Applied Animal Behaviour Science 191 (2017) 49–58

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

Persistence of food guarding across conditions of free and scheduled feeding in shelter dogs

Julie Lyle[a,*], Susan Kapla[b], Stephanie P. da Silva[c], Megan E. Maxwell[d]

[a] Humane Ohio, 3131 Tremainsville Rd., Toledo, OH 43613, United States
[b] Northern Michigan University, 1401 Presque Isle Ave., Marquette, MI 49855, United States
[c] Columbus State University, 4225 University Ave., Columbus, GA 31907, United States
[d] Pet Behavior Change, LLC, 4951 Preston Forest Dr., Blacksburg, VA 24060, United States

ARTICLE INFO

Article history:
Received 26 May 2016
Received in revised form 1 March 2017
Accepted 7 March 2017
Available online 10 March 2017

Keywords:
Aggression
Food guarding
Food-related aggression
SAFER® assessment
Shelter dogs

ABSTRACT

The hypothesis that free access to food might reduce food-related aggression in shelter dogs was tested. Dogs that exhibited food-related aggression in a standardized assessment (ASPCA SAFER®) were provided either unlimited access to food or two scheduled daily feedings for 3 days (Groups A and B) or 9 days (Groups D and E). Both within- and between-group comparisons revealed no systematic reductions in food-related aggression produced by unlimited access to food under these conditions. For subjects in all experimental groups (i.e., those that exhibited food-related aggression on an initial assessment), aggression scores sometimes decreased but were not related consistently to whether food access was unlimited or scheduled. For subjects that did not exhibit food-related aggression on an initial assessment (Group C), aggression scores increased slightly across assessments. Statistical tests to determine if SAFER® food scores changed across assessments due to 3-day feeding manipulations yielded *p* values above 0.05 on 5 of 6 tests. SAFER® food scores increased after (one of the) 3 days of scheduled feeding for dogs in a control group ($p = 0.048$). Food-related aggression decreased following 9 days of scheduled feeding ($p = 0.002$) and 9 days of free feeding ($p = 0.026$). Overall, then, food access did not systematically affect food-related aggression in shelter dogs as measured by the SAFER® assessment using the temporal parameters arranged.

1. Introduction

In dogs, food can set the occasion for aggressive behavior if a dog is approached or touched while eating (Lindsay, 2005; Overall, 2013). This response has been referred to as "food guarding" and has been reported to be the most common circumstance surrounding dog bites to familiar children (Reisner et al., 2007). Hence, an evaluation of dogs' behavior in the presence of food and their response to an attempt to remove the food is included in many animal shelters' behavioral assessment strategies prior to adoption [see Assess-A-Pet™ (Bollen and Horowitz, 2008); Match-Up Behavior Evaluation (Dowling-Guyer et al., 2011); Match-Up II Shelter Dog Rehoming Program (Marder et al., 2013); ASPCA SAFER® Aggression Assessment (Weiss, 2012)]. All of these evaluations include an assessment of a dog's response to being touched on the head or body or when attempting to remove the food bowl while the dog is eating. Dogs are scored based on the presence, absence, or severity of aggressive behavior exhibited. In a survey of 77 shelters nationwide, 14% of dogs being evaluated for adoption exhibited aggressive behavior in the presence of food or non-food items and over half these shelters considered the dogs unadoptable (Mohan-Gibbons et al., 2012).

The variables that affect food-related aggression are not well understood. For example, dogs that exhibit food-related aggression in a shelter do not always exhibit that aggression in their adopted homes and dogs that do not show food-related aggression in the shelter may exhibit the behavior after adoption (Marder et al., 2013). Variables that might affect the probability or severity of food-related aggression in shelter dogs include stress caused by the shelter environment (Bennett et al., 2015), the provocative nature of the food-guarding assessment (Marder et al., 2013), variables in individual dogs' learning histories, ages, or motivational variables such as the type or degree of access to valued food items.

Of these variables, the most feasible for shelters to control is probably the degree of food access, which would presumably change the motivational value of food. Dogs will guard food from

* Corresponding author.
E-mail address: julie@humaneohio.org (J. Lyle).

http://dx.doi.org/10.1016/j.applanim.2017.03.004
0168-1591/

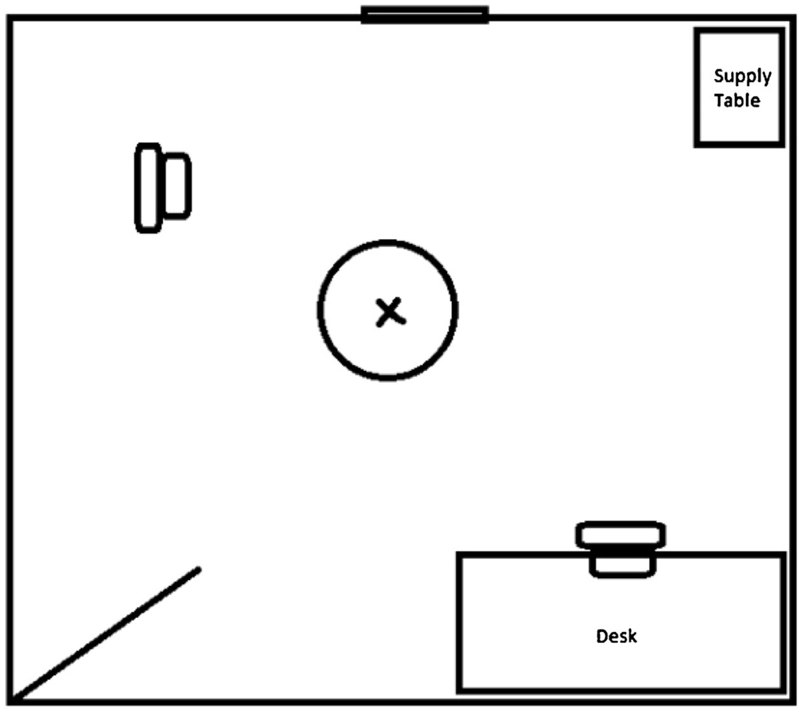

Fig. 1. Floor diagram of room where SAFER® Assessments were conducted. The *x* marks the spot where the food bowl was placed. The circle represents a 12-in (or, approximately 30-cm) radius of space that was marked on the floor to provide a visual demarcation, allowing the assessors to determine whether the dog moved more than 0.30 m from the bowl in those instances when a dog left the bowl while exhibiting aggression. A table, desk, and 2 chairs were in the room (as labeled) but were not used for food-related testing.

one another and food-related growls will deter other dogs from approaching a food item (Cafazzo et al., 2010; Farago et al., 2010). Thus, if access to a food source is restricted or limited making food highly valued, dogs may be more likely to engage in aggressive behavior to prevent food removal by another dog or a human. It is known from studies of deprivation and satiation in a variety of species that the value of a stimulus can be changed by controlling access to it (e.g., Epstein et al., 2003; Miniamimoto et al., 2012). For instance, in rats the motivational value of food can be affected by body weight (Ferguson and Paule, 1997), food deprivation level, and food quality (Gulotta and Byrne, 2015). In rats, food deprivation can engender competitive fighting (Davis, 1933; Zook and Adams, 1975) and higher levels of territorial aggression than free-fed controls (Lore et al., 1986). However, in group-housed dogs placed on restricted calorie diets (25, 40 or 50% reduction) to induce weight loss, most showed no change in the frequency of biting, snapping, mounting or focused barking (note, dogs were fed separately and food-guarding behavior was not evaluated) (Crowell-Davis et al., 1995a,b). Although scheduled daily feeding, as is typical in most shelter environments, is not equivalent to food deprivation, it remains possible that this restricted, scheduled feeding produces higher rates of food-related aggression relative to conditions of unlimited access to food. Indeed, one of the recommended components of at least one behavior modification program for reducing food-guarding behavior is free access to food (Mohan-Gibbons et al., 2012).

