 s social interaction to directly test these against one another, and in Phase 2 dogs alternated between 30-s social, 4-s social, and food sessions to allow for a comparison between our social interaction results and another well-established reinforcer.

In Phase 1, we counterbalanced which condition each dog started in and sessions were pseudorandomly determined, with the restriction that no more than two sessions of the same condition occurred in a row. In Phase 2, which immediately followed Phase 1, all dogs started with a food session because we already had 30- and 4-s sessions as comparison data from Phase 1. After the food session, each dog received one session each of 30 s and 4 s of social interaction, before experiencing another food session. The 30- and 4-s sessions were randomized as to which order they were provided after each food session. Because the dogs we tested were fed twice a day, and thus had more limited access to food compared with social interaction, we conducted food sessions between 30 and

60 min after the dogs had eaten, to minimize their food deprivation and make it more comparable to their deprivation from social interaction.

Analysis

In all three experiments, we recorded the number of responses per session. Sessions were live coded by a researcher (either the first or second author) who recorded each nose touch the dog emitted. The experimenter testing the dog (i.e., the owner) also reported the number of nose touches emitted by the dog. Starting in Session 3 of Experiment 3, we also video-recorded sessions to allow us to calculate latency to respond and to allow for interobserver agreement (IOA) calculations for latency. For number of nose touches, we calculated IOA between the researcher and the experimenter for all sessions; interobserver agreement was 100% for number of nose touches completed in a session. To calculate IOA for latency to respond, the first author scored the videos, along with a second trained research assistant. If the two latencies were within 3 s of each other, this was considered an agreement. The average IOA for latency was 98.8% (range 90%–100%).

For all three experiments, we used visual analysis on number of responses per session to determine whether there was an effect of condition on responding, along with non-parametric tests (Wilcoxon signed-rank tests) on the median number of responses in each condition, where appropriate.

In Experiment 3 only, we also recorded latency to respond in the three different conditions (30-s social interaction, 4-s social interaction, and food). To determine whether any differences in the latency to respond were meaningful, we conducted a Monte Carlo analysis, which is a type of analysis that relies on simulations of data rather than making statistical assumptions about the data. For single-subject designs, they are useful for determining whether a specific set of behavior is meaningfully different from the baseline behavior while accounting for the variability across all of the measured behavior (Friedel et al., 2022; Friedel et al., 2019). This is achieved by simulating a new set of behavior by randomly selecting samples, with replacement, hundreds or thousands of times from all of the recorded behavior. The goal of repeating this process is to determine the likelihood that the experimentally obtained data was due to a chance arrangement. The experimentally obtained data set is then compared with the simulated data set. If the simulation process reliably produces measures of behavior that are similar to the experimentally obtained measures, then the experimental data is not meaningfully different from the baseline. If the experimentally obtained sample is lower or higher than the vast majority of the random samples, it is reasonable to assume that the behavior of interest is lower or higher than the baseline. For in-depth descriptions and examples see Friedel et al. (2022), Friedel et al. (2017), and Friedel et al. (2019).

In this study, we compared the experimentally obtained latencies to a set of randomly selected latencies. We created nine sets of random samples of response latencies, one for each subject for each condition (4 s, 30 s, and food). For a given random sample, response latencies were only randomly selected from the response latencies for that subject and no latencies were sampled from the other subjects. The number of latencies selected for each simulated sample was based on the number of experimentally obtained latencies for that condition for that subject. For example, for each simulated sample in Leica's 4-s reinforcer condition we randomly selected 96 latencies and for the 30-s reinforcer condition we randomly selected 85 latencies. For each of the nine sets, we created 10,000 simulated samples. From each of these, we then counted how many of the simulated samples had mean latencies that were higher (or lower) than the associated experimental mean latency to generate a *p* value for that specific condition.

RESULTS

Experiment 1

We tested seven dogs comparing 30 s of social interaction to extinction. Figure 1 displays the results of individual dogs (a–g). Five of these dogs had clear increased responding during the 30 s of social interaction sessions—that is, there was no overlap in the dogs' data paths (Figure 1 a–d, f), except for the first two sessions for Iorek and Zaki, in which the dogs might not have fully discriminated the contingencies. Lucky (e) showed more variability in the data and had three extinction data points that overlapped with the 30-s social interaction data path. However, the other three extinction sessions were lower than the 30-s social interaction path by at least two nose touches. Only one dog, Ninja (g), did not show differentiated responding between the two conditions.

We also calculated the median number of nose touches emitted in each condition by each dog (Figure 1h). Using a Wilcoxon signed-rank test, we found that the dogs emitted a significantly greater number of nose touches in the 30-s condition compared with extinction (Figure 1h; $W = -28$, $p = .016$).

