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Growls to Wags: Success Factors Regarding Food Care at the Humane Society of Boulder Valley

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Abstract

The Behavior Modification Program at the Humane Society of Boulder Valley addresses behavioral problems of dogs by using counter-conditioning, changing a stimulus from positive to negative, and desensitization, decreasing the emotional response to a stimulus, on a variety of behavioral issues. One of the most prevalent issues is food guarding and is addressed through the Food Care Protocol. The protocol aims to alter the emotional reaction of a dog to a human approach to the food bowl. The behavior progresses from a guarding response (growling, snapping, etc) to a positive emotional response (tail wagging, stepping away from the bowl, etc).

This project analyzed potential success factors of the Food Care Protocol by comparing age, adult weight, intake score, breed aggression, and number of days in the program to overall success in the program. Success was defined as outtake score, received after completion of the program, subtracted from intake score, received upon entry to the shelter. Age was found to be the most prominent predictor of success, and was negatively correlated with success. Using these data, a model was created to predict the number of days each dog would need in order to reach a passing outtake score.

1. Introduction

1.1 Food Care at the Humane Society of Boulder Valley

The present study evaluated success factors of the Behavior Modification Program at the Humane Society of Boulder Valley. Although the program works on a variety of behavioral issues in both domestic cats and dogs, the present study focused on the success of the Food Care Protocol used for dogs expressing aggression around the food bowl. This aggression is referred to as food guarding.

Dogs were evaluated for food guarding upon entry to the shelter using the Safety Assessment For Evaluating Rehoming (S.A.F.E.R.). S.A.F.E.R. consisted of seven tests dogs must pass to become adoption candidates, and included a food guarding evaluation and several body handling evaluations. If a dog failed the food guarding evaluation, it was enrolled in the Food Care Protocol in an attempt to reverse the food guarding behavior. Food Care was chosen for this study because the scope of the entire Behavior Modification Program was too large for a single project. Furthermore, the Food Care Protocol lent itself to an informative study, as it had a clearly defined assessment for both an intake score, upon entry to the program, and outtake score, when the dog was evaluated for release from the program. These scores were compared to generate a quantitative measurement of success for dogs in the program. Other behaviors assessed in S.A.F.E.R. and/or present in the Behavior Modification Program were not formally tested to receive an outtake score before the animals become adoption candidates. Instead, these animals were evaluated by the shelter staff without a formal assessment, and therefore, without a formal outtake score. However, dogs enrolled in Food Care were required to pass an outtake assessment before they were considered adoption candidates. Dogs that

did not pass the outtake assessment may have re-entered the program, been reclaimed by a previous owner, been transferred to an animal rescue, or been euthanized.

The present study evaluated potential success factors of the dogs in the Food Care Protocol by comparing the success of the dogs to available demographic data. The demographic data included age, days in the program, breed aggression, and estimated adult weight. Success was quantified as the difference between intake scores and outtake scores.

1.2 Hypotheses of success factors

1.2.1 Age

Multiple possible hypotheses exist for how age may influence success of training. The first hypothesis is derived from research showing young and old dogs to be equally sufficient at learning new behaviors (Pongracz, 2005). Under this hypothesis, age would not be expected to have an influence on the success of a dog in the program. However, the latter hypothesis assumes dogs are only learning a new behavior when, in fact, they are also forgetting an old behavior. The addition of extinction, forgetting the old behavior, may cause the older dogs to learn at a slower pace (Burch et al., 1999). An alternative hypothesis takes the socialization period of a dog into account. The socialization period is defined as the time between when a pup is weaned and when it is approximately four months of age (Scott et al., 1965). During this period, the pup is more likely to accept new stimuli with curiosity instead of fear (Martin, 2011). The socialization period allows a dog to become acclimated in its environment, causing it not to be startled or worried about every day activities in its adult life. The end of this period,

at approximately four months, indicates the stabilization of behavior. This stabilization is thought to be the result of previously learned information beginning to interfere with new learning (Scott et al., 1965). Furthermore, some evidence suggests at the end of dogs' socialization period, a decrease in plasticity, or changeability, in connections in the brain occurs (Fox, 2004). The latter hypothesis is the leading hypothesis of the present study, as dogs are not only learning a new behavior. Furthermore, the latter hypothesis can be explained through behavioral neuroscience.

1.2.2 Breed aggression

Breed aggression is another factor that provides multiple hypotheses. Different pure breeds of dogs show predictable and varying levels of aggression, specifically in a handling test, where dogs are tested for reactivity when touched by the trainer (Scott et al., 1965). Different breeds also show differences in aggression directed at strangers (Duffy, 2008). While the latter research focused strictly on purebred strains, the majority of dogs in the present study were mixed breed dogs. This difference could confound the effect of differences in aggression between breeds, as mixed breeds do not show the same patterns as purebreds.

Dog breeds have been shown to read human social cues differently (Vas et al., 2005). Reading the intent of a human approaching the food bowl could change the reaction of a dog. If one breed reads an approach as threatening, while another breed views the same approach as friendly, this will change the response of the dog. As different breeds react differently to the human approach, variations in understanding human intent may change the amount a dog guards the food bowl.