The recommendation by Mohan-Gibbons et al. (2012) to provide food-guarding dogs with free access to food is consistent with a behavioral perspective that food-related aggression would vary as a function of the degree of food access if the aggression serves the purpose of food protection/procurement. From this perspective, the degree of food access may be interpreted as a *motivating operation* (see Laraway et al., 2003). Motivating operations are events, operations, or stimulus conditions that momentarily alter the reinforcing effectiveness (i.e., value) of other events. In the present case, food deprivation or food satiation could alter the reinforcing effectiveness (i.e., value) of food and, in turn, alter the likelihood of aggressive behavior that functions to prevent its removal or regain its access. In other words, if the dog has been deprived of food, even for just several hours, he or she may find food access more reinforcing and be more likely to exhibit behavior that in the past has prevented its removal. If the dog is provided with free access to food, the dog may be less motivated to prevent the removal of food.

The purpose of this study was to assess the effect of food access (free food access versus scheduled food access) on the behavior of dogs exhibiting food-related aggression in a shelter environment. Although the provision of free access to food as a means to ameliorate food guarding has sometimes been recommended, the efficacy of such a manipulation has, to our knowledge, not been tested systematically.

2. Materials and methods

The study design was approved by the Institutional Animal Care and Use Committee of Northern Michigan University.

2.1. Study site

This study was performed at the Lucas County Canine Care & Control shelter (LC4) in Toledo, Ohio, USA from October 2014 to September 2015. LC4 is an open-admission municipal dog shelter with an intake of approximately 3600 dogs per year. Their canine population consists of dogs surrendered by their owners and stray dogs brought in by citizens or picked up by Canine Control Officers. The approximately 25 shelter staff ranged in education level from completion of high school or equivalent to completion of a veterinary degree. The Live Release Rate (i.e., percentage of dogs adopted

Table 1
Dry Food and Canned Food Provided During SAFER® Assessments Based on Body Weights of Dogs.

Body Weight Range	Amount and Type of Food Offered
5–29.9 lbs (2.25–13.40 kg)	1 cup (236.6 g) kibble, 1/3 cup (78.8 g) canned food
30–60 lbs (13.50–27.00 kg)	2 cups (473.2 g) kibble, 2/3 cup (157.6 g) canned food
>60 lbs (>27.00 kg)	3 cups (709.8 g) kibble, 1 cup (236.6 g) canned food

Note: The English measurement system was used during the study.
Estimates of metric equivalents are provided here for dissemination purposes.

Table 2
SAFER® Assessment Score Based on Observed Dog Behavior.

Observed Dog Behavior	SAFER Score
Lifted its head out of the bowl and ceased eating or that followed the pulled bowl without interfering in its movement and remained soft and loose in its body carriage and lifted its head when its muzzle was pushed	1
Followed the moving bowl with tail down though slightly stiff in body and lifted its head from the bowl only after a bit of muzzle pressure	2
Followed the dish with tail between its legs, ears forward and body stiff or did not lift its head from the bowl when the artificial hand was pressed against its muzzle, or who gulped food, ate faster with bigger bites with a stiff body and did not lift its head out of the bowl when pressed	3
Froze or growled	4
Bit or attempted to bite	5
No interest in food	N/I

out or returned to their original owners as opposed to being euthanized) at this shelter during the time course of this study was 65%. The average length of stay for all dogs at this shelter during the time course of this study was 11.95 days.

2.2. Animals and housing

Approximately 1600 dogs were behaviorally evaluated over the time course of this study. Upon intake to the shelter, all dogs were briefly examined by a veterinarian or veterinary technician and provided with necessary vaccinations and deworming medication. Dogs were assessed behaviorally by shelter staff using the SAFER® assessment described below, and those who met inclusion criteria for the study were assigned to an experimental group. This initial SAFER® assessment was conducted after a mean of 6.5 days in the shelter, with a range of 1–16 days across dogs. All dogs were housed individually in the shelter; dogs over 11.33 kg (25 lbs) were housed in a cement kennel run and dogs under 11.33 kg were housed in a stainless steel cage. Except for those in free-feeding conditions, dogs were fed dry kibble twice daily, with the amounts determined by each dog's body weight (see Table 3), and had fresh water available in the kennel at all times. All dogs received two short walks per day and twice-weekly access to toys stuffed with canned food, dog treats, or peanut butter and "foodsicles" (dry kibble mixed with canned food and water, frozen in a plastic container and taken out of the container once frozen). Dogs were offered off-leash play opportunities with other dogs several times per week.

Dogs selected for this study ($N = 122$) were at least 6 months old (with a range in age from 6 months to 10 years and a median age of 1 year) and scored a 1 or 2 on all non-food components of the SAFER® assessment (see below). Dogs were excluded from the study if they exhibited any of the following responses or characteristics while being assessed at the food bowl:

1. Left the food bowl by more than 0.30 m to bite the fake hand (2 dogs).
2. Advanced up the hand while biting multiple times (1 dog).
3. Picked up and moved the bowl with teeth.
4. Placed body between the assessor and the food bowl.
5. Placed a foot into the food bowl while guarding (1 dog).
6. Urinated on/in the food bowl.
7. Were pregnant or lactating (2 dogs)
8. Were being treated with veterinarian-prescribed prednisone or phenobarbital.

Subjects included 80 males (70 of whom were intact) and 42 females (37 of whom were intact). Nineteen subjects were surrendered to the shelter by owners, while 103 were stray dogs surrendered to the shelter by the public or picked up by Canine Control Officers. Dogs represented 19 breeds or predominant breed mixes, with the majority identified by shelter staff as Pit Bull (60%), German Shepherd Dog (10.6%), or Boxer (6.5%) mixes. Remaining breeds or breed mixes comprised no more than 5% of dogs in the study. Data on breed were not analyzed in relation to general shelter population, so conclusions cannot be drawn in terms of the relation between breed and likelihood of meeting inclusion criteria for this study.

In accord with shelter policy, and after completion of the study, all dogs who had a SAFER® score of 1 or 2 and any non-pit bull type dogs who scored a 3 on the final assessment (see below) were placed up for adoption. All dogs who scored a 4 or 5 or pit bull type dogs who scored a 3 or higher on the third assessment were offered to the shelter's transfer partner agencies. Dogs that did not go up for adoption and had no transfer partner interest after 7 days were euthanized.

2.3. SAFER® assessment

All dogs were assessed using the American Society for the Prevention of Cruelty to Animals (ASPCA) SAFER® Aggression Assessment (Weiss, 2012). Several components of behavior were assessed (including responses to head restraint and direct eye contact, body touch, active play and noise, squeezed paws, when disturbed while eating from a bowl, when disturbed while in the possession of toys and rawhide, and the introduction of another dog). Overt behavior in each component was assigned a score ranging from 1 to 5. The assessments were conducted by two assessors, at least one of whom was SAFER® certified, in a room at the shelter measuring 3.35 m by 4.15 m. A floor diagram of the room is provided in Fig. 1. Duct tape was used to mark an X on the floor and a 0.61 m diameter circle surrounding it. This visual demarcation allowed the assessors to determine whether the dog moved more

Table 3
Dry Food Amounts (Based on Manufacturer's Guidelines) Provided to Dogs during Scheduled Feeding.

