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Retreat Space and Human Visitor Density Moderate Undesirable Behavior in Petting Zoo Animals

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This study focused on the relationship between nonhuman animal behavior and environment—specifically, between the undesirable behavior exhibited by domestic petting zoo animals in the presence of humans and the spatial design of the petting zoo environment. A spatial feature of a petting zoo referred to as a *retreat space* was manipulated so that it affected the animals' opportunity for individual control over interaction with humans. Three conditions were tested: no retreat space, semi-retreat space, and a full-retreat space. The subjects of this study were 5 African pygmy goats (*Capra hircus*) and 2 Romanov sheep (*Ovis aries*). Investigators used a focal sampling technique to analyze approximately 27 hr of behavioral data collected. The data were analyzed using multiple linear regression methods. The findings suggest that the

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full-retreat design beneficially moderated both sheep and goat behavior: Undesirable behaviors were lowest in the full-retreat condition. This study provides information that may improve human–animal interactions in a petting zoo setting and may increase animal well-being through exhibit design and management techniques.

Petting zoos provide an opportunity for the public to interact directly with animals. The goal of Zoo Atlanta's petting zoo is for visitors to develop positive attitudes because of one-on-one contact with an animal. Positive human–animal contact influences future attitudes toward animals (Kidd & Kidd, 1997; Kidd, Kidd, & Zaslof, 1995). A positive experience at the petting zoo requires that animals tolerate visitors' appropriate attempts to make contact. Unfortunately, the animals do not always tolerate contact and may run away from, bump into, or even charge at visitors. We conducted this study to determine whether such undesirable behavior of goats (*Capra hircus*) and sheep (*Ovis aries*) toward visitors could be moderated by the spatial design of the petting zoo environment.

Because this study focused on the animals' avoidance of humans, measures of aggressive and escape behavior are discussed as undesirable behavior. The label *undesirable* indicates that the behavior is incompatible with the goals of the petting zoo, not that it is maladaptive or inappropriate in any other way. Sheep aggressive and escape behavior may include rearing, charging, foot stamping, head butting, head tossing, threat jumps, rigid alarm posture, nose blowing, and sudden movements toward conspecifics (Geist, 1971). Goat aggressive and escape behavior include rearing, charging, foot stamping, head butting, and head tossing (Geist, 1965).

HUMANS AND AFRICAN PYGMY GOATS AND ROMANOV SHEEP

Domestic goats and sheep are both members of the ungulate family *Bovidae* and, as prey animals, are adapted to avoid predators. Both goats and sheep monitor their flight distance and rely on quick escapes when threatened (Grandin, 1987). Despite these similarities, goats and sheep appear to react differently to humans. Porter (1996) described goats as adapted to rugged mountain habitats, curious, and adaptable to new encounters. The African pygmy goat, the breed that Zoo Atlanta houses, is described as particularly gregarious. For decades, petting zoos have used pygmy goats bred in America for pets and for laboratory study because they are so amiable (Porter, 1996). A nationwide survey of children's zoo staff and visitors revealed that goats are the most popular petting zoo animal (Seifert, 1996). With regard to sheep, previous literature indicates that the ewes of Romanov sheep, the breed that Zoo Atlanta houses, are more fearful of humans and humanlike models than of novel objects (Bouissou &

Vandenheede, 1995). Romanov sheep are a Russian breed, bred for wool and for meat (Maijala, 1997).

Hart (1985) suggested that both aggressive and escape behavior of animals can be fear induced. Observations of animals in the presence of humans have revealed that animals maintain control over a critical distance around their bodies (Hart, 1985). Animals exert control over this critical distance by either allowing the approach of humans or by preventing the approach using aggressive or escape behavior. Hediger (1964) wrote that escape reactions are subject to fundamental laws characteristic by species; prevention of the escape reaction coupled with a breach in critical distance may result in attack with emergency defense characteristics until critical distance is restored. It has been suggested that the higher an animal's level of fear of humans, the greater the critical distance from a human that animal will maintain (Vasil'eva & Chepkasov, 1991).

