

THE ROLE OF ENVIRONMENTAL ENRICHMENT VIA SOCIALIZATION IN THE
ENHANCEMENT OF CAT ADOPTABILITY

By

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The Role of Environmental Enrichment via Socialization in the Enhancement of Cat Adoptability

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ABSTRACT

Individuals who are searching for a cat to adopt may be influenced by the behavior of their potential new pets. Thus, the Humane Society of Southern Arizona's cat socialization program is expected to enhance the adoptability of participating cats. This study sought a correlation between frequency of socialization and time to adoption for cats in the socialization program, and it investigated the effect of socialization on cats' positive and negative responses to humans. A significant association between frequency of socialization and reduction of negative behaviors was identified. An association between frequency of socialization and time to adoption was not found, possibly because adopters are more influenced by the presence of positive behaviors than the absence of negative ones.

KEYWORDS

Domestic cats, adoption, adoptability, behavior, socialization

INTRODUCTION

An estimated 3.4 million cats enter animal shelters in the United States each year (ASPCA). While some of these are lost or runaway cats who will hopefully be returned to their families, the most ideal outcome for the majority of shelter cats is adoption into a new home. Cats that do not quickly find a home in a kill-shelter environment may be euthanized, while those housed in no-kill environments may suffer detriments to their social and health-sustaining behaviors as a result of an extended

confinement (Gouveia, Magalhaes, & de Sousa, 2011). Thus, there is a need to implement strategies that will optimize cats' chances of adoption and reduce the amount of time that they spend in a shelter.

Numerous factors contribute to a cat's adoptability, including age, sex, breed, reason for relinquishment to the shelter (Lepper, Cass, & Hart, 2002), health status, and behavior (Weiss, Miller, Mohan-Gibbons, & Veba, 2012). The former four factors are unchangeable, and health status may or may not be addressable depending on the particular conditions suffered by the cat; however, in many shelter cats, behavior can be targeted as a means of improving the animal's chance of being adopted.

As a result of commonly-held perspectives regarding the ideal personality of a pet, animals exhibiting certain behaviors are expected to be more easily adopted than others. For instance, one would anticipate a friendly and affectionate cat to be adopted more quickly than one that is aggressive or afraid of humans. Research suggests that environmental enrichment can positively influence an animal's behavior, where environmental enrichment is defined as the addition of beneficial habitat features such as physical surroundings suited to the animal's tendencies or targeted social interaction (Newberry, 1995). In terms of the broad physical environment, minimal noise and disruptions have been found to boost cats' willingness to interact with strangers (Stella, Croney, & Buffington, 2014). In terms of the immediate environment (e.g. a cage or kennel within a shelter), inclusion of sufficient floor space for the cat to separate its behaviors (e.g. distance between the cat's eating space and litter box) and places for the cat to hide have been found to reduce behavioral problems and stress levels experienced by cats (Ellis, 2009). Human interaction has been demonstrated to have an effect on cats' activity patterns (Piccione et al., 2013) and may positively affect cats' overall demeanors (Ellis, 2009). Furthermore, within a shelter environment, regular human interaction has been shown to help sustain contentedness in cats (Gourkow & Phillips, 2015). Therefore, human-cat interaction can be expected to enhance the adoptability of shelter cats.

The Humane Society of Southern Arizona (HSSA) is a no-kill animal shelter located in Tucson, AZ. The HSSA hosts a Cat Enrichment program, established by adoption counselor Pamela Glantz in 2013, in which volunteers interact with cats deemed to have some sort of social difficulty which may impede their adoption. The program is hoped to help speed the adoption process, place a greater number of cats in permanent homes, and create room for more cats to be taken into the shelter. This program was studied as a means of confirming the effects of human interaction on cats' demeanors and the subsequent adoptability of the animals.

It was hypothesized that human interaction helps socially-impaired shelter cats to develop favorable demeanors, which in turn helps them to be adopted. A significant reduction in 'negative' actions and/or an increase in 'positive' actions may suggest a positive effect of human interaction on cat behavior. A reduced time to adoption may indicate that positive behavioral modification benefits the adoptability of shelter animals.

METHODS

Subjects

Cats that met one or more of the following criteria were considered eligible for entry into the HSSA's Cat Enrichment program:

1. "Shyness", as measured by:
 - a. Does not respond to the human after 5 min. human interaction
 - b. Shies away or hides from the human after 5 min. human interaction
2. "Aggression", as measured by:
 - a. Any intimidating or potentially injurious action, such as hissing, growling, raising hackles, lunging at the human, biting, or scratching that is unprovoked by a distressing

interaction (such as receiving a shot or a wound being touched) or by fright (such as being moved between kennels or hearing a loud noise)

3. Other behavioral tendencies that may be seen as undesirable by potential adopters, including:
 - a. Play aggression, such as biting or lunging during play
 - b. Excessive vocalization, such as incessant wailing
 - c. Love bites