However, traits such as aggression have been studied in the individual rather than the breed (Dowling-Guyrer et al., 2011, Svartberg et al., 2002). The latter research indicates that food guarding is an "equal opportunity problem". This statement implies food guarding appears randomly in the population, regardless of breed (Donaldson, 2002). This is the leading hypothesis for the present study, as food guarding is a behavior specific to the presence of food. In other words, a dog that guards the food bowl is not necessarily aggressive overall in behavior, and an index of general aggression across different breeds will not be informative about food guarding.

1.2.3 Breed size

Small dog breeds are hypothesized in the present study to perform less successfully in a Behavior Modification Program than large dog breeds. Small dogs have been found to be less obedient, more aggressive/excitable, and more anxious/fearful (Arhant et al., 2010). Such factors may limit the dogs' ability to succeed in a training program, resulting in lesser success rates in small dog breeds.

1.2.4 Days in program

The number of days an animal spent in the program was analyzed to discern the effect of time on success. A positive correlation, i.e. more days in the program correlated with a better score, would indicate dogs benefitting from spending a longer time in the program. A negative correlation, i.e. more days in the program correlated with a worse score, would indicate dogs more adept for training were overall more efficient in the

Behavior Modification Program. Such a negative correlation would suggest successful dogs experienced the greatest positive change in behavior in the least amount of time.

2. Background

2.1 Importance of Food Care

Although dogs are praised for being "man's best friend," not all household pet relationships are successful. Behavioral problems in dogs are the primary cause of relinquishment (Miller et al., 1996), the largest strain on the human-dog relationship (Houpt et al., 1996), and a common cause for euthanasia across the nation (ASPCA, 2013). Aggressive behaviors can lead to damaging bites, with one of the most prevalent precursors to bites being food bowl aggression (Manteca et al., 2008). For this reason, decreasing the degree of the latter behavior can greatly benefit the safety of the community. Furthermore, owning a dog that reliably does not guard the food bowl helps to foster the human-dog relationship, as aggression problems have been shown to be one of the most damaging aspects to this bond (Houpt et al., 1996). Furthermore, the number one reason for pet relinquishment is behavioral problems (Miller et al., 1996). Protocols such as Food Care allow shelters to save animal lives, as successful animals are not euthanized, improve human-dog relationships, and prevent future relinquishment of adopted animals. In terms of community safety, Food Care is thus important for preventing damaging dog bites and for protecting the community.

2.2 Prevalence of Food Guarding

General aggression in canines functions to increase or maintain a certain distance from other animals, including humans. This is a necessary function, as dogs are social animals that must live in close proximity to each other. A gradation of aggressive behaviors limits the amount of damaging interactions between dogs (Deputte, 2007). For this reason, aggressive displays, especially around the food bowl, have a strong evolutionary advantage. Dogs are able to display aggressive behaviors, such as snarling and growling, without actually damaging the other animal with a bite. Furthermore, as food is essential for survival, being able to protect food from other members of a pack is also necessary. Hundreds of generations of dogs selectively bred against food guarding behavior have proven to be unable to eliminate the latter behavior from the domestic dog population (Donaldson, 1996). As stated by Donaldson, founder of the Academy for Dog Trainers at the San Francisco SPCA, "Resource guarding is an equal opportunity behavior problem" (Donaldson, 2002). Dogs from any breed and any background are subject to this behavioral problem because food guarding has a strong evolutionary advantage that has persisted through selective breeding.

2.3 Food Guarding as a Single Behavior Issue

Dogs entering the shelter with a history of food guarding, as a specific behavior problem, can benefit from Behavior Modification (Wood, 2011). Aggression in the context of resource guarding has been shown to be context-specific, as seen through vocalizations that occur only in the context of a food bowl aggression warning (Faragó et al., 2010). Dogs utilize a specific growl, used only for defending their food bowl. This

suggests dogs can differentiate contexts of aggression; a dog demonstrating aggression over the food bowl may not show aggression in other situations.

The S.A.F.E.R. Food Behavior evaluation allows for an in depth assessment of a dog's food guarding behavior in this study. The only dogs chosen for the study were dogs that failed the food guarding evaluation, but passed all other evaluations. The presence of a frequently occurring, single behavior issue provides for a control, where dogs in the study are only food guarders and do not show general aggression. This control provides an opportunity to more accurately track the success specifically of the Food Care Protocol.

2.4 Food Care Beyond Boulder

The objectives of this study were not limited to the animals in Boulder, since the S.A.F.E.R. assessment is used nationwide through the American Society for the Prevention of Cruelty to Animals (A.S.P.C.A.). Quantifying success factors of the Food Care Protocol in Boulder allowed for critical examination of the benefit provided to these animals. The data presented here can help other shelters to determine whether a similar protocol may be beneficial to the animals in their respective communities.

Shelters can be confident in using results from assessments such as S.A.F.E.R. because behavioral assessments provide an accurate view of the animal being tested (Bollen et al., 2008). Specifically, the S.A.F.E.R. evaluation has been shown be repeatable, as dogs tested in a shelter in Kansas maintained the same score 13 days later 86% of the time (Weiss, 2008). However, research regarding Food Care and Behavior Modification in animal shelters is currently limited to examining the overall success rate

of Food Care (Wood, 2011) and the effectiveness of preventing food guarding in the home without Behavior Modification (Weiss, 2008).