Levels of fearfulness may be controlled in part by genetic influences, as suggested by studies in which breeds have been compared (Le Neindre, Poindroin, Trillat, & Orheur, 1993; Romeyer & Bouissou, 1992). The Romanov breed was found to have the strongest negative response to an approaching human and to keep the greatest distance between themselves and humans when compared with other sheep breeds, such as the Lacaune and Berrichon crossbreeds (Le Neindre, Boivin, & Boissy, 1996). When compared with the Ile-de-France breed, Romanov sheep are more fearful, as they are more disturbed by a surprise event, social isolation, and by the presence of a human (Romeyer & Bouissou, 1992). In addition, Romanov ewes are more fearful than Romanov rams (Vandenheede & Bouissou, 1993).

Levels of fearfulness also may be influenced by rearing conditions, as suggested by studies in which handling practices have been compared. For example, research on cattle, goats, and sheep have shown that a lack of positive human contact (neutral or aversive) when animals are young results in adult animals displaying higher levels of fear and aggression toward their caretakers (Le Neindre et al., 1996).

McBride (1984) suggested that when animals are able to exercise control over their environment by choice or manipulation they acquire new skills for avoiding aversive situations. Otherwise, he asserted, animals respond to the inability to gain control over their environment with flight, undesirable behavior, or attack.

INDIVIDUAL CONTROL AND THE SPATIAL ENVIRONMENT

Hediger (1964) described the restriction of space to be the most important factor in captivity because of the secondary effects associated with space confinement. The secondary effects of space restriction may be the prevention of the escape reaction and antisocial behavior. Some researchers view giving animals control over some aspect of their environment as a critical factor in promoting the psy-

chological well-being of captive animals (Bloomsmith, Baker, Lambeth, Ross, & Schapiro, 2000; H. Markowitz, 1979; Novak & Drewson, 1989; Snowdon & Savage, 1989). Opportunities for choice and control may prevent the development of behavioral problems within captive populations of laboratory and zoo animals (Bloomsmith et al., 2000).

PURPOSE AND HYPOTHESES

In this study we attempted to provide petting zoo animals with an opportunity to control their interactions with humans by redesigning their spatial environment to include a retreat space. The retreat space was an area in the pen in which the animals could limit interactions with visitors. We expected that access to the retreat space would give the animals greater individual control and that this might relieve the undesirable behavior of aggression and escape. The retreat space was varied under three levels: a no-retreat space, a semi-retreat space, and a full-retreat space.

Our study was designed to determine (a) whether changes in the layout of the spatial environment (no retreat, semi-retreat, and full retreat) moderate the amount of undesirable behavior exhibited by the petting zoo animals and (b) the effect of human density levels (how many humans were in the yard) and the amount of visitor interaction (visitor touches) on the amount of undesirable behavior exhibited by the animals. We hypothesized that the undesirable behavior of both species would lessen as the retreat space became available and that it would be lowest in the full-retreat condition. We also hypothesized that the amount of undesirable behavior exhibited would be lower in the characteristically less fearful African pygmy goats than in the characteristically more fearful Romanov sheep. Finally, we predicted that undesirable behavior would increase as human density levels and the number of visitor touches increased.

MATERIALS AND METHOD

Subjects and Setting

The subjects of this study were 5 African pygmy goats (*Capra hircus*) and 2 Romanov sheep (*Ovis aries*), all animals in Zoo Atlanta's petting zoo. Rearing conditions for 6 of the 7 animals are unknown. The seventh animal, the oldest goat in the group, was parent reared. The goats were introduced into the petting zoo at an average age of 5 weeks, and the sheep were introduced into the petting zoo at an average age of 32 weeks. At the beginning of this study the oldest goat was 11 years old, and the youngest was 2 years old. The sheep were both 2 years old.

The petting yard under study is corral style and is the animals' full-time habitat. It is approximately 198 m^2 and contains a shed, a covered feeder, a shade structure, and a small pool of fresh water (see Figure 1).