Body Weight Range	Amount of Dry Kibble Provided
5–10.9 lbs (2.26–4.98 kg)	1/4 cup or 2 oz (59.15 g)
11–20.9 lbs (4.99–9.52 kg)	1/2 cup or 4 oz (118.29 g)
21–30.9 lbs (9.53–14.05 kg)	3/4 cup or 6 oz (177.44 g)
31–40.9 lbs (14.06–18.59 kg)	1 cup or 8 oz (226.79 g)
41–60.9 lbs (18.60–27.66 kg)	1 1/4 cup or 10 oz (283.49 g)
61–80.9 lbs (27.67–36.73 kg)	1 1/2 cup or 12 oz (340.19 g)
81–100 lbs (36.74–45.36 kg)	1 3/4 cup or 14 oz (396.89 g)
>100 lbs (>45.36 kg)	2 cups or 16 oz (453.59 g)

Note: The English measurement system was used during the study.
Estimates of metric equivalents are provided here for dissemination purposes.

than 0.30 m from the bowl in those instances when a dog left the bowl while exhibiting aggression.

In the food aggression assessment component, the dog was provided access to a stainless steel bowl containing a mixture of dry kibble and canned food of an amount determined by the weight of the dog as shown in Table 1. In accordance with SAFER® assessment instructions, if the dog did not begin eating the assessment food within 10 s, 2.66 oz of thawed frozen dog food (Bil Jac® Frozen Dog Food, Bil-Jac, Medina, OH, USA) was added to the bowl and documented.

Two handlers were present during every assessment. One handler held a 1.22 m leash attached to a buckle or martingale collar on the dog but did not otherwise interact with the dog. The other handler conducted the assessment, which involved approaching the dog with an artificial hand (latex hand on a pole 0.60 m in length) while the dog was eating, using it to pull the dish away from the dog, and then pushing once on each side of the dog's muzzle with the artificial hand. In accord with SAFER® assessment instructions, the dog was scored based on criteria shown in Table 2.

2.4. *Experimental procedures*

Dogs meeting the inclusion criteria who also scored a 3, 4, or 5 on the food bowl assessment were considered to be showing food aggression (FA+) and were randomly assigned to Group A or Group B. Dogs that scored a 1 or 2 on the food bowl assessment were considered not to be showing food aggression (FA-) and were placed into Group C. Subjects in Groups A and B were exposed to experimental conditions in the context of a multiple baseline design with a reversal component. Subjects in Group C served as a control for any learning effects that might occur as a result of the repeated assessments. The multiple baseline design required that subjects in Groups A and B be exposed to the independent variable (free feeding) at different times.

Dogs assigned to Group A ($n = 27$) were free-fed dry kibble – either Diamond (Diamond Pet Foods, Meta, MO, USA) or Blue Buffalo – (Blue Buffalo Company, Wilton, CT, USA) available 24 h per day in each dog's kennel for 3 days, whereas dogs assigned to Group B ($n = 39$) were fed two fixed-quantity meals per day (same dry kibble brands, with quantities determined as described in Table 3) for 3 days. Dogs assigned to Group C ($n = 19$) remained on the regularly scheduled fixed-quantity meal twice per day. After 3 days, all dogs were reassessed and dogs in Groups A and B entered the reversal phase of the study. Dogs in Group A were then fed two fixed-quantity meals a day for 3 days and dogs in Group B were free-fed for 3 days. Dogs in Group C continued to receive the scheduled fixed-quantity feedings twice daily after the second assessment. Dogs in all groups were then reassessed. Experimental sessions were conducted at various times during the day based on staff availability and subjects' time since their last meal in scheduled feeding conditions was not controlled.

Table 4
Numbers and Mean Body Composition Score of Dogs Earning Each Food Score During the Initial SAFER® Assessment.

Food SAFER® Assessment Score	Number of Dogs	Body Composition Score
5	16	4.3
4	20	4.2
3	90	4.4
2	111	4.4
1	123	4.4
No Interest	59	4.8

To ensure that the dogs were only exhibiting aggression in the presence of food, during reassessment each dog's behavior was also reassessed in the presence of toys and rawhide in accord with SAFER® guidelines. Toy choices (rope toy with attached tennis ball and fleece stuffed toy) and rawhide type (20-cm retriever rolls) were consistent across all assessments.

To establish inter-rater reliability, 30% of the video-taped assessments were scored by an independent observer who was SAFER® certified, blind to experimental conditions, and unaffiliated at that time with the shelter or the subjects. Kappa was calculated to measure inter-rater reliability, yielding a significant value, $K = 0.571$, $p < 0.001$. Though significant, this Kappa value is weak by general standards of interpreting Kappa (see McHugh, 2012). But several points should help contextualize this Kappa value. First, original observers (i.e., those from whom scores are reported and analyzed in this paper) rated dogs' aggression based on live observation during the SAFER assessment. The second observer rated dogs' aggression from video tapes of the original sessions/assessments. Second, Bakeman et al. (1997) conducted simulations showing that Kappa values are smaller when the number of response codes is small; for a study like this one containing 5 codes/scores, they argue a Kappa value of 0.66 (rather than a typically sought 0.80) is considered good. Third, when analyzing the observers' scores more closely, the two scores reported by the observers for a dog's aggression never differed by more than one point (or, score decrement). Further, the two observers' scores were the same for 26 dogs while the second observer rated a dog's aggression higher than the original observer in 13 cases and lower than the original observer in 7 cases.

2.4.1. *Groups D and E*

After data collection was complete for Groups A, B, and C, two groups were introduced to assess the effect of longer access to free-feeding. Dogs in Group D ($n = 27$) and Group E ($n = 10$) were exposed to the same initial assessment and subject to the same inclusion criteria as Groups A and B. After the initial assessment, dogs in Group D were exposed to 9 days of unlimited food access and dogs in Group E were exposed to 9 days of twice-daily scheduled feedings. All dogs were then reassessed 10 days after the initial assessment.

2.4.2. *Body condition scores*

During the first 4 months of this study, data were kept on all dogs that were evaluated, including their score on the food assessment and their body condition score, using the Nestle Purina Body Condition System (Nestle Purina Pet Care Center, St. Louis, MO, USA) with the range of scores 1 (emaciated) to 9 (obese). The scores of 4 and 5 are considered ideal (Kealy et al., 2002). Of 419 SAFER® assessments completed between October 2014 and February 2015, Table 4 depicts the average body condition score of dogs assessed separated by their score on the food portion of the SAFER® assessment. There were no significant correlations between body condition scores and SAFER® scores ($p > 0.05$), so body condition scores were no longer analyzed according to Pearson's r analyses.

2.5. Statistical analysis

Statistical tests were chosen based on type of measurement, distribution of scores, and whether comparisons were made within or between subjects. Within-subject comparisons (i.e., statistical tests involving repeated assessments of the same dogs) were completed by comparing food scores from one administration to another and by calculating and comparing change scores. Change scores represent increases or decreases in food SAFER® scores (hereafter, food scores) from one administration to the next administration. Since distributions of food scores and change scores were not normal, their statistical significance was tested using Wilcoxon Sign Rank test with an alpha level of 0.05. Food scores, an ordinal measure, were compared between groups of dogs to validate further the within-subject findings. Kruskal Wallis and Mann Whitney U (non-parametric alternatives to ANOVA and independent-samples *t* test) were used to compare food scores between dogs in different groups. Change scores also were compared between dogs using the Mann Whitney U statistic because change scores were not normally distributed. All statistics used to determine experimental effects were calculated using XLSTAT (by Addinsoft) and interrater reliability was calculated using SPSS (by IBM).