CAT STUDY DATA

Cat name: _____ Volunteer name: _____
 Cat ID#: _____ Date: _____ Minutes: _____

POSITIVE RESPONSES		NEGATIVE RESPONSES	
Response type	# responses	Response type	# responses
Purring		Biting	
Head butting		Hissing	
Approaching human on its own		Taking a defensive position	
Nuzzling		Growling	
Tucking in front paws		Yowling	
Kneading		Flattening ears	
Grooming human		Raising hackles	
Slow eye blinking		Spitting	
Exposing belly		Puffing up tail	
Social talking; "chirping"		Hiding from human	
Laying on side		Lunging at human	
		Swatting/scratching	
		Eyes wide/dilated	
TOTAL		TOTAL	

Figure 1: Data sheet for volunteers

From the pool of eligible cats, participants were randomly selected and assigned to one of three groups, which were differentiated by how many times they are worked with per week – Group A consisted of cats worked with once per week, Group B consisted of cats worked with twice per week, and Group C consisted of cats worked with four times per week. The HSSA’s Cat Enrichment program meets four days per week (Tuesday through Friday) for one hour and fifteen minutes per day, and data was collected at each of these sessions from September 16, 2015 through April 1, 2016. Volunteers working with the animals recorded the number of ‘positive’ actions taken by their cat – e.g. purrs, head butts, or approaching a human of its own volition – and the number of ‘negative’ actions – e.g. bites, hisses, or defensive crouches. Figure 1 displays the data sheet that volunteers used to record this information.

Volunteers

Volunteers were recruited from the Humane Society’s preexisting Cat Enrichment team. All individuals working with the Humane Society are required to complete two training classes before being permitted to work in the Cat Enrichment program; these classes provide instruction on cat care, basic

recognition and management of common shelter diseases, interpretation of cat behavior, and strategies for working with shy, aggressive, or otherwise problematic cats. Volunteers who wished to take part in data collection for this study were provided with further training regarding how to measure cat behaviors and record data; this training was designed to reduce bias resulting from differential interpretation of the signals a cat presents.

Volunteers were randomly assigned to a different cat at each socialization session. With the exception of cats who were in the study for two sessions or less, all cats were socialized by at least three different volunteers in an effort to further minimize bias caused by individual volunteers' socialization styles.

Area Description

All cats in the study were housed at the Humane Society of Southern Arizona's main shelter, located at 3450 N Kelvin Boulevard, Tucson, AZ, 85716. Cats who were available for adoption were kept in room CA (Cat Adoptions); when they fell ill, they were removed to the SCU (Sick Care Unit) until healthy. Cats were kept in metal kennels of varying dimensions. Most kennels were individually-sized, but occasionally two cats who were friendly with each other were housed together and were placed in a correspondingly larger kennel (cats who were housed in the same kennel and who were a part of the socialization program were worked with simultaneously). All kennels were supplied with dry kibble, water, a litter box, at least two toys, and at least one blanket.

Behavioral Interventions

Behavioral interventions were specialized according to each cat's needs. In general, cats could be separated into one of three groups: Shy, Aggressive, or Other Behavioral Problems. The interventions utilized for each of these groups are as follows:

1. Shy cats

- a. Speaking to the cat in a gentle tone until the cat exhibited signs of relaxing
- b. Helping a cat become accustomed to human touch
 - i. If the cat was especially fearful of being touched, an object such as a feather or backscratcher was first presented to the cat (e.g. by placing it at the edge of the



Figure 2: a volunteer uses a backscratcher to help Munchies become used to human touch

cage). As the cat became more used to its presence, the object was slowly moved towards the cat, until eventually the volunteer was touching the cat with the object. If the cat was able to relax, the volunteer then slowly crept their hand along the object until they were touching the cat with their hand.

- ii. If the cat was only mildly fearful of being touched, the same process was accomplished using only the volunteer's hand; the volunteer placed their hand at the edge of the cage, then gradually moved it forward until the cat accepted their touch.
- c. Coaxing the cat out of a hiding place using one or more of the following methods:
 - i. Presenting treats or toys to lure the cat out
 - ii. Using gentle vocal encouragements
 - iii. If possible to accomplish without causing stress to the cat, removing the object that the cat is hiding under (e.g. lifting a blanket under which the cat is buried) at a slow and gentle pace

2. Aggressive cats

- a. Speaking to the cat in a gentle tone until the cat exhibited signs of relaxing
- b. Helping a cat become accustomed to human touch (using same process as 1b)
- c. Conditioning against undesirable behaviors using one or more of the following methods:

- i. When the behavior is exhibited, placing the cat in a “time-out” where the volunteer closes the cage and turns their back on the cat for 1 – 2 minutes
- ii. Clapping loudly when the behavior is exhibited
- iii. Saying “no” firmly when the behavior is exhibited