Experiment 2

We tested six dogs, all of which participated in Experiment 1, comparing 4 s of social interaction to extinction. Figure 2 displays the results of individual dogs (a–f). Five of these dogs had clear increased responding in the 4-s social interaction sessions; there was no overlap in data paths except for Session 3 for Shelby (c) and Session 5 for Nintendo (e). The sixth dog, Ninja, initially did not show differentiated responding but showed an increasing trend in the 4-s social interaction sessions starting in session 11. Although there

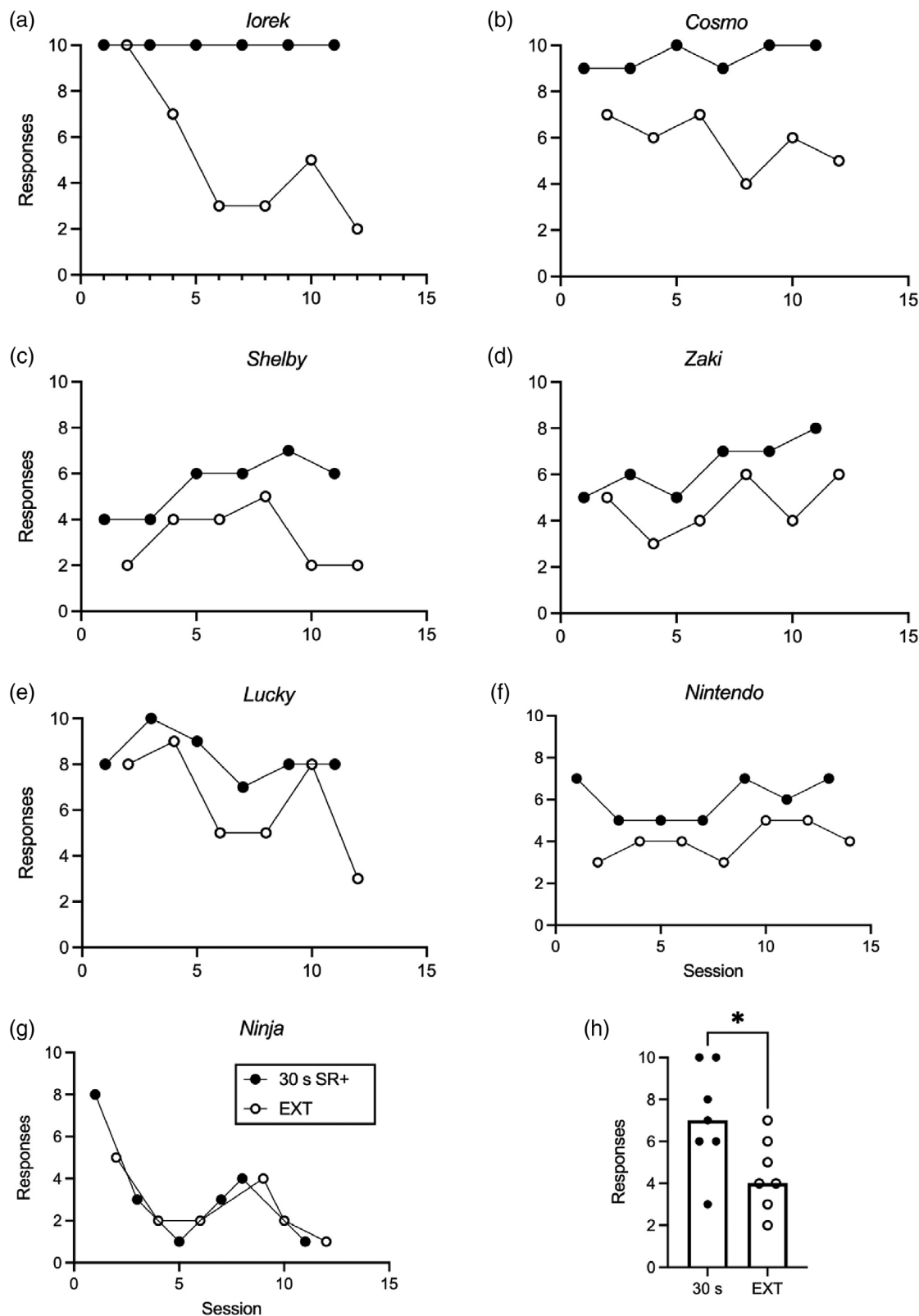


FIGURE 1 Experiment 1: 30 s of social interaction versus extinction. Individual dog data from Experiment 1 (a–g) and the median number of nose touches across all dogs (bar) and individual dogs (data points) in each condition (h); * $p < .05$.

was some variability in her data, the final five out of six sessions of 4 s of social interaction were higher, and near maximal responding, compared with extinction.

We also calculated the median number of nose touches emitted in each condition by each dog (Figure 1h). Using a Wilcoxon signed-rank test, we found