3. Results

3.1. Groups A–C

Data were analyzed for dogs in Groups A ($n = 27$), B ($n = 39$), and C ($n = 19$) that earned a food score on all three occasions of assessment. All food scores for each dog in each group are provided in Appendix A. (Scores for Toy and Rawhide assessments are available from the first author upon request.) Table 5 contains descriptive statistics of food scores for dogs in each group at each administration time of the SAFER® assessment. Table 5 also contains mean change score for dogs in each group. Individual change scores were calculated for each dog by taking the difference between a dog's food score for one assessment administration and that dog's food score for the previous assessment administration (e.g., second assessment score minus first assessment score). A positive change score indicates that the dog's food score increased (i.e., aggression increased) from one assessment administration to the next assessment administration. A negative change score indicates that a dog's food score decreased from one assessment to the next assessment.

Table 5
Mean, Median, Mode, Minimum (Min), and Maximum (Max) for dogs in each groupat each SAFER® administration and for change scores.

	Descriptive Statistic			
	Mean	Median	Mode	Min–Max
Group A				
Initial	3.30	3	3	3–5
Post Free	3.04	3	3	2–5
Post Sched	3.04	3	3	1–5
Change (Initial – Post Free)	−0.26	0	0	−3 to 2
Change (Post Free – Post Sched)	0.00	0	0	−1 to 1
Group B				
Initial	3.18	3	3	3–5
Post Free	3.08	3	3	2–5
Post Sched	2.85	3	3	1–5
Change (Initial – Post Sched)	−0.10	0	0	−2 to 2
Change (Post Sched – Post Free)	−0.23	0	0	−3 to 1
Group C				
Initial	1.53	2	2	1–2
Post Free	1.84	2	2	1–3
Post Sched	2.26	2	3	1–5
Change (Initial – Post Sched)*	0.32	0	0	0–2
Change (Post Sched – Post Sched)	0.42	0	0	−1 to 3
Group D				
Initial	3.22	3	3	3–5
Post Free	2.41	3	3	1–4
Change (Initial – Post Free)*	−0.81	0	0	−3 to 1
Group E				
Initial	4.20	4	4	3–5
Post Sched	3.30	3.5	4	1–5
Change (Initial – Post Sched)*	−0.90	−1	−1	−4 to 0

Note: Asterisk (*) indicates significant changes in food scores according to a Wilcoxon Sign Rank test. Positive change score means food scores increased across the assessments; negative change score means food scores decreased across the assessments.

3.1.1. Group A

For dogs in Group A, the second assessment occurred after 3 days of free feeding and the third assessment occurred after 3 days of scheduled feeding. After the free feeding period, only 1 dog showed an increase and 6 dogs showed a decrease in food score. There was no change in food score for the remaining 20 dogs in Group A after the free feeding period. After aggregating food scores for the initial assessment and the post free-feeding assessment (see Table 5), a Wilcoxon Sign Rank test indicated there is not enough evidence to conclude food scores changed for dogs in Group A after 3 days of free feeding, $W = 22.50$, $p = 0.17$.

After the scheduled feeding period, 4 dogs showed an increase and 4 dogs showed a decrease in food score. There was no change in food score for the remaining 19 dogs in Group A after the scheduled feeding period. After aggregating food scores for the post free-feeding assessment and the post scheduled-feeding assessment (see Table 5), a Wilcoxon Sign Rank test indicated there is not enough evidence to conclude food scores changed for dogs in Group A after 3 days of scheduled feeding, $W = 18.00$, $p = 1.00$.

3.1.2. Group B

For dogs in Group B, the second assessment occurred after 3 days of scheduled feeding and the third assessment occurred after 3 days of free feeding. After the scheduled feeding period, 4 dogs showed an increase and 9 dogs showed a decrease in food score. There was no change in food score for the remaining 26 dogs in Group B after 3 days of scheduled feeding. After aggregating food scores for the initial assessment and the post scheduled-feeding assessment (see Table 5), a Wilcoxon Sign Rank test indicated there is not enough evidence to conclude food scores changed for dogs in Group B after 3 days of scheduled feeding, $W = 56.00$, $p = 0.46$.

After the free feeding period, 2 dogs showed an increase and 8 dogs showed a decrease in food score. There was no change in food score for the remaining 29 dogs in Group B after the free feeding period. After aggregating food scores for the post scheduled-feeding assessment and the post free-feeding assessment (see Table 5), a Wilcoxon Sign Rank test indicated there is not enough evidence to conclude food scores changed for dogs in Group B after 3 days of free feeding, $W = 46.0$, $p = 0.052$.

3.1.3. Group A versus Group B

To further assess the efficacy of free feeding as a means to decrease food-related aggression, scores for dogs in Groups A and B were compared for each administration of the SAFER® assessment. Comparing food scores for the initial assessment did not reveal any significant difference between dogs in Groups A and B upon intake,

$U = 559.00$, $p = 0.503$; that is, there is no evidence that dogs in the two groups were different in food-related aggression prior to any manipulation of food availability. Food scores for dogs in Groups A and B for the second and third assessments also were not different: $U = 519.50$, $p = 0.92$ and $U = 592.50$, $p = 0.347$, respectively. This between-group analysis fails to support for any prediction that exposure to freely available food changes food-related aggression in dogs (at least as measured by the SAFER® assessment).

3.1.4. Group C

For dogs in Group C, the second and third assessments occurred after 3 days of scheduled feeding; that is, dogs in this group received scheduled feeding throughout the study. After the first 3 days of scheduled feeding, 5 dogs showed an increase in food scores and 0 dogs showed a decrease in food score. There was no change in food score for the remaining 14 dogs in Group C after the first 3 days of scheduled feeding. After aggregating food scores for the initial assessment and the post scheduled feeding assessment (see Table 5), a Wilcoxon Sign Rank test indicated that food scores increased significantly after 3 days of scheduled feeding ($W = 0.00$, $p = 0.048$). From the initial assessment to the second assessment, there was a 20.7% increase in food score (averaged across all dogs in Group C), but only 5 of 19 dogs (or 26.3% of dogs) exhibited an increase in food aggression.

After the second 3 days of scheduled feeding, 7 dogs showed an increase and 2 dogs showed a decrease in food scores. There was no change in food scores for the remaining 10 dogs in Group C. Aggregated food scores from the second assessment to the third assessment for dogs in Group C was not significant, $W = 8.00$, $p = 0.08$, indicating that food scores did not increase after continued scheduled feeding for another 3 days.

3.2. Groups D and E

Aggregated food scores for the dogs in Group D ($n = 27$) are shown in Table 5 for each administration of the SAFER® assessment. In Group D, only 1 dog showed an increased food score after 9 days of free feeding. Food scores decreased for 13 dogs and remained the same for 13 dogs in Group D from the first assessment to the second assessment. As a group, a significant decrease in food scores occurred from the first assessment to the second assessment, $W = 102.00$, $p = 0.002$. The percent reduction in aggression exhibited by dogs in Group D after 9 days of free feeding was 25.2%; 13 of 27 dogs (48% of dogs) showed at least some decrease in food scores after free feeding.