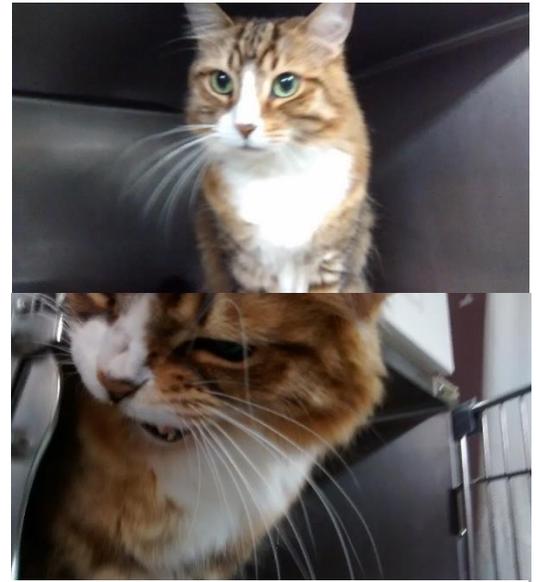


Figure 3: Cabo hisses at a volunteer

3. Other behavioral problems

- a. Conditioning against undesirable behaviors (using same process as 2c)
- b. Rewarding desirable substitute behaviors (e.g. nuzzles instead of love bites) using one or more of the following methods:
 - i. Giving treats
 - ii. Petting and scratching
 - iii. Praising the cat in a gentle, happy tone

Statistical Analysis

Data collection was done from the time the cat entered the Cat Enrichment program until it was adopted. The time in days between entry into the Cat Enrichment program and the day of adoption was then recorded. Kaplan-Meier statistical analysis, with the cats’ adoption defined as the final event, was

applied to determine if there was a significant association between the amount of socialization received by a cat and the time it took for that cat to be adopted. With regards to positive and negative behaviors, the average number of positive and negative responses was calculated during each cat's first week of socialization and last week before adoption. For cats who were not adopted by the study's conclusion, the last week of collected data was substituted for adoption week data. Numerical increases/decreases in positive and negative behaviors between week 1 and end week were calculated for each cat, and ANOVA was then applied to determine if there was a significant association between the amount of socialization received by the cats and the change in their positive/negative behaviors.

Cats who fell ill during the course of the study were temporarily removed and were returned to the program once their health was restored. The number of days that the cat was out for sickness was subtracted from its total days in the study.

Time to adoption data was calculated for all cats who were adopted during the time frame of the study. Cats who were not adopted by the study's conclusion were returned to the Humane Society's Cat Enrichment program for further socialization. Cats who were returned to the Humane Society after being adopted were returned to the Cat Enrichment program, but no further data was collected on these cats as adoption was defined as the conclusion of a cat's time in the study.

Ethical Approval

Protocol approval was granted by the University of Arizona Institutional Animal Care and Use Committee (IACUC protocol number 16-108).

RESULTS

Time to Adoption Analysis

In the Kaplan Meier analysis, time to adoption was used for the survival parameter, while adoption was substituted for death. Significant results were not identified for the association between

frequency per week of socialization and time to adoption (Log-rank p-value = 0.268, Wilcoxon p-value = 0.589, Tarone-Ware p-value = 0.446). Mean survival of group A was 26.343 days, mean survival of group B was 24.2 days, and mean survival of group C was 15.167 days.

Summary statistics (Events):

Stratum	Total observed	Total failed	Total censored	Time steps
A	11	8	3	9
B	13	12	1	9
C	12	12	0	9

Figure 4: Observation and censorship for all groups

Mean survival time (A)	Standard deviation	Lower bound (95%)	Upper bound (95%)
26.343	9.712	7.307	45.380

Figure 5: Mean survival time for group A

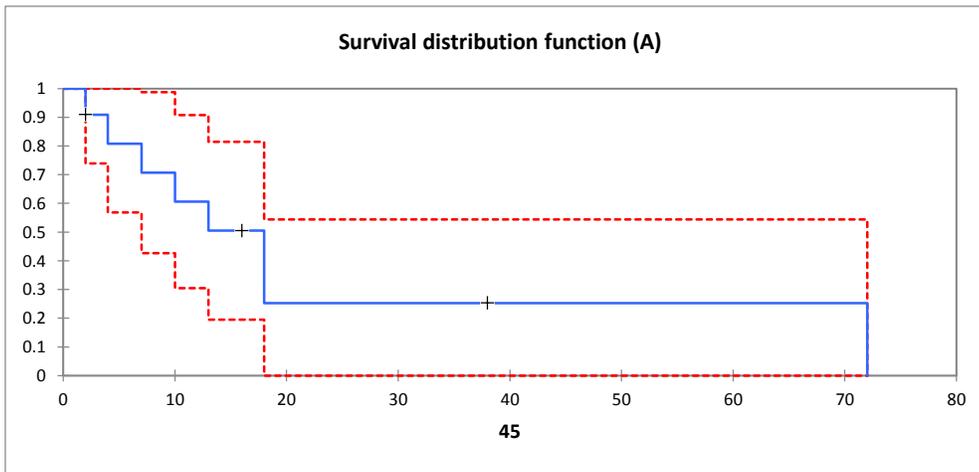


Figure 6: Survival distribution function for group A (blue) bounded by confidence intervals (red)