The petting yard is open about 3 hr each day of the week. It closes occasionally because of extreme weather conditions and various husbandry procedures. If the yard is closed, and if the animals are close enough to touch, visitors can try to pet animals through the fence. It is estimated that the particular yard under study is open for visitor petting an average of 21 hr/week (1,092 hr/year). Visitor ages range from toddler to adult. No more than 20 visitors may enter the petting yard at any one time. A staff person always administers verbal instructions to visitors before allowing them access. Instructions include petting tips, reminders not to feed, and a suggestion to leave edibles (including paper) outside the yard. A second staff person is always present in the yard while visitors are interacting with the animals.

The no-retreat space consisted of the normal spatial design of the yard just described. The public had access to all parts of the yard.

The semi-retreat space was created within the dimensions of the yard, encompassing approximately 53 m^2. The semi-retreat space encompassed the pool of water and the only fresh grass available in the yard. The semi-retreat was constructed of a 5-cm × 10-cm wooden board nailed horizontally 0.90 m off the ground and to the surrounding shed structure. The animals could enter or exit the semi-retreat area by simply stepping under the barrier at any point. Depending on how far into the semi-retreat area the animal ventured, the public may or may not have been able to reach the animal. Staff instructed visitors not to enter the semi-retreat space.

The full-retreat space was created within the dimensions of the yard, encompassing approximately 53 m^2. The full retreat encompassed the pool of water and

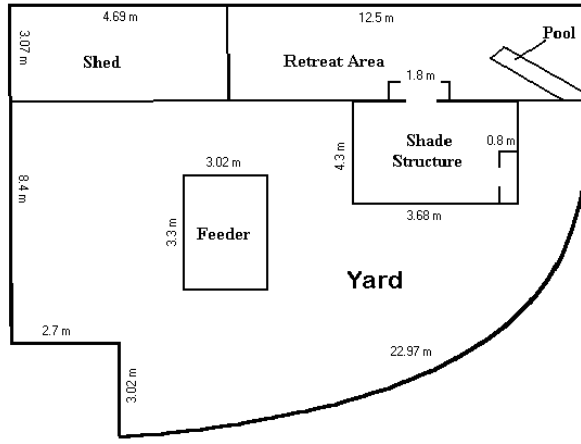

FIGURE 1 Map of Zoo Atlanta's petting zoo.

the only fresh grass available in the yard. The full retreat was a wall 1.7 m high, constructed of chicken wire style fencing and connected to the surrounding shed structure. The animals had three entrance and exit points: at the left end of the retreat barrier, the right end of the retreat barrier, and the center of the retreat barrier. The public could not touch an animal that was in full retreat because of the wire fencing, but the animal and the public had visual access to each other. Staff instructed visitors not to enter the full-retreat space.

Data Collection Procedure

Each of the 7 animals was studied unobtrusively using a focal sampling method (Altmann, 1974). The frequency of undesirable behavior—head tossing, head butting, foot stamping, rearing, nose-blowing, and leaving—were recorded for each animal during the observation period. The observers also recorded the number of humans in the yard when the animal exhibited the undesirable behavior as well as the number of touches the animal received in a session.

The observation period was 8 min/animal each day such that all 7 animals were studied within the data collection session. Data collection occurred during the first hour the yard was open, alternating daily between 10:00 a.m. and 11:00 a.m. Approximately 27 hr of data were analyzed for the entire experiment: 14.67 hr for the no-retreat condition, 9.52 hr for the semi-retreat condition, and 3.60 hr for the full-retreat condition. The testing order of retreat condition was (a) semi-retreat, (b) no retreat, and (c) full retreat. Because of the limited number of animals, and because of the permanent nature of the retreat structures, it was not possible to randomize treatment order among the subjects.

Statistical Analysis

We analyzed the data using linear regression methods. The independent variable was the number of undesirable behaviors exhibited per hour. The dependent or predictor variables analyzed were animal species, number of visitor touches per hour, human density level, and the retreat condition (no retreat, semi-retreat, or full retreat). Human density was divided into three categories representing low (1 to 6 people), medium (7 to 12 people), and high (13 to 18 people) levels of human density.