2.5 Other Applications

The training methods used in Behavior Modification offer insight into the mechanisms animals use to learn. The Behavior Modification Program uses only positive reinforcement in its training endeavors. Dogs trained via positive reinforcement, as opposed to punishment, are more likely to obey commands as well as less being likely to have behavior issues (Hiby et al., 2004). Using positive reinforcement allows for more success than using punishment. Therefore, the present study did not need to analyze this aspect of the program as it is already shown to be the most effective training method.

The training methods used in Behavior Modification utilize positive reinforcement through both counter-conditioning, creating a positive association to a once aversive stimulus, and desensitization, creating a positive association to an aversive stimulus much smaller than the original stimulus. Both of these methods stem from classical conditioning, an approach well documented in animal behavior research (Rescorla et al., 1967, Burch et al., 1999). Furthermore, both methods can be applied to any animal and are not limited to companion, or household, animals.

In the context of food guarding, Lindsay Wood, Director of Animal Training and Behavior at the Humane Society of Boulder Valley, eloquently states how the method of desensitization is used in the Food Care Protocol. “Desensitization involves exposing a dog to a less intense version of the event that makes him feel tense or threatened. The key element of desensitization is that the initial intensity of the event

must be so low that the dog feels none of the original tension or threat" (Wood, 2011). Food Care utilizes this method in the beginning of the protocol when the dog is presented with an empty food bowl, in hopes that the object is not of high enough value for the dog to guard. Furthermore, desensitization can be successful even when not used consistently (Butler et al., 2011). This fact is beneficial to a Food Care Protocol in an animal shelter because the program requires the animal to complete the protocol with two different trainers. The shelter may also not have the resources to work with the animal every day, and inconsistencies can thus not be avoided.

Lindsay Wood also describes the method of counter-conditioning in the context of Food Care, "Counter-conditioning teaches a dog to feel better about a thing or event that initially caused him to feel fearful, anxious, or threatened...We can do this by creating a positive association to our approach and removal of the food bowl" (Wood, 2011). The Food Care Protocol uses this approach by requiring a positive conditioned emotional response (CER) to a human approach to the food bowl. This is achieved by providing a dog with high value treats upon approach of a human to the food bowl. These high value treats result in increased success in dog training (Bentosela et al., 2009). The use of high value treats and creating a CER are essential, effective pieces of the Food Care Protocol.

3. Materials and methods

3.1 Subjects

All dogs (n=135; 73 males and 62 females) in the analysis were held at the Humane Society of Boulder Valley. Information was held in the data system, *PetPoint,* and all dogs that participated in the Food Care Protocol between April 2008 and August 2012 were analyzed. Seven dogs that did not have intake assessment scores were not included. The remaining dogs included 23 different pure breeds and 97 distinct mixed breed combinations. Some purebreds were represented by more than one individual. Mean age of the dogs used in the study was 13.71 months (sd= 13.81) and ranged from 1 month to 72 months. Furthermore, 51 dogs were classified as juvenile (2-5 months), 67 dogs were classified as young adult (6 months- 2 years), and 17 dogs were classified as adult (3 years- 9 years). The mean weight of dogs used in the study was 21.12 kg (sd= 9.38) and ranged from 1.93 kg to 48.99 kg.

As a control, dogs that failed only the food guarding test were used in the study. Dogs enrolled in multiple behavior modification programs were not included in the study. Rawhide (bone) guarding was considered a type of food guarding, meaning dogs that guarded both food and a rawhide were included in the study. However, dogs with touch sensitivity, separation anxiety, dog-dog aggression, or fear in addition to food guarding were not included.

3.2. Assessment Scores

All dogs included in the study had reported intake assessment scores recorded in *PetPoint,* determined by members of the shelter's Behavior and Health team at the time

the dog arrived at the shelter. However, outtake scores were not reported in the database. Instead, the database contained notes about the outtake assessment of each animal, stating the behavior of the animal and whether that animal was eligible to become an adoption candidate. In order to obtain numerical scores for the present study, outtake assessment notes from the database were used. Outtake notes were reviewed separately from demographic information about the animals. With these notes, dogs were scored based on the same system used by the shelter's Behavior and Health team upon intaking the dog. The food guarding test was the Food Behavior Assessment portion of S.A.F.E.R. and used nationally by the American Society for the Prevention of Cruelty to Animals (A.S.P.C.A.).

The Food Behavior Assessment portion of S.A.F.E.R. was scored on a 5-point system, with one indicating no guarding and five indicating severe guarding. The scale read as follows:

> 1. Dog lifts head and ceases eating when you reach to pull the bowl away or push him out OR Dog calmly allows the food to be moved, follows the dish, but does not interfere with the dish's movement; dog's body is soft and loose, eyes soft, tail neural; he lifts head when hand is pushed against his cheek.
>
> 2. Dog follows the dish with his tail down, body a bit stiff; dog likely a bit stiff; dog lifts head after a bit of pressure from hand to cheek.
>
> 3. Dog follows dish, his tail between legs, ears are forward; his body is stiff; dog does not lift his head from the bowl when hand is applied to his cheek OR Dog gulps food, begins to eat faster and with bigger bites, body stiff; he does not lift head when hand is applied to cheek.
>
> 4. Dog freezes and/ or growls.
>
> 5. Dog tries to bite.