Mean survival time (B)	Standard deviation	Lower bound (95%)	Upper bound (95%)
24.200	5.372	13.671	34.729

Figure 7: Mean survival time for group B

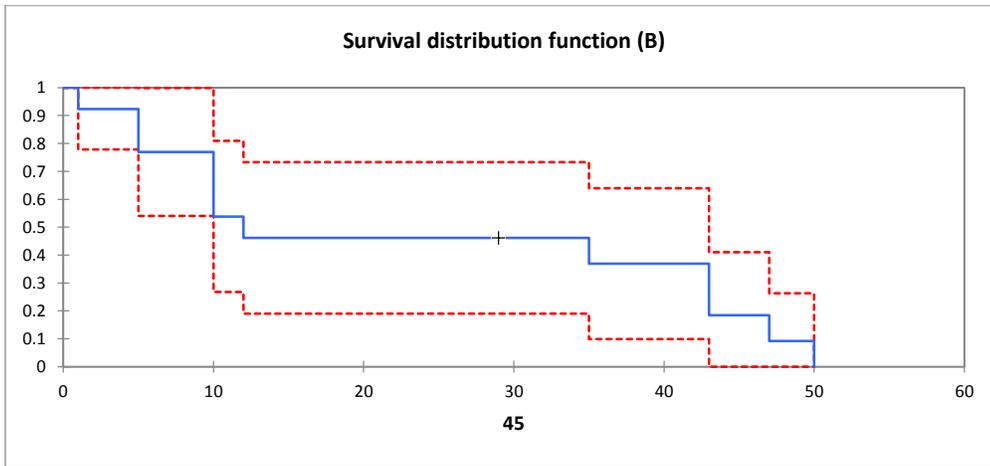


Figure 8: Survival distribution function for group B (blue) bounded by confidence intervals (red)

Mean survival time (C)	Standard deviation	Lower bound (95%)	Upper bound (95%)
15.167	3.814	7.692	22.641

Figure 9: Mean survival time for group C

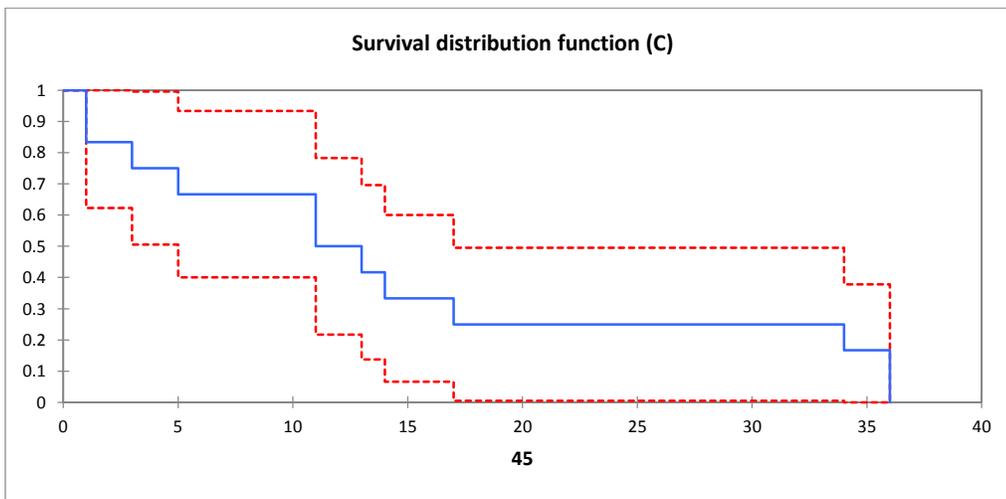


Figure 10: Survival distribution function for group C (blue) bounded by confidence intervals (red)

Test of equality of the survival distribution functions (DF = 2):

Statistic	Observed value	Critical value	p-value	alpha
Log-rank	2.630	5.991	0.268	0.050
Wilcoxon	1.059	5.991	0.589	0.050
Tarone-Ware	1.614	5.991	0.446	0.050

Figure 11: Statistical comparison of time to adoption between all groups using three analyses