Aggregated food scores for the dogs in Group E ($n = 10$) are shown in Table 5 for each administration of the SAFER® assessment. In Group E, no dogs showed an increase in food scores after 9 days of scheduled feeding. Food scores decreased for 6 dogs and remained the same for 4 dogs in Group E from the first assessment to the second assessment. As a group, a significant decrease in food scores occurred from the first assessment to the second assessment, $W = 21.00$, $p = 0.026$. The percent reduction in aggression exhibited by dogs in Group E after 9 days of scheduled feeding was 21.4%; 6 of 10 dogs (60% of dogs) showed at least some decrease in food scores after scheduled feeding.

3.2.1. Group D versus Group E

To further assess the efficacy of free feeding to decrease food-related aggression, scores for dogs in Groups D and E were compared for each administration of the SAFER® assessment. The comparison of food scores for the initial intake revealed significantly higher food scores for dogs in Group E upon intake ($U = 35.50$, $p < 0.001$) and the second assessment ($U = 75.00$, $p = 0.032$) compared to dogs in Group D. The decrease in food scores (i.e., change scores) for dogs in Groups D and E were not significantly different ($U = 137.00$, $p = 0.96$), indicating there was not enough evidence to conclude the reduction in food scores was related to food availability (i.e., whether dogs received 9 days of free feeding or scheduled feeding).

4. Discussion

We found no systematic nor robust differences in subjects' food aggression scores as a function of access to free versus scheduled feeding in the shelter setting. Food scores for dogs in Groups A and B did not change following 3 days of free feeding followed by 3 days of scheduled feeding. When the feeding conditions were extended to 9 days before SAFER® reassessment, Groups D (free feeding) and E (scheduled feeding) both exhibited significant reductions in food scores of 25% and 21%, respectively, with no difference in change scores between groups.

Interestingly, the only group to show significant increases in scores across assessments (indicating increases in aggression) was Group C. Before we conclude that scheduled feeding for this group resulted in increases in food aggression, however, it is important to note that subjects in Group C were included only if they scored 1 or 2 during the initial assessment. Their overall increase thus could have been due to a floor effect combined with the possible role of repeated assessing. Yet for all other groups, repeated assessing was associated with decreases in food scores, suggesting that repeated assessing alone cannot be the major determining factor of increased food scores for Group C dogs.

Levels of food-related aggression among groups whose subjects exhibited food aggression in the initial assessment tended to decrease across assessments, with half of these decreases reaching statistical significance. It is possible that time in the shelter may attenuate levels of stress, in turn impacting the probability or intensity of aggression exhibited during behavioral assessments. Hennessey et al. (2001) found that initially high plasma cortisol levels in dogs admitted to animal shelters decreased across the first 9 days in the shelter. Relationships between stress and time in the shelter can be complicated by other factors, however, including the dogs' previous living conditions relative to current shelter conditions (Beerda et al., 1999; Hiby et al., 2006). Bennett et al. (2015) compared dogs' scores on all components of the SAFER® assessment at Day 0 to those on Day 3 in the shelter, and found highly variable results across subtests with no overall trend in scores across assessment days. In this study, we did not control for time spent in the shelter at assessment, and subjects were initially assessed between 1 and 16 days after arriving in the shelter (mean of 6.5 days). We must consider as well, however, that subjects in Group C, who exhibited no food aggression during the initial assessment, showed a small but significant increase in SAFER® score after the first 3 days of scheduled feeding, drawing into question the sole influence of abating stress over time. The interactions between stress and aggressive responses obtained by behavioral assessments in the shelter environment require further elucidation.

Our findings that unlimited access to food did not reduce food-related aggression relative to restricted access seem to contradict the finding that satiation reduces the value of a reinforcer and thus presumably the motivation to acquire and defend access to it. O'Reilly et al. (2007) examined levels of challenging behavior in a child whose aggression had been maintained by access to snacks. They found that providing the child with free access to snacks (as opposed to no access for several hours) dramatically reduced aggression during subsequent instructional tasks. Satiation of other functional reinforcers has also been used to successfully reduce hoarding (Ayllon, 1963), stereotypy (Lang et al., 2010; Rispoli et al., 2014), obsessive-compulsive behavior (Khodarahimi, 2009), and sexually deviant behavior (O'Donohue and Fisher, 2009) in humans.

Based on the fact that physical pain has been found to elicit aggression in animals, Scott (1958) hypothesized that food deprivation may increase aggression by serving as a pain-inducing condition (i.e., through hunger pangs and stomach contractions). This conceptualization has some support in the literature. For example, Davis (1933) found that rats deprived of food for 24 h exhibited no aggression toward a conspecific placed into their cage with food present. When food deprivation was increased to 48 h, however, aggression was exhibited. It is possible that the latter deprivation levels were necessary to produce physical pain. Cahoon et al. (1971) measured aggression by rats toward an inanimate object and found that, while rats deprived of food for 24 h did not exhibit any aggression, food-deprived rats who also received electric shock were significantly more likely to bite at the object than their non-deprived counterparts, suggesting that the combination of pain and deprivation was necessary to produce aggression. In group-housed dogs exposed to caloric restriction but fed separately, Crowell-Davis et al. (1995a) found that most dogs showed no change in the frequency of biting, snapping, mounting or focused barking; noted exceptions were limited to a specific breed (Miniature Schnauzer) at the highest restriction levels and were characterized by an initial increase and then a decrease in focused barking (defined as lunging toward and repeatedly barking at another dog). The authors suggest the initial increase may have been a response to hunger. Based on this interpretation, one could argue that the scheduled food access in the current experiment was insufficient to produce physical pain and thus result in an increased likelihood of aggression. To our knowledge, there have been no direct comparisons of food deprivation or satiation on food-related aggression in dogs.

There are several possible explanations for our finding that food-related aggression was not reduced by free access to food. First, it might be the case that true satiation did not take place. That is, we provided dogs with free access to food in their kennels, but did not measure consumption of food. It is possible that some dogs ate more than others, and further research should examine relationships between food guarding and recent food consumption rather than mere availability. True satiation also may not have taken place to the extent that food quality was altered during assessment conditions. Specifically, to comply with SAFER® instructions, some canned food was added to the kibble during the assessment. Yet only kibble (without canned food) was provided ad libitum. Perhaps satiation effects are specific to the type of food offered and would better predict food-related aggression if this type matched that used during the assessment. Second, it is possible that food-related aggression is not strictly a function of food value. That is, aggression as it was assessed here may have a history of being maintained by other reinforcers (Mehrkam et al., 2015, manuscript in preparation). No functional analyses were conducted here to determine that food-related aggression was in fact maintained by access to food. For some dogs, for example, aggression around the food bowl produces attention from owners in the form of attempts to calm or assuage the dog. If attention is a maintaining variable for aggression around the food bowl, we would not expect changes in levels of aggression related to food availability.

Third, aggression may be evoked by conditioned stimuli associated with food, including the food bowl or the smell of food. If such stimuli serve as conditioned reinforcers through a history of pairing with the food itself, then their presence during assessment and/or the threat of their removal may continue to evoke guarding/aggressive behavior, even if the current value of the food itself is relatively low. Fourth, food-related aggression in some dogs may be a product of stimulus generalization (Guttman and Kalish, 1956). That is, dogs may have a history of reinforcement for exhibiting resource guarding in the presence of a variety of other potential resources (e.g., toys, rawhides, resting places, preferred family members) and food-related aggression then may be evoked through the process of response generalization under conditions in which aggression is not currently reinforced and the value of the food is not necessarily high. Certainly, there are many situations in the home environment in which dogs may engage in guarding behavior in the presence of an item to which they have free access (e.g., toys), suggesting that satiation cannot be the sole factor influencing resource guarding. Finally, while it has traditionally been assumed that resource guarding in the form of aggression toward humans might be a function of a dog's dominance or attempts to gain dominance status, it is more generally accepted that dominance is not a trait characteristic of any individual dog and that dominance relations arise only from repeated interactions between known individuals (Shepherd, 2002). Even if we characterize the series of SAFER® assessments conducted with each dog as repeated interactions, an ethological explanation of aggression would be better characterized in terms of the dog's assessment of resource-holding potential (Parker, 1974; Reisner, 2002), which would in turn be determined in part by the subjective value of the resource (Bradshaw et al., 2009). Thus, satiation would still be expected to play some role.