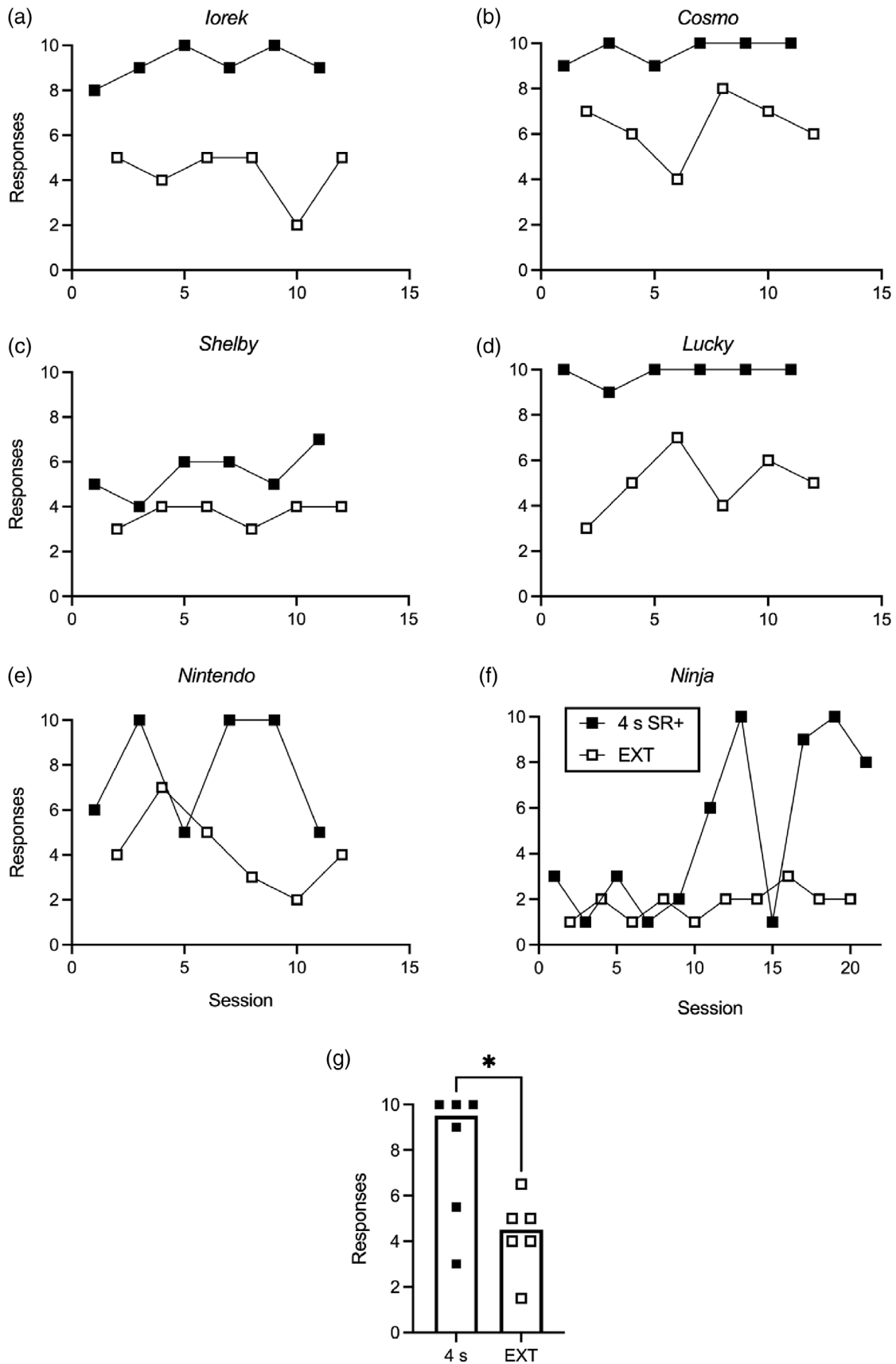


FIGURE 2 Experiment 2: 4 s of social interaction versus extinction. Individual dog data from Experiment 2 (a–f), and the median number of nose touches across all dogs (bar) and individual dogs (data points) in each condition (h); $*p < .05$.