RESULTS

We conducted a multiple regression analysis to predict the rate of undesirable behavior exhibited from the predictor variables of animal species, human density level, visitor touches per hour, and the retreat condition (no retreat, semi-re-

treat, and full retreat). In the analyses we used forward regression methods with an F-enter criterion of $p < .05$ and listwise deletion of missing data. The assumptions of homoscedasticity, linearity, and normality were evaluated and met for the data. The retreat condition variable was dummy coded to test each level of the effect. Human density level was coded in the regression analysis as 1 = low, 2 = medium, and 3 = high human density, and animal species was coded as 0 = goats and 1 = sheep. All results were analyzed for statistical significance at the .05 alpha level using SPSS (Windows 10.0).

The results presented in Table 1 indicate that the predictor variables of animal species, human density level, and retreat condition related significantly to the rate of undesirable behavior exhibited. The regression equations for predicting the rate of undesirable behavior exhibited were statistically different from zero for all four models, as indexed by the F test.

The results presented in Table 2 indicate the goodness of fit of the final model (how well the final model predictors together explain the variation in the rate of undesirable behavior exhibited) indexed by R^2 was .60, indicating a good fit of the final model. The final regression equation predicting the rate of undesirable behavior exhibited was $Y' = \text{constant} + b_1X_{\textit{animal species}} + b_2 \times X_{\textit{human density level}} + b_3 \times X_{\textit{semi-retreat condition}} + b_4 \times X_{\textit{full-retreat condition}}$.

TABLE 1
Analysis of Variance Summary Table

Model	*Sum of Squares*	*df*	*Mean Square*	*F*	*p*
1[a]					
Regression	24.33	1	24.33	41.26	.001
Residual	35.97	61	0.59		
Total	60.31	62			
2[b]					
Regression	31.67	2	15.83	33.17	.001
Residual	28.64	60	0.48		
Total	60.31	62			
3[c]					
Regression	33.92	3	11.31	25.28	.001
Residual	26.39	59	0.45		
Total	60.31	62			
4[d]					
Regression	36.11	4	9.03	21.64	.001
Residual	24.20	58	0.42		
Total	60.31	62			

Note. The dependent variable was the frequency of undesirable behavior per hour.
[a]Predictor: animal species. [b]Predictors: animal species, semi-retreat. [c]Predictors: animal species, semi-retreat, full retreat. [d]Predictors: animal species, semi-retreat, full retreat, human density.

TABLE 2
Regression Model Summary With Change Statistics

Model	*R*	R^2	*Adjusted* R^2	*Standard Error*	*Change Statistic*[a]
1.00	.64[b]	.40	.39	.77	.001
2.00	.72[c]	.53	.51	.69	.001
3.00	.75[d]	.56	.54	.67	.03
4.00	.77[e]	.60	.57	.65	.03

[a]Change statistic is significant *F* change. [b]Predictor: animal species. [c]Predictors: animal species, semi-retreat. [d]Predictors: animal species, semi-retreat, full retreat. [e]Predictors: animal species, semi-retreat, full retreat, human density.

The results presented in Table 3 reveal, as indexed by the significance levels of the *t* tests, that animal species, retreat condition, and human density level were statistically significant predictors of the dependent variable—incidents of undesirable behavior—exhibited per hour. The predictor variable, number of touches per hour, did not meet the *F*-enter probability of .05 and thus was not entered into the regression model.

For the predictor variable of animal species, the unstandardized beta coefficients indicated a positive relationship such that the rate of undesirable behavior exhibited was higher in the sheep than in the goats. The partial correlation measured the strength of the effect of animal species on the dependent variable. The correlation indicated that animal species was a significant predictor of the rate of undesirable behavior exhibited (see Table 3).

For the predictor variable of human density level, the unstandardized beta coefficients indicated a positive relationship such that the rate of undesirable behavior exhibited increased as human density levels increased. The partial correlation indicated that human density level was a significant predictor of the rate of undesirable behavior exhibited (see Table 3).