In conclusion, within the temporal parameters of this study there is no evidence to suggest that providing free access to food in the shelter environment can robustly reduce food-related aggression, at least as assessed by the SAFER® Agression Assessment. Elucidating the variables that control food-related aggression and developing strategies that most effectively prevent or reduce its occurrence remain important goals. Ultimately, as has been recommended by others (e.g., Mohan-Gibbons et al., 2012), an individualized behavior plan designed to prevent and/or address food-related aggression directly remains an important element in tackling this behavior.

Appendix A.

Tables A1–A4

Table A1
Food SAFER® assessment scores at each assessment time (bold font) for each dog in Group A, and change scores that show increases or decreases in food score across assessments.

Dog/Subject	Food SAFER® assessment Scores and Change Scores					
	SAFER® $_1$ Initial	SAFER® $_2$ Post Free Feeding	Change Score (Initial to Post Free)	SAFER® $_3$ Post Sched Feeding	Change Score (Post Free to Post Sched)	Change Score (Initial to Post Sched)
Hazel	**3**	**3**	*0*	**3**	*0*	*0*
Oscar	**3**	**3**	*0*	**4**	*1*	*1*
BabyGirl	**4**	**4**	*0*	**4**	*0*	*0*
Pixie	**3**	**5**	*2*	**5**	*0*	*2*
Simba	**5**	**3**	*−2*	**3**	*0*	*−2*
Tony	**3**	**3**	*0*	**3**	*0*	*0*
Boss	**3**	**3**	*0*	**4**	*1*	*1*

Table A1 (*Continued*)

Dog/Subject	Food SAFER® assessment Scores and Change Scores					
	SAFER® 1 Initial	SAFER® 2 Post Free Feeding	Change Score (Initial to Post Free)	SAFER® 3 Post Sched Feeding	Change Score (Post Free to Post Sched)	Change Score (Initial to Post Sched)
EllieMae	**3**	**2**	*−1*	**3**	*1*	*0*
SugarBear	**3**	**3**	*0*	**2**	*−1*	*−1*
Holly	**3**	**3**	*0*	**3**	*0*	*0*
Dude	**5**	**2**	*−3*	**2**	*0*	*−3*
Suzie	**4**	**2**	*−2*	**N/I**	*N/A*	*N/A*
Cookie	**3**	**3**	*0*	**3**	*0*	*0*
Snookie	**3**	**2**	*−1*	**2**	*0*	*−1*
Buck	**3**	**3**	*0*	**3**	*0*	*0*
Salem	**3**	**2**	*−1*	**1**	*−1*	*−2*
Cotton	**3**	**3**	*0*	**3**	*0*	*0*
Lilly	**3**	**3**	*0*	**4**	*1*	*1*
Fred	**3**	**3**	*0*	**2**	*−1*	*−1*
Dozer	**3**	**3**	*0*	**3**	*0*	*0*
Jameson	**4**	**4**	*0*	**4**	*0*	*0*
Levi	**3**	**3**	*0*	**3**	*0*	*0*
Buzz	**3**	**3**	*0*	**3**	*0*	*0*
Diamond	**3**	**2**	*−1*	**2**	*0*	*−1*
Cynthia	**3**	**3**	*0*	**3**	*0*	*0*
Clyde	**3**	**3**	*0*	**3**	*0*	*0*
Midnight	**3**	**3**	*0*	**3**	*0*	*0*
Lionel	**5**	**5**	*0*	**4**	*−1*	*−1*

Note: N/I = Score of No Interest recorded during SAFER® assessment; N/A = Not Applicable.

Table A2
Food SAFER® assessment scores at each assessment time (bold font) for each dog in Group B, and change scores that show increases or decreases in food guarding across assessments.

Dog/Subject	Food SAFER® assessment Scores and Change Scores					
	SAFER® 1 Initial	SAFER® 2 Post Sched Feeding	Change Score (Initial to Post Sched)	SAFER® 3 Post Free Feeding	Change Score (Post Sched to Post Free)	Change Score (Initial to Post Free)
Potter	**3**	**3**	*0*	**3**	*0*	*0*
Ginger	**3**	**3**	*0*	**3**	*0*	*0*
Becca	**3**	**4**	*1*	**4**	*0*	*1*
Doodle	**3**	**2**	*−1*	**3**	*1*	*0*
Hercules	**3**	**3**	*0*	**3**	*0*	*0*
Flounder	**3**	**3**	*0*	**2**	*−1*	*−1*
Vegas	**3**	**3**	*0*	**3**	*0*	*0*
Frosty	**3**	**3**	*0*	**3**	*0*	*0*
Curly Sue	**3**	**3**	*0*	**N/T**	*N/A*	*N/A*
Heidi	**3**	**3**	*0*	**3**	*0*	*0*
Betty	**3**	**5**	*2*	**5**	*0*	*2*
Lucy	**3**	**2**	*−1*	**2**	*0*	*−1*
Roscoe	**4**	**2**	*−2*	**2**	*0*	*−2*
Ollie	**3**	**3**	*0*	**3**	*0*	*0*
Chocolate	**3**	**3**	*0*	**3**	*0*	*0*
Sam	**3**	**3**	*0*	**3**	*0*	*0*
Shaggy	**4**	**5**	*1*	**4**	*−1*	*0*
Cooper	**3**	**3**	*0*	**3**	*0*	*0*
BooBoo	**5**	**4**	*−1*	**1**	*−3*	*−4*
Pacino	**3**	**3**	*0*	**3**	*0*	*0*
Huckleberr	**3**	**3**	*0*	**3**	*0*	*0*
Adelina	**3**	**3**	*0*	**3**	*0*	*0*
Orbie	**3**	**3**	*0*	**3**	*0*	*0*
Chase	**5**	**5**	*0*	**5**	*0*	*0*
Leroy	**3**	**2**	*−1*	**2**	*0*	*−1*
Kylah	**3**	**3**	*0*	**3**	*0*	*0*
Wonderwoof	**3**	**3**	*0*	**3**	*0*	*0*
Fiesta	**3**	**2**	*−1*	**2**	*0*	*−1*
Oreo	**3**	**3**	*0*	**3**	*0*	*0*
Hamilton	**3**	**3**	*0*	**3**	*0*	*0*
Rango	**3**	**5**	*2*	**4**	*−1*	*1*
Savannah	**3**	**3**	*0*	**3**	*0*	*0*
Elmer	**3**	**2**	*−1*	**2**	*0*	*−1*
Gustavo	**4**	**3**	*−1*	**4**	*1*	*0*
Iggy	**3**	**3**	*0*	**1**	*−2*	*−2*
Scout	**3**	**3**	*0*	**2**	*−1*	*−1*
Piggy	**3**	**3**	*0*	**3**	*0*	*0*
Zeus	**3**	**2**	*−1*	**1**	*−1*	*−2*
Chester	**3**	**3**	*0*	**2**	*−1*	*−1*
Saul	**3**	**3**	*0*	**3**	*0*	*0*

Note: N/A = Not Applicable; N/T = Not Tested (Assessment was not conducted).