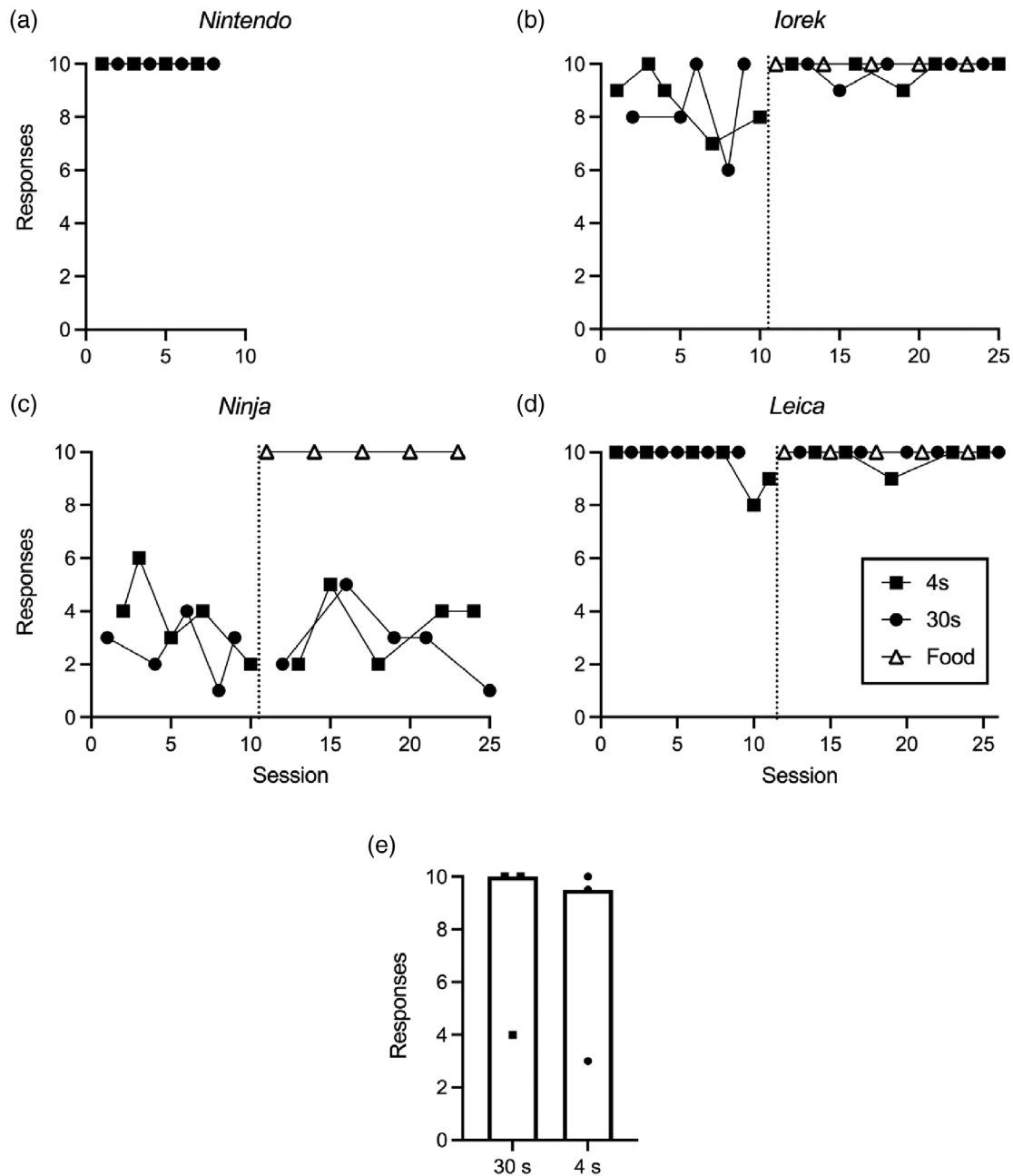


FIGURE 3 Experiment 3: 4 s of social interaction versus 30 s social interaction versus food. Individual dog data from Experiment 2 (a–f) and the median number of nose touches across all dogs (bar) and individual dogs (data points) in each condition of Phase 1 (e).

that the dogs emitted a significantly greater number of nose touches in the 4-s condition compared with extinction (Figure 1h; $W = -21, p = .031$).

Experiment 3

Phase 1

We tested three dogs that participated in Experiments 1 and 2 and an additional dog that was new to the study,

comparing 4 s of social interaction to 30 s of social interaction. Figure 3 displays the results of individual dogs (a–d). In all four dogs, there was substantial overlap in the data paths for responding in the 30-s social interaction and 4-s social interaction phases.

We also calculated the median number of nose touches emitted in each condition by each dog (Figure 3e) in Phase 1. Using a Wilcoxon signed-rank test, we found that the dogs did not emit a significantly different number of nose touches in the 4-s condition compared with the 30-s condition ($W = -3, p = .50$).