For the present study, a score of zero was used to indicate the dog was tested before completion of the protocol and passed the outtake assessment. A score of six was used to indicate the dog was unable to successfully complete the protocol. Dogs that passed the program before completing the protocol were often assessed early for young dog considerations, small dog considerations, and shelter space considerations. Dogs unable to complete the protocol typically made little progress and were transferred to a rescue shelter.

3.3 Data Collection

Demographic data of animals were collected through the data system *PetPoint*. Outtake scores and number of days in the program were manually recorded based on notes stored in *PetPoint.* Age, weight, intake score, and breed(s) were collected from the system, with the exception of seven dogs whose weights were estimated based on a correlation comparing estimated adult weight and age ($p < 0.001$):

$$Weight = 1.19 + Age(.65) + Estimated\ Adult\ Weight(.51)$$

A correlation was found using data from dogs that did have reported weights. Furthermore, estimated adult weight was assumed to be the average adult weight for the gender and primary breed of the dog. Breed aggression was estimated based on an aggression temperament test of the dog's primary breed in the *American Temperament Test Society, Inc.*

3.4 Data Analysis

A multiple linear regression was run comparing dogs' success in the program against several demographic factors. These factors included age, days in the program, breed aggression, and estimated adult weight. Furthermore, these factors acted as potential predictors of success for dogs enrolled in the program. Success was defined as the difference between outtake and intake scores, where a higher value represented greater improvement between the beginning and end of the program.

Because resources are limited in a training program, days needed to complete the program were considered to be a factor in success. For example, a dog completing the program in six days would be considered more successful than a dog completing the program in eleven days. Therefore, a linear model was created to estimate the number of days a dog would need to successfully complete the program. The model was created by utilizing data from a second multiple linear regression that predicted outtake scores. By transposing this regression onto a set of axes comparing outtake score to age, the model was able to predict the number of days a dog of a certain age would need to complete the program.

4. Results

4.1 Multiple Linear Regression of change in S.A.F.E.R. score

A multiple linear regression was run to examine the significance of different factors on the success of dogs in the Food Care Protocol. Success was defined as the difference between intake and outtake scores. The factors tested in the regression included age in months, days in the program, breed aggression, and estimated adult weight. Current weight was not included because it created redundancy or co-linearity in the regression as it was already predicted through age and estimated adult weight. A separate regression on age and estimated adult weight significantly predicted weight ($p < 0.001$). Intake score was also not included in this regression because it was highly correlated with the overall change in score ($p < 0.001$). Relevant values are reported in *Table I.*

Table 1: Results of multiple linear regression predicting change in S.A.F.E.R. score

Variable	Estimate (β)	St. Error	t-value	p-value
Age in Months	-0.033	0.013	-2.44	0.016*
Days in Program	0.032	0.066	2.079	0.040*
Breed Aggression	0.028	0.008	0.293	0.770
Estimated Adult Weight	0.008	-0.002	-0.305	0.761
R^2		0.045		
F		2.447*		

* $p < 0.05$. ** $p < 0.01$ *** $p < 0.001$

The results of this multiple linear regression showed age in months was the best predictor of success ($p=0.016$). The number of days in the program also significantly predicted success ($p=0.040$).

4.2 Effect of age on days in program

Because both age and days in the program were significant, as shown in *Table I*, number of days needed for success were analyzed as dependent on age (*Figure 1*).