Table A3
Food SAFER® assessment scores at each assessment time (bold font) for each dog in Group C, and change scores that show increases or decreases in food score across assessments.

Dog/Subject	Food SAFER® assessment Scores and Change Scores					
	SAFER® $_1$ Initial	SAFER® $_2$ Post Sched Feeding	Change Score (Initial to Post Sched)	SAFER® $_3$ Post Sched Feeding	Change Score (Post Sched To Post Sched)	Change Score (Initial to Post Sched)
Dale	**1**	**3**	*2*	**3**	*0*	*2*
Rambo	**1**	**N/I**	*N/A*	**1**	*N/A*	*0*
Emma	**1**	**2**	*1*	**N/I**	*N/A*	*N/A*
Matilda	**1**	**1**	*0*	**1**	*0*	*0*
George	**1**	**1**	*0*	**1**	*0*	*0*
Sarah	**1**	**N/I**	*N/A*	**1**	*N/A*	*0*
Ginger	**1**	**2**	*1*	**2**	*0*	*1*
Major	**2**	**2**	*0*	**5**	*3*	*3*
Jordan	**2**	**2**	*0*	**2**	*0*	*0*
Elvis	**2**	**2**	*0*	**3**	*1*	*1*
Roofer	**2**	**2**	*0*	**3**	*1*	*1*
Otis	**2**	**N/T**	*N/A*	**N/T**	*N/A*	*N/A*
Cali	**2**	**2**	*0*	**2**	*0*	*0*
Scooby	**2**	**2**	*0*	**1**	*−1*	*−1*
Axel	**1**	**1**	*0*	**3**	*2*	*2*
Curtis	**2**	**3**	*1*	**3**	*0*	*1*
Junior	**1**	**1**	*0*	**1**	*0*	*0*
Noah	**1**	**2**	*1*	**1**	*−1*	*0*
Canelo	**1**	**N/T**	*N/A*	**N/T**	*N/A*	*N/A*
Fiona	**2**	**2**	*0*	**3**	*1*	*1*
Twinkle	**1**	**1**	*0*	**1**	*0*	*0*
Slater	**2**	**2**	*0*	**3**	*1*	*1*
Baxter	**1**	**1**	*0*	**2**	*1*	*1*
Dweezil	**2**	**3**	*1*	**3**	*0*	*1*

Note: N/I = Score of No Interest recorded during SAFER® assessment; N/A = Not Applicable; N/T = Not Tested (Assessment was not conducted.).

Table A4
Food SAFER Assessment scores at each assessment time (in bold font) for each dog in Group D and Group E, and the Change Score that shows increases or decreases in food guarding between first and second assessments.

Group D Dog	Food SAFER Assessment Scores and Change Scores		
	Initial	Post Free Feeding	Change Score (Initial to Post Free)
JJ	**3**	**1**	*−2*
Dauber	**4**	**1**	*−3*
Sofia	**3**	**1**	*−2*
Lansing	**3**	**2**	*−1*
Lady	**3**	**3**	*0*
Memphis	**3**	**3**	*0*
Wiley	**4**	**3**	*−1*
Ozzie	**3**	**3**	*0*
Ava	**3**	**N/T**	*N/A*
Dino	**3**	**3**	*0*
Jackson	**3**	**3**	*0*
Buddy	**3**	**3**	*0*
Chubbs	**3**	**1**	*−2*
MJ	**3**	**3**	*0*
Emerald	**3**	**3**	*0*
Keebler	**3**	**1**	*−2*
Conrad	**3**	**4**	*1*
Hebert	**3**	**2**	*−1*
Hootie	**3**	**3**	*0*
Pablo	**3**	**3**	*0*
Pluto	**3**	**3**	*0*
Sheba	**4**	**2**	*−2*
Breeze	**3**	**3**	*0*
Viola	**3**	**1**	*−2*
Kiwi	**3**	**1**	*−2*
Beverly	**3**	**1**	*−2*
Brook	**5**	**4**	*−1*
Archie	**4**	**4**	*0*
Spencer	**5**	**4**	*2*
Bliss	**3**	**2**	*−1*
Bear	**4**	**4**	*1*
Yogi	**4**	**3**	*1*
Soloman	**5**	**1**	*2*

Table A4 (*Continued*)

Group D Dog	Food SAFER Assessment Scores and Change Scores		
	Initial	Post Free Feeding	Change Score (Initial to Post Free)
Clifford	**5**	**5**	*2*
Harry	**4**	**3**	*0*
Abe	**4**	**3**	*1*
Dennis	**4**	**4**	*1*
Patch	**4**	**4**	*1*

Note: N/A = Not Applicable; N/T = Not Tested (Assessment was not conducted).

References

Ayllon, T., 1963. Intensive treatment of psychotic behavior by stimulus satiation and food reinforcement. Behav. Res. Ther. 1, 53–61, http://dx.doi.org/10.1016/0005-7967(63)90008-1.

Bakeman, R., Quera, V., McArthur, D., Robinson, B.F., 1997. Detecting sequential patterns and determining their reliability with fallible observers. Psychol. Methods 2, 357–370, http://dx.doi.org/10.1037/1082-989X.2.4.357.

Beerda, B., Schilder, M.B.H., Van Hooff, J.A.R., 1999. Chronic stress in dogs subjected to social and spatial restriction. I. Behavioral responses. Physiol. Behav. 66, 233–242, http://dx.doi.org/10.1016/S0031-9384(98)00289-3.

Bennett, S.L., Weng, H., Walker, S.L., Placer, M., Litster, A., 2015. Comparison of SAFER® behavior assessment results in shelter dogs at intake and after a 3-day acclimation period. J. Appl. Anim. Welf. Sci. 18, 153–168, http://dx.doi.org/10.1080/10888705.2014.999916.

Bollen, K.S., Horowitz, J., 2008. Behavioral evaluation and demographic information in the assessment of aggressiveness in shelter dogs. Appl. Anim. Behav. Sci. 112, 120–135, http://dx.doi.org/10.1016/j.applanim.2007.07.007.

Bradshaw, J.W.S., Blackwell, E.J., Casey, R.A., 2009. Dominance in domestic dogs—useful construct or bad habit? J. Vet. Behav. 4, 135–144.

Cafazzo, S., Valsecchi, P., Bonanni, R., Natoli, E., 2010. Dominance in relation to age, sex, and competitive contexts in a group of free-ranging domestic dogs. Behav. Ecol. 21, 443–455, http://dx.doi.org/10.1093/beheco/arq001.

Cahoon, D.D., Crosby, R.M., Dunn, S., Herrin, M.S., Hill, C.C., McGinnis, M., 1971. The effect of food deprivation on shock elicited aggression in rats. Psychon. Sci. 22, 43–44.

Crowell-Davis, S.L., Barry, K., Ballam, J.M., Laflamme, D.P., 1995a. The effect of caloric restriction on the behavior of pen-housed dogs: transition from unrestricted to restricted diet. Appl. Anim. Behav. Sci. 43 (1), 27–41, http://dx.doi.org/10.1016/0168-1591(94)00547-R.