For the dummy coded retreat condition, the unstandardized beta coefficients revealed that the rate of undesirable behavior exhibited was higher in the semi-retreat condition than in the no-retreat condition and that the rate of undesirable behavior exhibited was lower in the full-retreat condition than in the no-retreat condition. The partial correlation revealed that both the semi-retreat and no retreat were significant predictors of the rate of undesirable behavior exhibited (see Table 3).

DISCUSSION

The African pygmy goats were expected to exhibit lower rates of undesirable behavior because this breed typically plays an interactive role with humans (Por-

ter, 1996). Because of characteristically higher levels of fearfulness in the Romanov sheep (Le Neindre et al., 1996; Le Neindre et al., 1993; Romeyer & Bouissou, 1992; Vandenheede & Bouissou, 1993), we expected that the sheep would exhibit a higher rate of undesirable behavior. Both the goats and sheep acted accordingly with our expectations: The goats exhibited an average of 0.15 undesirable behaviors/hr, whereas the sheep averaged 1.68 undesirable behaviors/hr (see Table 4 for descriptive statistics). The finding of a higher rate of undesirable behavior in the sheep suggests that the sheep we studied demonstrated behavior consistent with patterns indicating greater fear of humans (Le Neindre et al., 1996). Although the levels of fearfulness that appeared among the animals in this study, as indexed by the rate of undesirable behavior, are assumed the result of both genetic and environmental influences, the proportionate influence of either factor was not the focus of this study because complete rearing histories were not available. Rather, the implication of this finding is that modifications to the environment can beneficially moderate such fearful behavior.

The data supported our expectation that higher human density levels would be associated with higher rates of undesirable behavior. As the number of visitors in the yard increased, the rate of undesirable behavior exhibited increased. At the low human density level, the rate of undesirable behavior averaged 0.44; at medium, it averaged 0.76; and at a high human density level it averaged 0.90. One explanation is that as the human density in the yard increases it becomes increasingly difficult

TABLE 3
Regression Coefficients With Undesirable Behavior Per Hour As the Dependent Variable

		Unstandardized Coefficients					
Model	*Coefficients*	β	*SE*	*Standardized Coefficients* β	*t*	*p*	*Partial Correlations*
1	Constant	0.31	0.11		2.67	.01	
	Animal species	1.38	0.21	0.64	6.42	.001	0.64
2	Constant	0.06	0.12		0.54	.59	
	Animal species	1.38	0.19	0.64	7.14	.001	0.64
	Semi-retreat	0.72	0.18	0.35	3.92	.001	0.35
3	Constant	0.30	0.16		1.91	.06	
	Animal species	1.38	0.19	0.64	7.38	.001	0.64
	Semi-retreat	0.49	0.21	0.24	2.38	.02	0.21
	Full retreat	–0.46	0.21	–0.22	–2.24	.03	–0.19
4	Constant	–0.16	0.25		–0.64	.52	
	Animal species	1.38	0.18	0.64	7.64	.001	0.64
	Semi-retreat	0.49	0.20	0.24	2.47	.02	0.21
	Full retreat	–0.46	0.20	–0.22	–2.32	.02	–0.19
	Human density	0.23	0.10	0.19	2.29	.03	0.19

TABLE 4
Descriptive Statistics for the Dependent Variable, Rate of Undesirable Behavior Exhibited

Retreat Condition	*Animal Species*	*Human Density*	*M*	*SD*
No retreat	Goats	Low	0.08	0.09
		Medium	0.25	0.36
		High	0.40	0.26
	Sheep	Low	0.94	0.06
		Medium	1.91	1.27
		High	2.58	0.05
Semi-retreat	Goats	Low	0.47	0.70
		Medium	0.72	0.34
		High	0.53	0.49
	Sheep	Low	1.55	1.01
		Medium	3.10	0.53
		High	3.45	0.73
Full retreat	Goats	Low	0.30	0.43
		Medium	0.00	0.00
		High	0.00	0.00
	Sheep	Low	0.00	0.00
		Medium	0.53	0.75
		High	1.09	1.54

for animals to maintain critical distances; thus, aggressive or escape behaviors may be initiated in attempts to restore and maintain critical distances. The rate of undesirable behavior exhibited was independent of the number of visitor touches the animals received.