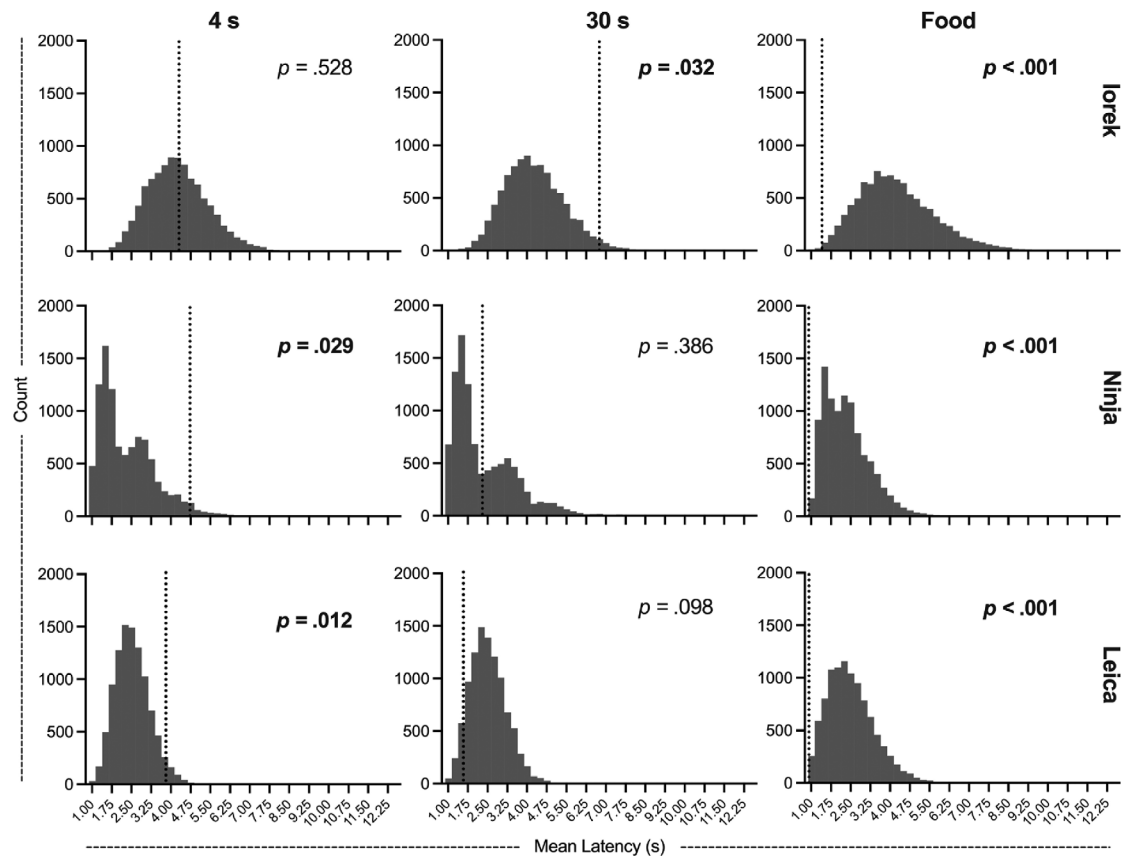


FIGURE 4 Monte Carlo analysis on latencies to respond. Frequency distribution of mean latencies produced by a Monte Carlo analysis for each condition (columns) and each dog (rows). The vertical line on each graph shows the individual dog's experimentally measured mean latency to respond in that condition (p values are provided; those in bold are statistically significant).

Phase 2

We tested three dogs that completed Phase 1 (Figure 3b–d) in Phase 2 in which we compared 4 s of social interaction to 30 s of social interaction to food. Two of these dogs (b and d) showed high and sometimes maximal responding in sessions with social interaction. When we added in food as a condition, the dogs' data paths for the three conditions were indistinguishable. We were only able to detect differentiated responding for one dog (c) in this phase; Ninja responded maximally for food but emitted no more than five nose touches for either 4 s or 30 s of social interaction, and these two conditions continued to have complete data path overlap in this phase. We did not conduct a nonparametric test on these data because we had only three subjects and three experimental conditions.

To evaluate latency to respond in the three conditions (30 s of social interaction, 4 s of social interaction, and food), we conducted a Monte Carlo analysis. Figure 4 displays the results from the Monte Carlo analysis compared with the experimental mean latency. This analysis found that in the food condition, all dogs responded with significantly shorter latencies than expected from a random sample of latencies. On the other hand, for each dog

there was one social interaction condition in which it responded with significantly longer latencies than expected from a random sample of latencies. For Iorek, this was the 30-s social interaction condition, whereas for Ninja and Leica, it was the 4-s social interaction condition.

DISCUSSION

In this study, we assessed whether different durations of social interaction would function as a reinforcer for dog behavior when we limited the number of trials per session and temporally spaced sessions within and across days to reduce the chance that satiation would affect our results. We found that both 30 s and 4 s of social interaction produced higher responding than extinction for most dogs and the median number of nose touches in each of those conditions was significantly higher than the number of responses in the extinction condition.

These results support earlier research that suggested 30 s of social interaction functioned as a reinforcer for dogs (Fonberg et al. 1981). Nevertheless, the results we obtained differ from those found by Feuerbacher and Wynne (2012), even in the experiment in which owners

provided the interaction and food (Experiment 3), as occurred in the current study. In that study, 4 s of social interaction did not maintain much responding and, in fact, looked like extinction curves, with the exception of one dog. What differs between that study and the current study is how we scheduled trials and sessions. In the current study, we limited our sessions to 10 trials and spaced sessions out with at least 30 min between them, with a maximum of four social interaction sessions (Experiment 3) in a day. That we found similar responding in both the 30-s and 4-s conditions suggests that both durations can function as reinforcers for dogs but that session parameters might influence whether they do or not—that is, when many trials per session are provided and sessions are run back-to-back, dogs might satiate on social interaction as a reinforcer, whereas with fewer trials and temporally spaced sessions, we see a reinforcing effect even with only 4 s of social interaction. In other work, dogs did not show any decrement in time spent by the owner when the owner was providing petting for eight 3-min sessions that were run with only a short break in between each (Feuerbacher & Wynne, 2015). Nevertheless, in that study the only response required was to be near the owner. Although we chose a lower effort response in the current study, that effort could still influence reinforcer value.

Despite finding a reinforcer effect in Experiments 1 and 2 of the current study, only two dogs responded maximally (10 nose touches) in more than one session and four of the dogs never had a session in which they responded on all 10 trials. We chose a relatively low-effort response on a fixed ratio 1 (FR1) schedule and conducted the sessions in a familiar, low-distraction environment. With a more effortful response, or with a thinner schedule of reinforcement, or in an environment with more environmental reinforcement available, social interaction might not function as a very effective reinforcer. Future studies should evaluate the reinforcing effect of 30 s and 4 s of social interaction in these other scenarios to elucidate the generality of our results. Additionally, in both experiments we continued to see responding in extinction conditions. This is likely because we rapidly alternated sessions between social interaction and extinction and, other than the absence of social interaction during the extinction condition, there were no other discriminative stimuli that would have indicated the prevailing contingency. Another possibility is that the dogs that had more extensive preexperimental histories of the nose-touch response producing food continued to respond in extinction because of that history of reinforcement. However, of the two dogs that had the most extensive preexperimental history of reinforcement (Iorek and Ninja), one showed the most rapid discrimination between social interaction and extinction (Iorek) and the other showed no or little discrimination at all (Ninja) but also very low responding overall. It is possible that Iorek's prior history of reinforcement also came with more

experience with extinction, and thus he more quickly discriminated the contingencies (e.g., Vaughan, 1988). We expect that with continued exposure to the contingencies, as well as the addition of clear discriminative stimuli for each condition, differentiation between social interaction and extinction conditions would increase.