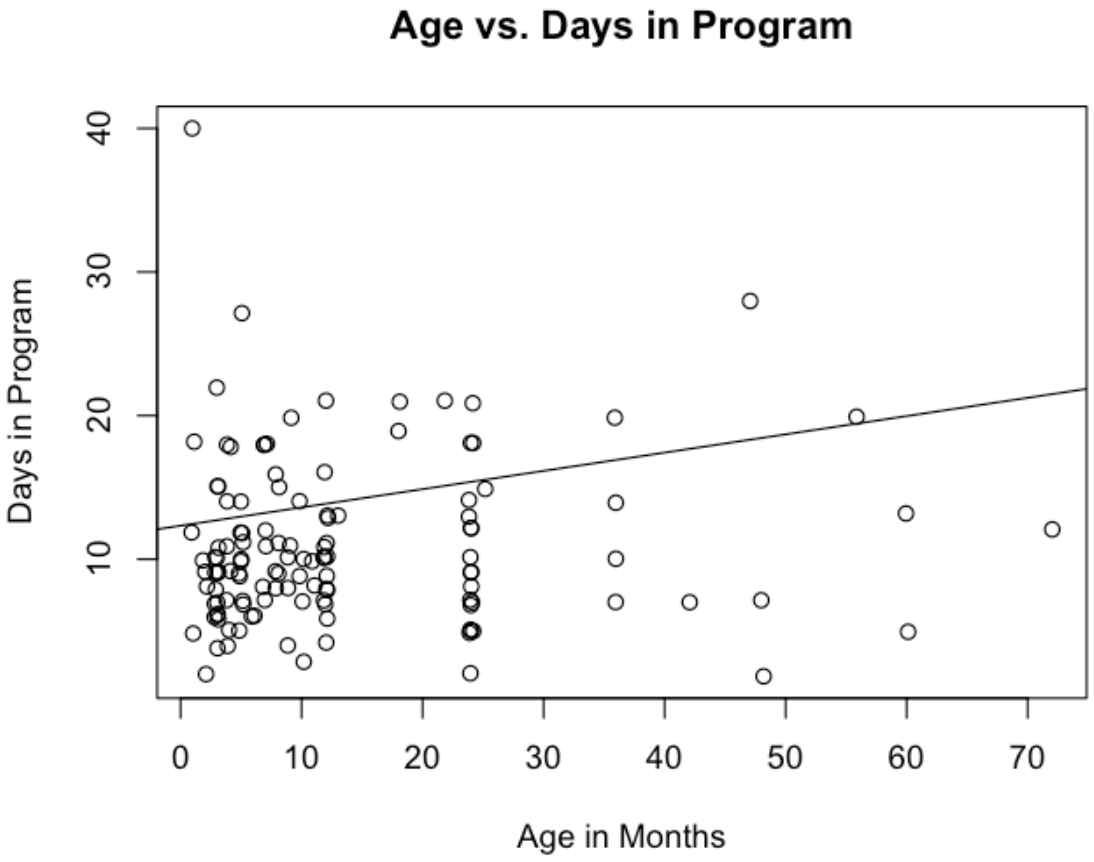

Figure 1 Relationship between number of days spent in the program and age in months. p=0.56, R^2=0.003

This regression showed a correlation of age and days in the program. However, when the impact of change in S.A.F.E.R. score was not considered, this correlation was not significant (p=0.56).

4.3 Effect of age on success

Because age represents an informative demographic about animals entering a program, age was compared to success of dogs in the program. Success here was also defined as the difference between intake and outtake scores (*Figure 2*).

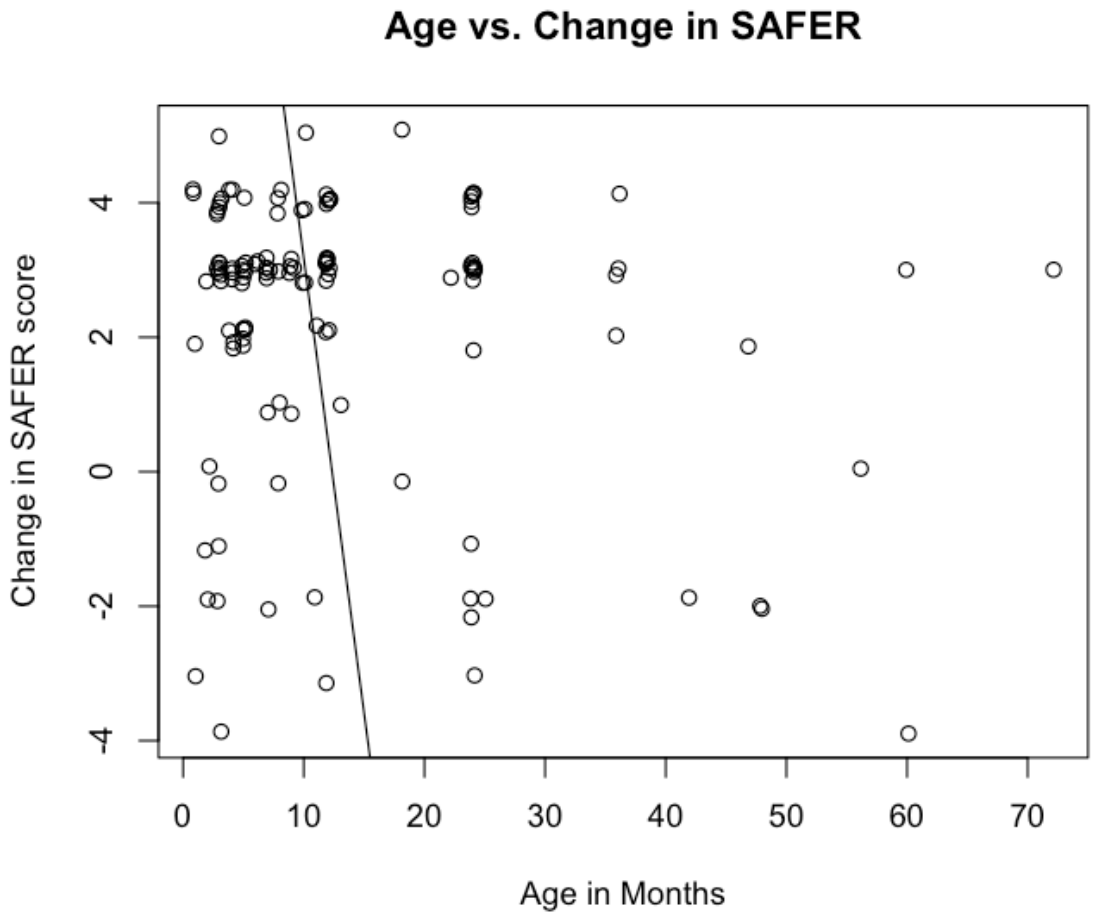

Figure 2 Relationship between success of the animal as defined by the change in S.A.F.E.R. score and age in months. p=0.022, R^2=0.042

A significant, negative, linear correlation was found (*Figure 2*). As age increased, overall success in the program decreased.