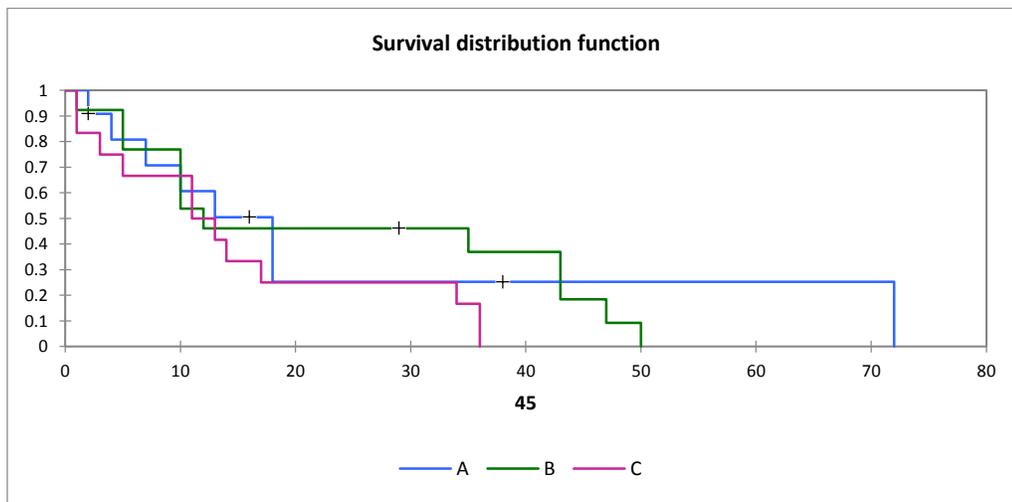


Figure 12: Survival distribution function for all groups

Behavioral Analyses

Because positive and negative responses in the cats’ beginning week and end week were used in the behavioral analysis, only cats who were present for at least two full weeks of socialization were eligible for this analysis. Those who were adopted or otherwise removed from the program before completing two full weeks were not included. This left group A with five eligible cats, group B with nine eligible cats, and group C with seven eligible cats.

Ten separate single-measure ANOVA analyses were performed to assess various aspects of how cat behavior changed over time. Two of these analyses investigated the difference between groups in 1.) increase of positive behaviors, and 2.) decrease of negative behaviors between a cat’s first week in the program and its last week in the program. The remaining eight analyses investigated whether there was a

significant change in positive and/or negative behavior as a result of socialization for group A, group B, group C, and all groups.

DIFFERENCE BETWEEN GROUPS – POSITIVE RESPONSES

A significant difference between the increase in positive responses for groups A, B, and C was not identified ($p = 0.495$). The average increase in positive responses for group A was 18.35, for group B was 12.611, and for group C was 2.426.

Group A	Group B	Group C
12.75	14.5	1
-1.5	0	-4
29.75	0	-43
-1.25	51.5	4
52	-16.5	30
	43	34
	18.5	-5
	0	
	2.5	

Figure 13: Difference in number of positive responses between week 1 and end week for each eligible cat in each group

SUMMARY

Groups	Count	Sum	Average	Variance
Group A	5	91.75	18.35	517.9563
Group B	9	113.5	12.61111	487.6111
Group C	7	17	2.428571	653.619

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	804.11349	2	402.0567	0.731424	0.494988	3.554557
Within Groups	9894.4282	18	549.6905			
Total	10698.542	20				

Figure 14: Single-measure ANOVA analyzing the difference in the number of positive responses from week 1 to end week between all groups

DIFFERENCE BETWEEN GROUPS – NEGATIVE RESPONSES

The difference of the decrease in negative responses from week 1 to end week between groups was found to be significant (p-value = 0.013). The average decrease in negative responses for group A was -8.042 responses, for group B was -0.389 responses, and for group C was -0.286 responses.

Figure 15: Difference in number of negative responses between week 1 and end week for each eligible cat in each group

	Group A	Group B	Group C
	-19.25	-1.5	3
	0	1.5	-2
	-1.25	-1.5	1
	-4.5	-1	1
	-15.21	3.5	-1
		-4	-1
		-0.5	-3
		0	
		0	

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
Group A	5	-40.21	-8.042	75.08757
Group B	9	-3.5	0.38889	4.361111
Group C	7	-2	0.28571	4.238095

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	225.80593	2	112.903	5.634697	0.012581	3.554557
Within Groups	360.66774	18	20.0371			
Total	586.47367	20				

Figure 16: Single-measure ANOVA analyzing the difference in the number of negative responses from week 1 to end week between all groups

EFFECT OF SOCIALIZATION – ALL GROUPS

Significant results were not found for the difference in average positive responses between week 1 and end week (p-value = 0.086) or for difference in average negative responses between week 1 and end week (p-value = 0.106) for all eligible cats.