As was indicated from the comparing the results of Experiments 1 and 2, we found no difference in amount of responding maintained by the two different durations when we compared them directly in Experiment 3. We did find differences in latencies, with Iorek responding more quickly for 4 s of social interaction (4.10 vs. 6.57 s) and Ninja and Leica responding more quickly for 30 s of social interaction (2.33 vs. 4.75 s and 1.66 vs. 3.73 s, respectively), suggesting that there might be a difference in reinforcer value between the two durations but that it varies across individuals.

That we found no differences in responding between 4-s and 30-s social interactions was not expected given that the magnitude of reinforcement often affects reinforcer value (e.g., Hoch et al., 2002; Hodos & Kalman, 1963; Nader & Woolverton, 1991), including in dogs (Feuerbacher et al., 2022). However, there might be differences that we did not detect; in an effort to reduce satiation as a possible factor, we capped sessions at 10 trials. This, though, produced a ceiling effect, without which we might have detected differences in reinforcer value between the two social interaction durations. Three of the four dogs were potentially affected by ceiling effects, as they often or always responded on every trial. However, the fourth dog, which responded at a relatively low frequency and therefore was not subject to a ceiling effect, also showed no difference in responding between conditions. Future research might use a progressive-ratio schedule to further investigate differences between the two social interaction durations. Progressive-ratio schedules have been effectively used to detect differences in other reinforcers for dogs (Feuerbacher et al., 2022; Vicars et al., 2014) and are especially effective at distinguishing differences in reinforcer efficacy (Hodos, 1961). Larger response schedule requirements have also been found to reveal differences in learner preferences for reinforcers that were not evident at smaller response schedule requirements (DeLeon et al., 1997).

Interestingly, two of the dogs that responded near or at maximum participated in Experiments 1 and 2, and although they responded on the higher side in those experiments, their responding was even higher in Experiment 3. Whether this increase in responding was due to extended exposure to the contingencies, the possible influence of no longer alternating with an extinction condition or other factors is unknown.

Given our evidence that both durations of social interaction could function as a reinforcer for dog behavior, we measured how dogs' responding for social interaction in the current experimental set up (limited trials and temporally spaced sessions) compared with food as a

reinforcer, which has been established as a highly effective reinforcer for dog behavior (Feuerbacher et al., 2022; Feuerbacher & Wynne, 2012; Fukuzawa & Hayashi, 2013; Okamoto et al., 2009). When we consider number of responses in the food condition compared with the social interaction, we again encounter a potential ceiling effect, with two of the dogs responding near maximally in all conditions, highlighting again the utility of progressive-ratio schedules for future research. However, the third dog, which had low responding in both social conditions, increased to maximum responding in all food conditions, indicating that it was a more valuable reinforcer for this dog. Additionally, when we analyzed the latencies to respond, the mean experimental latency for all three dogs was shorter than what we would have expected based on a random sample of latencies. Thus, even for dogs for which there was a ceiling effect for response probability, we still saw differential responding for food with shorter latencies. Although our results indicate that social interaction can function as a reinforcer for dog behavior in some instances, food is likely a still more effective reinforcer, which parallels prior research (Feuerbacher & Wynne, 2012; Fukuzawa & Hayashi, 2013; Okamoto et al., 2009). The results we obtained occurred even when we had set up the food sessions against finding this result; we tested dogs within 1 hr of one of their daily meals such that we were testing them when they were least deprived of food. Differences between food and social interaction as reinforcers could be even more pronounced when tested further from mealtime.

One of the only notable differences we detected between the two social interaction conditions was the amount of barking that one dog (Leica) engaged in during sessions. She sometimes would bark after the reinforcer delivery had been completed (social interaction was stopped to start a new trial, or the food item had been delivered [Phase 2]) and as the next trial was starting. In the 4-s social interaction condition, she barked in 24 trials across six sessions for a cumulative 141.8 s, whereas she only barked in one trial of the 30-s social interaction condition for a cumulative 3.94 s, and she barked in two sessions of the food condition for a cumulative 2.98 s. That barking occurred after petting had been removed, and especially in the 4-s social interaction phase, is reminiscent of extinction-induced responding such that the shortened duration of social interaction might have produced extinction-like side effects in that trial while still maintaining responding to access more social interaction in the subsequent trial. The behaviors induced in individual dogs by the reinforcer and schedule of reinforcement used is worth considering to ensure owner buy-in for training plans. Although we found little difference in responding between 4-s and 30-s social interaction, an owner might opt for the 30-s social interaction if it produces fewer undesirable behaviors.