The presence of a retreat space was expected to lower the rate of undesirable behavior exhibited for both species when compared to the rates in the absence of a retreat space. Mixed evidence supported our expectation. First, for both the sheep and goats the rates of undesirable behavior were significantly lower in the full-retreat condition than the rates in the no-retreat and semi-retreat conditions. However, for both goats and sheep the rates of undesirable behavior exhibited were significantly higher in the semi-retreat condition than were the rates in the no-retreat and full-retreat conditions. These findings indicate that some aspect of the structural design of the full retreat was beneficial in reducing undesirable behavior, whereas some aspect of the semi-retreat's structural design not only was ineffective in reducing undesirable behaviors but also increased undesirable behavior.

Possible elements of the full retreat responsible for the lowering of undesirable behavior were the construction of entrance and exit points by using chicken wire fencing. The use of such fencing not only prevented direct contact by the visitors but also prevented any attempts to contact the animals. However, the structural design of the semi-retreat area allowed visitors to attempt to touch animals directly

by reaching with the hand over and under the wooden bar or even by wandering underneath the wooden bar.

RECOMMENDATIONS FOR MANAGING UNDESIRABLE BEHAVIOR IN A PETTING ZOO

Our data suggest that both the general temperament of the animals and the environment should be carefully considered when managing a petting zoo. Levels of fearfulness vary among breeds of sheep and goats. The African pygmy goats appear to be a good choice for petting zoos, and other breeds of goats might also be tolerant. On the other hand, Romanov sheep may be questionable animals for a petting zoo environment. Research conducted by Le Neindre and colleagues (Le Neindre et al., 1996; Le Neindre et al., 1993) clearly revealed that this particular breed is fearful of humans. Even given these breed and species differences, the behavior of both the African pygmy goats and the Romanov sheep in this experiment suggest that a retreat space can beneficially moderate undesirable behavior.

The architectural design of retreat spaces needs further experimentation. The rates of undesirable behavior may have been higher in the semi-retreat condition because of the design of the retreat. Specifically, an animal could have entered the semi-retreat space after exhibiting one undesirable behavior in the yard and then because of further human contact by a reaching hand or a wandering visitor, the animal could have exhibited another undesirable behavior while in the semi-retreat space. The full-retreat barrier may have reduced undesirable behavior because of an increase in the perceived control by the animal—that is, the animals were able to maintain control over their environment with regard to the amount of interaction with humans. By maintaining control over their environment, the animals gained mastery over potentially aversive stimulation without the responses of flight, aggressive behavior, or attack (H. Markowitz, 1979; McBride, 1984; Novak & Drewson, 1989; Snowdon & Savage, 1989). In this way the use of the full-retreat condition may be beneficial.

In this study, we discussed the known factors of breed type, human density, and environmental layout as influences on undesirable behavior. We did not discuss the rearing conditions for these particular animals because they are unknown, but the literature clearly suggests that an animal's introduction to humans is an important factor in optimally managing a petting zoo. If humans handle animals during a particular period of their development, the animals may become more tolerant of humans (T. M. Markowitz, Dally, Gursky, & Price, 1998; Mateo, Estep, & McCann, 1991). Another approach to mitigate undesirable behavior is for zoo staff to attempt to train animals or desensitize animals who exhibit undesirable behavior in the presence of humans. Although such training may be time intensive, in some circumstances it may be appropriate.

Because there is wide variability in the behavior displayed by animals of the same species, of the same breed, and even among animals from the same rearing condition (Romeyer & Bouissou, 1992), zoo curators will ultimately have to observe each individual animal's behavior to determine appropriate animal selection and management for a petting zoo setting.

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