Crowell-Davis, S.L., Barry, K., Ballam, J.M., Laflamme, D.P., 1995b. The effect of caloric restriction on the behavior of pen-housed dogs: transition from

restriction to maintenance diets and long-term effects. Appl. Anim. Behav. Sci. 43 (1), 43–61, http://dx.doi.org/10.1016/0168-1591(94)00548-s.
Davis, F.C., 1933. The measurement of aggressive behavior in laboratory rats. J. Genet. Psychol. 43, 213–217.
Dowling-Guyer, S., Marder, A., D'Arpino, S., 2011. Behavioral traits detected in shelter dogs by a behavior evaluation. Appl. Anim. Behav. Sci. 130, 107–114, http://dx.doi.org/10.1016/j.applanim.2010.12.004.
Epstein, L.H., Truesdale, R., Wojcik, A., Paluch, R.A., Raynor, H.A., 2003. Effects of deprivation on hedonics and reinforcing value of food. Physiol. Behav. 78 (2), 221–227.
Farago, T., Pongracz, P., Range, F., Viranyi, Z., Miklosi, A., 2010. 'The bone is mine': affective and referential aspects of dog growls. Anim. Behav. 79, 917–925, http://dx.doi.org/10.1016/j.anbehav.2010.01.005.
Ferguson, S.A., Paule, M.G., 1997. Progressive ratio performance varies with body weight in rats. Behav. Process. 40, 177–182, http://dx.doi.org/10.1016/S0376-6357(97)00786-9.
Gulotta, K.B., Byrne, T., 2015. A progressive-duration schedule of reinforcement. Behav. Process. 121, 93–97, http://dx.doi.org/10.1016/j.beproc.2015.10.022.
Guttman, N., Kalish, H., 1956. Discriminability and generalization. J. Exp. Psychol. 51, 79–88.
Hennessey, M.B., Voith, V.L., Mazzei, S.L., Buttram, J., Miller, D.D., Linden, F., 2001. Behavior and cortisol levels of dogs in a public animal shelter, and an exploration of the ability of these measures to predict problem behavior after adoption. Appl. Anim. Behav. Sci. 73, 217–233, http://dx.doi.org/10.1016/S0168-1591(01)00139-3.
Hiby, E.F., Rooney, N.J., Bradshaw, J.W.S., 2006. Behavioural and physiological responses of dogs entering rehoming kennels. Physiol. Behav. 89, 385–391, http://dx.doi.org/10.1016/j.physbeh.2006.07.012.
Kealy, R.D., Lawler, D.F., Ballam, J.M., Mantz, S.L., Biery, D.N., Greeley, E.H., Lust, G., Segre, M., Smith, G.K., Stowe, H.D., 2002. Effects of diet restriction on life span and age-related changes in dogs. J. Am. Vet. Med. Assoc. 220, 1315–1320, http://dx.doi.org/10.2460/javma.2002.220.1315.
Khodarahimi, S., 2009. Satiation therapy and exposure response prevention in the treatment of obsessive compulsive disorder. J. Contemp. Psychother. 39, 203–207.
Lang, R., O-Reilly, M., Sigafoos, J., Machalicek, W., Rispoli, M., Lancioni, G.E., Aguilar, J., Fragale, C., 2010. The effects of an abolishing operation intervention component on play skills, challenging behavior, and stereotypy. Behav. Modif. 34, 267–289, http://dx.doi.org/10.1177/0145445510370713.
Laraway, S., Snycerski, S., Michael, J., Poling, A., 2003. Motivating operations and terms to describe them: some further refinements. J. Appl. Behav. Anal. 36, 407–414, http://dx.doi.org/10.1901/jaba.2003.36-407.
Lindsay, S., 2005. Handbook of applied dog behavior and training. Procedures and Protocols, vol. 3. Blackwell, Ames, Iowa.
Lore, R., Gottdiener, C., Delahunty, M.J., 1986. Lean and mean rats: some effects of acute changes in the food supply upon territorial aggression. Aggress. Behav. 12 (6), 409–415, http://dx.doi.org/10.1002/1098-2337(1986)12:6<409:AID-AB2480120603>3.0.CO;2-6.
Marder, A.R., Shebelansky, A., Patronek, G.J., Dowling-Guyer, S., D'Arpino, S., 2013. Food-related aggression in shelter dogs: a comparison of behavior identified by a behavior evaluation in the shelter and owner reports after adoption. Appl. Anim. Behav. Sci. 148, 150–156, http://dx.doi.org/10.1016/j.applanim.2013.07.007.
McHugh, M.L., 2012. Interrater reliability: the kappa statistic. Biochem. Med. 22 (3), 276–282.
Mehrkam, L.R., Perez, B.C., Self, V.N., Vollmer, T.R., Dorey, N.R., 2015. Functional analysis and operant treatment of food guarding in a pet dog. (Submitted for publication).
Miniamimoto, T., Yamada, H., Hori, Y., Suhura, T., 2012. Hydration level is an internal variable for computing motivation to obtain water rewards in monkeys. Exp. Brain Res. 218, 609–618.
Mohan-Gibbons, H., Weiss, E., Slater, M., 2012. Preliminary investigation of food guarding behavior in shelter dogs in the United States. Animals 2, 331–346, http://dx.doi.org/10.3390/ani2030331.
Nestle Purina Pet Care Center (n.d.). Nestle Purina body condition system [Fact sheet]. Retrieved from http://research.unc.edu/files/2012/11/CCM3_032387.pdf.
O'Donohue, W.T., Fisher, J.E. (Eds.), 2009. General Principles and Empirically Supported Techniques of Cognitive Behavior Therapy. John Wiley & Sons Inc., Hoboken, NJ, US.
O'Reilly, M., Edrisinha, C., Sigafoos, J., Lancioni, G., Cannella, H., Machalicek, W., Langthorne, P., 2007. Manipulating the evocative and abative effects of an establishing operation: influences on challenging behavior during classroom instruction. Behav. Interv. 22, 137–145, http://dx.doi.org/10.1002/bin.226.
Overall, K.L., 2013. Manual of Clinical Behavioral Medicine for Dogs and Cats. Elsevier, St. Louis, MO.
Parker, G.A., 1974. Assessment strategy and the evolution of animal conflicts. J. Theor. Biol. 47, 223–243.
Reisner, I.R., Shofer, F.S., Nancy, M.L., 2007. Behavioral assessment of child-directed canine aggression. Inj. Prev. 13, 348–351, http://dx.doi.org/10.1136/ip.2007.015396.
Reisner, I.R., 2002. An overview of aggression, In: Horwitz, D.F., Mills, D.S, & Heath, S. (Eds.) BSAVA Manual of Canine and Feline Behavioral Medicine, Gloucester, England, John Wiley & Sons, Inc., Hoboken, NJ, USA, pp. 181-194.
Rispoli, M., Camargo, S., Neely, L., Gerow, S., Lang, R., Goodwyn, F., Ninci, J., 2014. Pre-session satiation as a treatment for stereotypy during group activities. Behav. Modif. 38 (3), 392–411, http://dx.doi.org/10.1177/0145445513511631.
Scott, J.P., 1958. Aggression. University of Chicago Press, Chicago, Illinois.
Shepherd, K., 2002. Development of behaviour, social behaviour and communication in dogs, In: Horwitz, D.F., Mills, D.S, & Heath, S. (Eds.) BSAVA Manual of Canine and Feline Behavioral Medicine, Gloucester, England, John Wiley & Sons, Inc., Hoboken, NJ, USA, pp. 8–20.
Weiss, E. (2012, November). Canine Assessment: ASPCA SAFER® Overview. Retrieved from http://aspcapro.org/webinar/2012-11-28-000000/canine-assessment-aspca-safer-overview.
Zook, J.M., Adams, D.B., 1975. Competitive fighting in the rat. J. Comp. Physiol. Psychol. 88 (1), 418–423, http://dx.doi.org/10.1037/h0076225.