In all three experiments, we observed a range of individual differences. Some dogs consistently responded at

near-maximal levels (e.g., Iorek, Cosmo, and Lucky); other dogs showed intermediate responding, and one dog (Ninja) showed very low responding in all sessions, except the last sessions of 4 s social interaction in Experiment 2 and in all the food sessions. We did not explore the factors that generated these differences, such as genetic or breed differences or prior learning history. Although there is little research into breed differences in sensitivity to reinforcement, in a behavioral test conducted to validate the Canine Reward Responsiveness Survey, herding and retriever breeds scored the highest on ball/toy responsiveness and retrievers scored highest on food responsiveness (Gerencsér et al., 2018) compared with other breed groups; of course, this sensitivity might not translate into sensitivity to social interaction as a reinforcer. When considering whether sociability to humans varies by breed, Labrador retrievers, golden retrievers, and pit bulls were more likely to score in the highest quartile of human sociability, as reported by their owners, whereas German shepherds, dachshunds, and Chihuahuas were less likely (Morrill et al., 2022); whether this equates to reinforcer sensitivity has not been investigated. In our study, a purebred German shepherd (Iorek) and a standard poodle (Cosmo) showed the highest rates of responding for 30 s of social interaction, whereas Zaki, a golden retriever, did not show as high a rate of responding, and Ninja, a pit bull cross, showed the lowest rate of responding. Morrill et al. (2022) similarly concluded that although there were some breed tendencies, breed alone is inadequate to predict individual behavior. Nevertheless, the role of breed in reinforcer sensitivity warrants further exploration.

In terms of prior learning history, two dogs (Iorek and Ninja) had extensive histories with the nose touch response producing food. Nevertheless, the two dogs ended up on opposite ends of the responding scale, with Iorek being a high responder for both food and social interaction and Ninja only engaging in high rates of responding when food was the provided consequence. Thus, although we did not detect any clear relation between prior learning and how dogs responded in this experimental set up, it is likely to be an interaction with other organismal characteristics. Future research could experimentally establish different histories of reinforcement for the experimental response and evaluate the influence of that history of reinforcement on current responding.

The increase in responding for 4 s of social interaction that we observed in Ninja's data in Experiment 2 and her return to low responding for social interaction in Experiment 3 parallels her wearing a different collar after a delay in data collection, suggesting that different environmental stimuli, such as a different collar or having skin allergies, might act as establishing operations to make certain forms of petting more reinforcing.

As we have noted earlier, future research should further evaluate whether there are differences in reinforcer efficacy between 30 s and 4 s of social interaction and how the reinforcing value might be affected by response

effort, schedule of reinforcement, and context. Additionally, we combined petting and vocal praise; investigating these separately to determine whether one or both are producing the observed effects is warranted. Prior research has suggested that petting, but not vocal praise, can function independently as a reinforcer for dog behavior (McIntire & Colley, 1967). More recent research has found vocal praise is not a preferred reinforcer for dogs (Feurbacher & Wynne, 2015) and does not influence the reinforcer value of food when delivered simultaneously with food (Feurbacher et al., 2022). Additionally, investigating different forms of petting and its possible interaction with response topography would be useful; we used more active massaging and scratching petting. Whether other forms of petting (stroking or slow massaging) are as effective a reinforcer is unknown, as is whether the response topography we are trying to reinforce matters. It is possible that our form of petting is more effective for active responses, whereas slow stroking might be more effective for reinforcing calm, stationary behavior.

In sum, our results suggest that both 4 s and 30 s of social interaction provided by the owner can function as a reinforcer. The use of the owner as experimenter adds to the applied utility of our results, given that the owner is likely the person most frequently providing training consequences for their dog. In practical terms, both shorter and longer duration social interaction can function as a reinforcer, as long as possible satiation effects are mitigated and possible individual preferences for different durations are taken into account. Even though social interaction might not be effective for long or frequent sessions of repeated responding, such as in a training class, the scheduling of trials and sessions in the current study likely more closely parallels dogs' everyday experiences at home. Owners probably provide social interaction sporadically throughout the day with other reinforcers such as food or access to preferred activities like playing with toys, going on walks, or playing with conspecifics being interspersed between instances of the owner delivering social interaction in the form of petting and vocal praise to the dog. Nevertheless, our results still suggest that food is typically a more valuable reinforcer and likely especially useful in training contexts in which the owner asks the dog to respond repeatedly for an extended period.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

ETHICS APPROVAL

Ethical animal use was approved by the Virginia Tech Institutional Animal Care and Use Committee (Protocol #20–023).