Week 1	End Week
4.25	17
8.25	6.75
22.25	52
21.75	20.5
0	52
1.5	16
2	2
5	5
9	60.5
26.5	10
2	45
4.5	23
0	0
11.5	14
12	13
8	4
45	2
38	42
45	75
20	54
43	38

Figure 17: Average number of positive responses in week 1 and end week for all eligible cats

SUMMARY

Groups	Count	Sum	Average	Variance
Week 1	21	329.5	15.69048	240.3119
End Week	21	551.75	26.27381	519.9744

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1176.0729	1	1176.073	3.093763	0.086241	4.084746
Within Groups	15205.726	40	380.1432			
Total	16381.799	41				

Figure 18: Single-measure ANOVA analyzing the difference in the average number of positive responses between week 1 and end week for all eligible cats

Week 1	End Week
20.5	1
0	0
1.25	0
9.5	5
19.5	4.25
2.5	1
0.5	2
1.5	0
1	0
1.5	5
4	0
0.5	0
2.5	2.5
2.5	2.5
0	3
4	2
0	1
0	1
1	0
1	0
4	1

Figure 19: Average number of negative responses in week 1 and end week for all eligible cats

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
Week 1	21	77.25	3.678571	34.14464
End Week	21	31.25	1.488095	2.802976

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	50.380952	1	50.38095	2.727156	0.106485	4.084746
Within Groups	738.95238	40	18.47381			
Total	789.33333	41				

Figure 20: Single-measure ANOVA analyzing the difference in the average number of negative responses between week 1 and end week for all eligible cats

EFFECT OF SOCIALIZATION – GROUP A

Significant results were not found for the difference in average positive responses between week 1 and end week (p-value = 0.117) or for difference in average negative responses between week 1 and end week (p-value = 0.108) for eligible cats in group A.

	Week 1	End Week
<i>Figure 21: Average number of positive responses in week 1 and end week for cats in group A</i>	4.25	17
	8.25	6.75
	22.25	52
	21.75	20.5
	0	52

SUMMARY

Groups	Count	Sum	Average	Variance
Week 1	5	56.5	11.3	103.95
End Week	5	148.25	29.65	441.8

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	841.80625	1	841.8063	3.084952	0.117086	5.317655
Within Groups	2183	8	272.875			
Total	3024.8063	9				

Figure 22: Single-measure ANOVA analyzing the difference in the average number of positive responses between week 1 and end week for cats in group A

Week 1	End Week
20.5	1
0	0
1.25	0
9.5	5
19.5	4.25

Figure 23: Average number of negative responses in week 1 and end week for cats in group A

SUMMARY

Groups	Count	Sum	Average	Variance
Week 1	5	50.75	10.15	94.3
End Week	5	10.25	2.05	5.7625

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	164.025	1	164.025	3.278451	0.107784	5.317655
Within Groups	400.25	8	50.03125			
Total	564.275	9				

Figure 24: Single-measure ANOVA analyzing the difference in the average number of negative responses between week 1 and end week for cats in group A

EFFECT OF SOCIALIZATION – GROUP B

Significant results were not found for the difference in average positive responses between week 1 and end week (p-value = 0.107) or for difference in average negative responses between week 1 and end week (p-value = 0.581) for eligible cats in group B.

	Week 1	End Week
	1.5	16
	2	2
	5	5
	9	60.5
	26.5	10
	2	45
	4.5	23
	0	0
	11.5	14

Figure 25: Average number of positive responses in week 1 and end week for cats in group B

SUMMARY

Groups	Count	Sum	Average	Variance
Week 1	9	62	6.888889	67.98611
End Week	9	175.5	19.5	421.625

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	715.68056	1	715.6806	2.923465	0.106619	4.493998
Within Groups	3916.8889	16	244.8056			
Total	4632.5694	17				

Figure 26: Single-measure ANOVA analyzing the difference in the average number of positive responses between week 1 and end week for cats in group B

Week 1	End Week
2.5	1
0.5	2
1.5	0
1	0
1.5	5
4	0
0.5	0
2.5	2.5
2.5	2.5

Figure 27: Average number of negative responses in week 1 and end week for cats in group B

SUMMARY

Groups	Count	Sum	Average	Variance
Week 1	9	16.5	1.833333	1.3125
End Week	9	13	1.444444	2.965278

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.6805556	1	0.680556	0.318182	0.580524	4.493998
Within Groups	34.222222	16	2.138889			
Total	34.902778	17				

Figure 28: Single-measure ANOVA analyzing the difference in the average number of negative responses between week 1 and end week for cats in group B

EFFECT OF SOCIALIZATION – GROUP C

Significant results were not found for the difference in average positive responses between week 1 and end week (p-value = 0.844) or for difference in average negative responses between week 1 and end week (p-value = 0.726) for eligible cats in group C.