4.4 Linear model to predict number of days needed from age of dogs

A second multiple linear regression was run to examine how demographic factors influence the final outtake S.A.F.E.R. score. Factors included age, breed aggression, estimated adult weight, and intake score. Relevant regression values are reported in *Table II*.

Table II: Estimates of Outtake Scores

Variable	Estimate (β)	St. Error	t-value	p-value	Mean
Age in Months	0.021	0.012	1.781	0.077	13.86
Breed Aggression	-0.001	0.024	-0.062	0.951	84.31
Est. Adult Weight	0.002	0.007	0.358	0.358	21.12
Intake Score	-0.195	0.189	-1.031	-1.031	3.94
R^2		0.079			
F		3.125**			

* p < 0.05. ** p < 0.01 *** p < 0.001

Estimates and means from this model were used to create a linear model that predicted the number of days an average dog would need in the program, as days in the program represent another measure of success. The value of age was then varied to determine how long a dog of a certain age would need in the program. Age was varied as is was the only known demographic factor that was a predictor of success when a dog enters a shelter.

The data from this regression were transposed onto axes comparing outtake S.A.F.E.R. score to the number of days in the program was created. In the model, all dogs began with the average intake score of 3.9. Depending on age, different dogs took different amounts of time to complete the program. Where the regression intercepted the line x = 2, represents the expected amount of time the dog will need to reach a passing

score. A passing score was defined as one allowing a dog to graduate from the program and become an adoption candidate. *Figure 3* shows the averages of the three different age groups that participated in the Food Care Protocol. These groups were juveniles (2 months- 5 months), young adults (6 months- 2 years), and adults (3 years- 9 years).

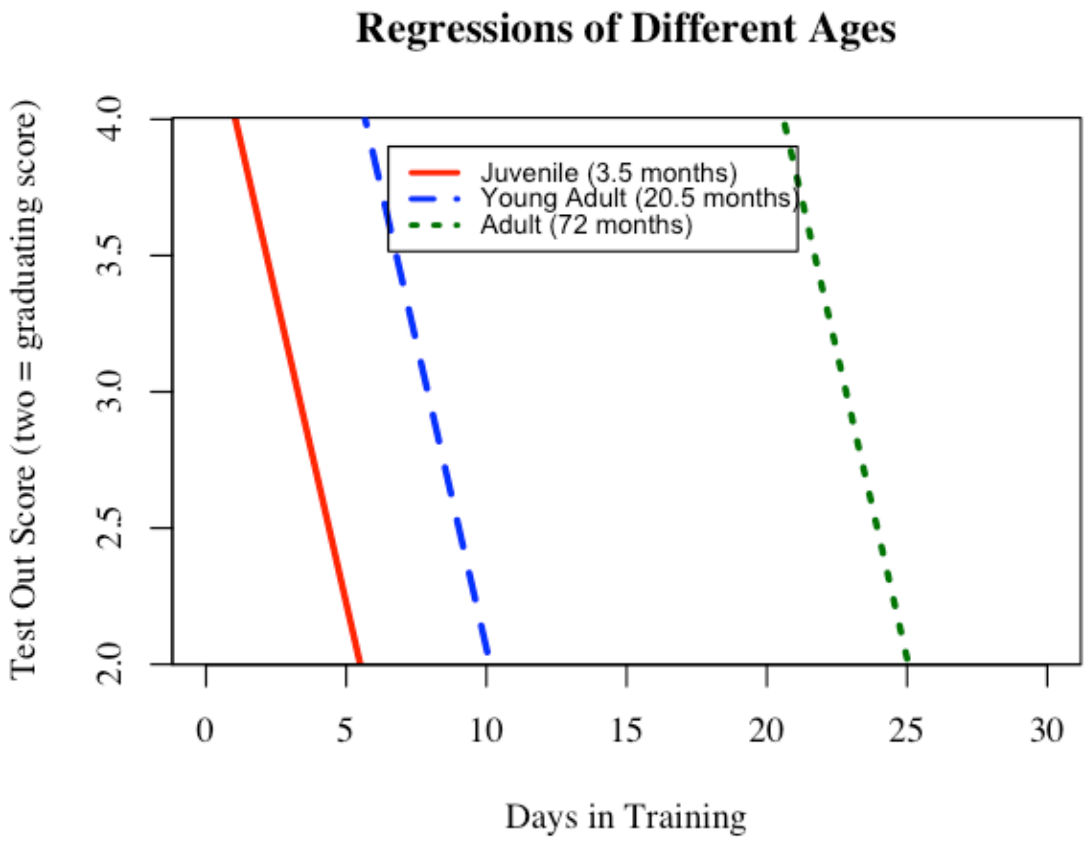

Figure 3 Relationship between success in the program and days in training for average ages of juveniles (2 months-5 months), young adults (6 months-2years), and adults (3 years-9 years). Where the regressions intersect the line x=2 represents the number of days an animal needs to reach a passing score.