REFERENCES

- Deleon, I. G., Iwata, B. A., GOH, H. L., & Worsdell, A. S. (1997). Emergence of reinforcer preference as a function of schedule requirements and stimulus similarity. *Journal of Applied Behavior Analysis, 30*(3), 439–449. doi:<https://doi.org/10.1901/jaba.1997.30-439>
- Feurbacher, E. N., Stone, C., & Friedel, J. E. (2022). Give the dog a big bone: Magnitude but not delivery method of food impacts preference and reinforcer efficacy in dogs. *Behavior Analysis: Research and Practice, 22*, 31–49. doi:<https://doi.org/10.1037/bar0000237>
- Feurbacher, E. N., & Wynne, C. D. (2012). Relative efficacy of human social interaction and food as reinforcers for domestic dogs and hand-reared wolves. *Journal of the Experimental Analysis of Behavior, 98*(1), 105–129. doi:<https://doi.org/10.1901/jeab.2012.98-105>
- Feurbacher, E. N., & Wynne, C. D. L. (2014). Most domestic dogs (*Canis lupus familiaris*) prefer food to petting: Population, context, and schedule effects in concurrent choice. *Journal of the Experimental Analysis of Behavior, 101*(3), 385–405. doi:<https://doi.org/10.1002/jeab.81>
- Feurbacher, E. N., & Wynne, C. D. L. (2015). Shut up and pet me! Domestic dogs (*Canis lupus familiaris*) prefer petting to vocal praise in concurrent and single-alternative choice procedures. *Behavioural Processes, 110*, 47–59. doi:<https://doi.org/10.1016/j.beproc.2014.08.019>
- Friedel, J. E., Cox, A., Galizio, A., Swisher, M., Small, M. L., & Perez, S. (2022). Monte Carlo analyses for single-case experimental designs: An untapped resource for applied behavioral researchers and practitioners. *Perspectives on Behavior Science, 45*(1), 209–237. doi:<https://doi.org/10.1007/s40614-021-00318-7>
- Friedel, J. E., DeHart, W. B., & Odum, A. L. (2017). The effects of 100 dB 1-kHz and 22-kHz tones as punishers on lever pressing in rats. *Journal of the Experimental Analysis of Behavior, 107*(3), 354–368. doi:<https://doi.org/10.1002/jeab.254>
- Friedel, J. E., Galizio, A., Berry, M. S., Sweeney, M. M., & Odum, A. L. (2019). An alternative approach to relapse analysis: Using Monte Carlo methods and proportional rates of response. *Journal of the Experimental Analysis of Behavior, 111*(2), 289–308. doi:<https://doi.org/10.1002/jeab.489>
- Fonberg, E., Kostarczyk, E., & Prechtl, J. (1981). Training of instrumental responses in dogs socially reinforced by humans. *Pavlovian Journal of Biological Science, 16*, 183–193.
- Fukuzawa, M., & Hayashi, N. (2013). Comparison of 3 different reinforcements of learning in dogs (*Canis familiaris*). *Journal of Veterinary Behavior: Clinical Applications and Research, 8*, 221–224. doi:<https://doi.org/10.1016/j.jveb.2013.04.067>
- Gerencsér, L., Bunford, N., Moesta, A., & Miklósi, Á. (2018). Development and validation of the Canine Reward Responsiveness Scale: Examining individual differences in reward responsiveness of the domestic dog. *Scientific Reports, 8*(1), Article 4421. doi:<https://doi.org/10.1038/s41598-018-22605-1>
- Hennessy, M. B., Williams, M. T., Miller, D. D., Douglas, C. W., & Voith, V. L. (1998). Influence of male and female petters on plasma cortisol and behaviour: Can human interaction reduce the stress of dogs in a public animal shelter? *Applied Animal Behaviour Science, 61*(1), 63–77. doi:[https://doi.org/10.1016/S0168-1591\(98\)00179-8](https://doi.org/10.1016/S0168-1591(98)00179-8)
- Hoch, H., McComas, J. J., Johnson, L., Faranda, N., & Guenther, S. L. (2002). The effects of magnitude and quality of reinforcement on choice responding during play activities. *Journal of Applied Behavior Analysis, 35*(2), 171–181. doi:<https://doi.org/10.1901/jaba.2002.35-171>
- Hodos, W. (1961). Progressive ratio as a measure of reward strength. *Science, 134*(3483), 943–944. doi:<https://doi.org/10.1126/science.134.3483.943>
- Hodos, W., & Kalman, G. (1963). Effects of increment size and reinforcer volume on progressive ratio performance. *Journal of the*

- Experimental Analysis of Behavior*, 6(3), 387–392. doi:<https://doi.org/10.1901/jeab.1963.6-387>
- Nader, M. A., & Woolverton, W. L. (1991). Effects of increasing the magnitude of an alternative reinforcer on drug choice in a discrete-trials choice procedure. *Psychopharmacology*, 105(2), 169–174.
- McIntire, R., & Colley, T. A. (1967). Social reinforcement in the dog. *Psychological Reports*, 20(3), 843–846.
- Morrill, K., Hekman, J., Li, X., McClure, J., Logan, B., Goodman, L., Gao, M., Dong, Y., Alonso, M., Carmichael, E., Snyder-Mackler, N., Alonso, J., Noh, H., Johnson, J., Koltookian, M., Lieu, C., Megquier, K., Swofford, R., Turner-Maier, J., ... Karlsson, E. K. (2022). Ancestry-inclusive dog genomics challenges popular breed stereotypes. *Science*, 376(6592), Article eabk0639. <https://doi.org/10.1126/science.abk0639>
- Okamoto, Y., Ohtani, N., Uchiyama, H., & Ohta, M. (2009). The feeding behavior of dogs correlates with their responses to commands. *Journal of Veterinary Medical Science*, 71(12), 1617–1621.
- Trosclair-Lasserre, N. M., Lerman, D. C., Call, N. A., Addison, L. R., & Kodak, T. (2008). Reinforcement magnitude: An evaluation of preference and reinforcer efficacy. *Journal of Applied Behavior Analysis*, 41(2), 203–220. doi:<https://doi.org/10.1901/jaba.2008.41-203>
- Vaughan, W. (1988). Formation of equivalence sets in pigeons. *Journal of Experimental Psychology: Animal Behavior Processes*, 14(1), 36–42. doi:<https://doi.org/10.1037/0097-7403.14.1.36>
- Vicars, S. M., Miguel, C. F., & Sobie, J. L. (2014). Assessing preference and reinforcer effectiveness in dogs. *Behavioural Processes*, 103, 75–83. doi:<https://doi.org/10.1016/j.beproc.2013.11.006>

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