	Week 1	End Week
	12	13
	8	4
	45	2
	38	42
	45	75
	20	54
	43	38

Figure 29: Average number of positive responses in week 1 and end week for cats in group C

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
Week 1	7	211	30.14286	265.1429
End Week	7	228	32.57143	751.9524

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	20.642857	1	20.64286	0.040592	0.843703	4.747225
Within Groups	6102.5714	12	508.5476			
Total	6123.2143	13				

Figure 30: Single-measure ANOVA analyzing the difference in the average number of positive responses between week 1 and end week for cats in group C

Week 1	End Week	
0	3	<i>Figure 31: Average number of negative responses in week 1 and end week for cats in group C</i>
4	2	
0	1	
0	1	
1	0	
1	0	
4	1	

SUMMARY

Groups	Count	Sum	Average	Variance
Week 1	7	10	1.428571	3.285714
End Week	7	8	1.142857	1.142857

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.2857143	1	0.285714	0.129032	0.725679	4.747225
Within Groups	26.571429	12	2.214286			
Total	26.857143	13				

Figure 32: Single-measure ANOVA analyzing the difference in the average number of negative responses between week 1 and end week for cats in group C

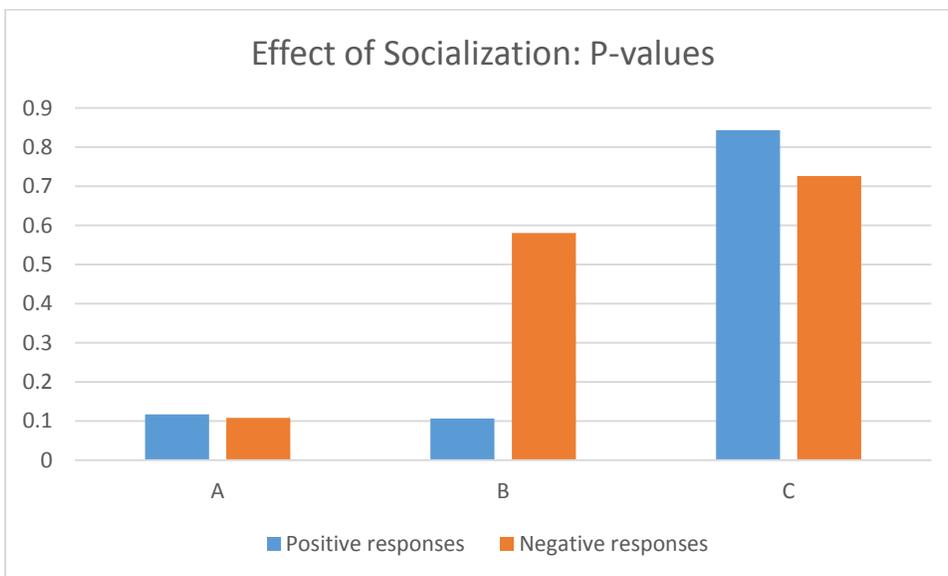


Figure 33: P-values for effect of socialization on groups A, B, and C showing trend of lower p-values with more frequent socialization

DISCUSSION

Effect of Socialization on Behavior

Significant results were achieved for the analysis of the difference in decrease of negative responses between groups A, B, and C. The average decrease in negative responses for group A was of a

much greater magnitude than for groups B and C (-8.042 responses for A, -0.389 responses for B, and -0.286 responses for C; p-value = 0.013). This indicates that frequent training may have a more potent effect on the reduction of unwanted behaviors in cats than less-frequent training. The analogous analysis regarding increase of positive responses followed the expected trend; there were greater increases in positive responses with greater frequency of socialization (an average increase of 18.35 responses for group A, 12.611 responses for group B, and 2.429 response for group C). However, these results did not achieve significance. This suggests that there may be inherent differences in cats' responsiveness to training which a., seeks to supply new positive behaviors or amplify preexisting positive behaviors, and b., seeks to eliminate unwanted behaviors.

One explanation for these differences may lie in what prompts positive versus negative behaviors in cats. Frequently, cats express negative behaviors as a result of fear; actions such as hiding or hissing can be interpreted as a cat's way of defending itself. Through regular socialization, cats can learn that they do not have to fear humans, so a reduction in negative behaviors over time is expected. This also increases the cats' quality of life since they are able to feel safe in their daily lives as opposed to living in fear. However, expression of positive behaviors is typically a result of the cat's individual personality as opposed to the cat's emotions. Cat personalities generally show limited plasticity, so it can be expected that cats who are not initially friendly are less likely to learn friendly behaviors through socialization.

As opposed to the between-group analyses, significant results were not seen for the analyses that studied the within-group effect of socialization on behavior from week 1 to end week. However, the results showed a distinct trend where p-values were smaller when cats were worked with more frequently (see figure 33 above). Except for the analysis on increase in positive responses for group B, group A's p-values were smaller than group B's, and group B's p-values were smaller than group C's.

This trend further indicates that frequency of interaction may have an influence on improvement in cat behavior and merits additional study. A higher power may have yielded significant results.