The information from the model in *Figure 3* was used to further detail the different age categories and provide more in depth information about days needed to complete the program for dogs of different ages (*Table III*).

Table III: Estimated days in program needed based on age taken from model

Age Category	Age in Months	Days needed in Program
Juvenile	2	4.8
2-5 months	3	5.1
	4	5.4
	5	5.7
Young Adult	6	6.0
6 months- 2 years	12	7.7
	18	9.4
	24	11.2
	30	12.9
Adult	36	14.6
3 years- 9 years	48	18.1
	60	21.6
	72	25.1
	84	28.5
	96	32.0
	108	33.5

Table III further analyzes the three age groups specified in this study, i.e. juveniles, young adults, and adults. Each age category was broken down to more specific ages with the corresponding number of days expected for a dog of that age to require in the program.

5. Discussion and Conclusions

5.1 Recommendations based on results and literature

The results of the present study can be used in the future to help shelters plan the expected amount of time dogs will need in a Behavior Modification Program, specifically Food Care. Furthermore, shelters can use this information to determine how many dogs can feasibly be kept in a Behavior Modification Program at one time. By utilizing *Table III*, shelters can estimate how much time to budget for dogs of different ages when deciding how many dogs to allow into a training program.

By combining the time estimates derived here with the results of other studies, shelters can create flexible programs as both training and Behavior Modification have been shown to be effective even without consistent training (Butler et al., 2011). Furthermore, dogs trained once or twice a week learned faster than dogs trained daily (Demant, 2011). By training either a couple times a week or daily, the results were similarly retained for at least 4 weeks after training (Demant, 2011). In a situation where training resources are limited, creating a staggered training program, where daily training is not a necessity, can help to greatly increase the amount of dogs that can be treated at a given time.

Managing food guarding in the home has been shown to prevent guarding behavior (Weiss, 2012). In other words, if guardians of the food-guarding dog utilize specific protocols in the home, guarding will virtually never be seen. However, life is unpredictable and Behavior Modification is the best way to prevent damaging bites (ASPCA, 2013). Therefore, if Behavior Modification is a viable option, it is highly recommended that the dog be enrolled in such a program before it is available for

adoption. If the dog is a juvenile or young adult, it will almost certainly succeed in the program, as Food Care has been shown to have a 95% success rate (Wood, 2011). Donaldson recommended that a Behavior Modification Protocol should begin with an experienced trainer going through the protocol with the dog, specifically when the dog is being trained against guarding objects or food. This is largely because experienced trainers are able to see when a dog is offering a positive conditioned emotional response and therefore when the dog would benefit from moving to the next step of the protocol (Donaldson, 2010). A board-and-train program is also recommended (Donaldson, 2010). Because dogs are already housed in the shelter, they are mimicking a board-and-train scenario and would benefit from the Food Care Protocol before being considered for adoption.

In the case of adult dogs, spending the estimated amount of time, upwards of 30 days in the Food Care Protocol, will likely not be feasible. However, since guarding has been shown to be manageable in the home, as shown by Weiss (2012), these dogs could still be adopted into the community. This solution would require the owners to be vigilant about not putting the dog in a situation where it has the opportunity to guard. Using techniques, such as feeding the dog small amounts of food at a times and not allowing people near the food bowl, accomplishes this goal (Donaldson, 2010).

5.2 Limitations of study

5.2.1 Control groups

The results of this study are limited by the lack of a control group. With this limitation, the success of the animals cannot be unequivocally contributed to the program. It is possible animals housed in the shelter for a week would exhibit similar results as animals that went through the protocol. This study would greatly benefit from controls; however, these parameters would need special consideration as will be discussed in *5.3 Future research.*

5.2.2 Frequent outtake assessments

Another limitation of the study was the lack of frequent outtake assessments. The dogs were only tested at the beginning and the end of the program. With this design, the amount of time dogs spent in the program was likely skewed to be longer than suggested. Because dogs were not tested until the trainers were certain the dog would pass, dogs may have met a successful score before they were tested. Creating a design to incorporate frequent outtake assessments would require special consideration to ensure benefit for the animals. These considerations will also be discussed in *5.3 Future research.*

5.2.3 Distribution of ages

The distribution of ages in this study was severely limited in terms of adult dogs. Sample sizes for the different age groups represented included 51 juveniles, 67 young adults, and 17 adults. The small sample of adult dogs raises question as to the validity of the results of this study for adult dogs as opposed to only juveniles and young adults.

Furthermore, in making decisions about how many dogs a shelter can accept, it is important to note the estimates given in this study may be less accurate for the adult dogs than the younger dogs.

5.2.4 Estimates of breed aggression

The estimates used for breed aggression have some considerable limitations. The estimates were obtained through the *American Temperament Test Society*. Limitations of the estimates used from this source mostly lie in the inconsistency of sample size. For example, some breeds were only represented by one or two dogs, while other breeds had thousands of individual dogs tested for the breed. This is an important factor, especially because the score for each breed was based on the percent of animals that pass the test for a particular breed.

The temperament test used to estimate breed aggression does not apply to purposes of the present study because general aggression does not translate to food guarding behavior, which is the focus of this study. Dogs have been shown to have behavior specific problems, meaning they may only show aggression over food and not in any other context (Wood, 2011). Therefore, a temperament test may not provide insight into tendencies for food guarding. Dogs also have context specific growls, allowing them to show aggression in particular, not generalized, situations (Faragó et al., 2010). This gives dogs a practical way to express guarding to other dogs without expressing general expression.

Scott and Fuller (1965) has suggested purebred dogs consistently show different levels of aggression. However, only 23 of the 135 dogs used in the present study were

noted as purebred dogs. The remaining dogs were mixed breeds. This distinction is important because purebred dogs represent inbred strains due to a severe loss of genetic variability (Ruefenacht, 2002). For example, a golden retriever has almost identical genes to other purebred golden retrievers. The animals are *breed true* for many behavioral traits, meaning they will act in predictable ways (Ruefenacht, 2002). This is caused by a fixation of alleles (versions of the specific genes present in one location on the genome). Because genes for behavior are fixed within a breed, the effect of different breeds have on levels of aggression can be assessed. However, when a purebred dog mates with a dog of another breed, alleles are no longer fixed and patterns such as aggression no longer have a predictable outcome based on the primary breed of the dog (Scott et al., 1965, Ruefenacht, 2002). This means breed aggression, in general, will not be a useful measure in predicting the behavior of a mixed breed animal.

5.3 Future research

5.3.1 Controls

Future research on this topic will require controls to determine the success that can be attributed to the program and not the dogs' physical presence in the shelter. However, these controls would need to be taken with consideration, as they would require animals to stay in the shelter for extended periods of time. These animals would require enrichment, including contact with conspecifics and humans, as well as stimulating environments (Wells, 2004). Current studies at the Humane Society of Boulder Valley uphold these requirements and include control groups to determine the amount of success due specifically to the program.

5.3.2 Frequent outtake assessments

More frequent outtake assessments would provide for a better representation of how much time the animals need in the program. However, this would require an outtake assessment every couple of days. This would be detrimental to the animal's training process because if the dog fails, and is able to guard its food, it would have been self rewarded for guarding its food. When a dog is rewarded for a behavior that is being modified, the behavior needs to be retrained from the beginning (Martin, 2011). Therefore, instating frequent test out attempts, while making for better data, would be detrimental to the training success of the animal.

5.3.3 Impact of socialization

Studies with better controls may reveal the influence of the socialization period. This period exists until a dog is about four months old (Scott et al., 1965). Controls that focus on this developmental period of the animals would allow behaviorists to determine if the end of the developmental period creates a significant difference in training needs of the animals. Future studies to determine if this effect exists would focus on animals on either side of the four-month mark. To support this hypothesis, the data would no longer be linear when comparing the age to the success of the dogs in the program. Instead, the line would have a steep slope until the dogs reached four months of age. At this point, the line would begin to plateau as the dogs left the socialization period.

5.3.4 Impact of extinction

Dogs in this study were assumed to be learning a new behavior; however, this assumption does not take into account the behavior the animal must forget in the process. In Behavior Modification, the dog must forget an old behavior, an event known as extinction. As dogs continue to age, it may take them longer to forget a behavior that has been successful in the past. This phenomenon could explain why older dogs appear to need more time in the program. The longer a behavior, such as guarding the food bowl, has been successful, the longer it may take for the animal to learn a new behavior. Future studies could assess whether extinction is an important factor for the amount of time a dog needs for success in Behavior Modification. These studies would require significant numbers of animals of many different ages. Here, a regression of the effect of age on success in the program would likely remain linear when comparing age to success, with success being negatively correlated with age.

5.3.5 Program schedules

Dogs trained once or twice a week learn more quickly than dogs trained daily (Demant, 2011). Therefore, future research could assess whether Behavior Modification is more successful when the dogs are not trained daily. Such studies would randomly assign animals to different program schedules, where some animals are trained daily, some are trained every other day, and some are trained only a couple of times a week. The animals would complete the steps of the Food Care Protocol as normal, with number of training sessions required as an indicator of speed of success in the program.

5.4 Broader Applications

Any animal and human interaction will benefit from better a understanding of how animals learn. In zoo settings or animal parks, knowing how animals learn will help improve enrichment of captive animals. Data about success factors of enrichment can help animal facilities to accurately gauge how to allocate limited resources. Information about animal learning will help to save time and resources. Furthermore, knowledge about animal learning can help animal keepers stay safe.

Applications of this research are not limited to animal settings. Knowledge about how learning occurs can also have human applications. For example, research regarding learning schedules can be extended to classroom schedules. Animals may prove to be a valuable model for human learning.

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