Adoptability

Kaplan-Meier survival analysis did not detect a significant relationship between the frequency of socialization and the time to adoption. At its core, this suggests that cats who are socialized the most frequently are not necessarily the most desirable for adoption. Two possibilities arise from this conclusion: 1., increased socialization affects behavior but behavior does not play a major role in adopters' choice of cats, or 2., increased socialization does not affect behavior, although adopters may consider behavior in their choice of cats. It is likely that there are elements of both these possibilities at play. Results from the behavioral analysis suggest that increased socialization does affect behavior in terms of reducing negative responses, but an increase in positive responses with increased socialization was not detected. It could be that while adopters are less deterred from adopting a cat who has been trained to not exhibit negative behaviors than one that does exhibit negative behaviors, they are more strongly affected by the presence of positive behaviors than by the absence of negative ones. Thus, since positive behaviors are not as easily taught to cats via socialization, increased socialization has limited effects on time to adoption.

Furthermore, confounding factors may override any behavioral benefit that may have been achieved through socialization. For example, an adopter may prefer an unruly kitten over a well-behaved, friendly adult cat simply because they value the longer projected time that they will have with the kitten, and they may believe that they will be able to shape the kitten's behavior over time. Further analysis of the various factors that influence adopters' choice of cats is merited.

Limitations

Not all cats who are eligible for the Humane Society's socialization program feature equal magnitudes of behavioral issues; some exhibit only mild behavioral problems, while others are extremely difficult to work with. It was assumed that randomization of cats as they entered the study would result in an approximately equal level of "cat difficulty" for each study group. However, sample sizes were not large enough for this to occur. By chance, all especially difficult cats (with an average of 5 or more negative responses during their first week of socialization) were placed in A group with none in B or C. This confounds the results because the most difficult cats were worked with the most frequently. In the future, a preliminary analysis should be conducted on each cat to estimate its approximate level of difficulty, and cats should be assigned to each group in such a manner that all groups feature similar amounts of less-difficult and more-difficult cats. Alternatively, more-stringent criteria could be used to select cats for entry into the study so that there is minimal variation in the cats' initial number of negative responses (e.g. only cats that initially display between five and ten negative responses will be included in the study).

However, cat behavior is but one characteristic that may influence a cat's likelihood of adoption. Other significant factors may include age, health status, and reason for relinquishment to the shelter; for instance, one cat's especially lengthy time to adoption was likely influenced by her FeLV status (Chatty Cathy; 96 days in program) while another's was likely influenced by his history of litter box issues (Buster; 72 days in program). Chatty Cathy was not included in the time to adoption analysis due to exceptional difficulties associated with FeLV cat adoption policies (These cats may only be released to an FeLV-cat-only home or a single-cat home), but other non-behavioral adoption difficulties were not explicitly addressed. Furthermore, end sample size was not high enough to eliminate such bias via randomization. Obtaining a higher sample size, ensuring that each study group contains equal numbers of cats with non-behavior-related adoption difficulties, and ensuring that each group contains similar

proportions of kittens, adult cats, and senior cats will improve the accuracy of results in a future study. Alternatively, more-stringent criteria for inclusion in the study that would normalize age, difficulty, and non-behavioral adoption difficulties (e.g. exclude cats with Fe-LV or litter box issues) could be used to ensure that the groups feature similar cat profiles.

Sample size was also limited for the behavioral analysis. Because two full weeks' worth of socialization data was necessary to run the analyses, several cats were excluded from the study. Group A suffered especially because cats in this group required the most socialization sessions in order to fulfill two full weeks (4 socializations per week times 2 weeks = 8 socializations needed for group A, 2 socializations per week times 2 weeks = 4 socializations needed for group B, and 1 socialization per week times 2 weeks = 2 socializations needed for group C). The analysis on average increase in positive behaviors between groups followed a distinct trend but did not yield significance, and an increase in sample size may lead to significant results. There are multiple ways to address this issue. For example, sample size would benefit from a policy requiring that cats in the study do not become available for adoption until researchers have collected two weeks' worth of data on them. After this point, socialization and data collection would continue as normal until the cat was adopted. This would ensure that all cats who enter the study accumulate enough data so that they can be included in the behavioral analysis.

In this study, length of data collection was limited by the researcher's impending graduation. The study was used to fulfill an honors thesis requirement for the University of Arizona, and undergraduate honors seniors were required to submit their thesis prior to graduation. Thus, study length was a function of the researcher's availability rather than the time required to collect sufficient data. A future study may benefit from a longer period of data collection to increase sample size.

Other means of improving behavior

Other factors which cannot be addressed through socialization may have an effect on cat demeanor. For example, the quality of the environment in which the cat is housed has been associated with cat behavior (Stella & Buffington, 2014). Environmental adjustments may benefit cats who showed little to no improvement after significant amounts of socialization. Future studies might address the effect of the cat's immediate environment – e.g. presence of bedding, hiding places, perches, etc. – and broader environment – e.g. noise level, lighting, number of people present, etc. – on cat behavior as a means of enhancing adoptability.

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