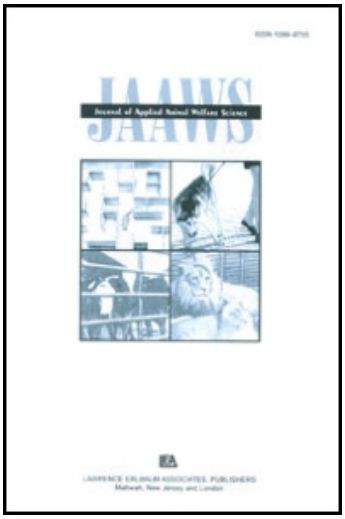

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RESEARCH REPORTS

Influence of Cinnamon and Catnip on the Stereotypical Pacing of Oncilla Cats (*Leopardus tigrinus*) in Captivity

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Nonhuman animals in captivity can experience environmental privation that results in their exhibiting abnormal behaviors. Environmental enrichment techniques can help improve their welfare. This study investigated the behavior of 8 zoo-housed oncilla cats (*Leopardus tigrinus*) in response to 2 odors (catnip and cinnamon) introduced individually into the animals' enclosures for 3 consecutive days. Proportion of scans spent engaging in stereotypical pacing were compared before, during, and after treatments. The addition of cinnamon reduced the proportion of pacing during and after enrichment (Wilcoxon: $Z = 3.16$, $p < .001$; $Z = 3.16$, $p < .001$, respectively), indicating a prolonged effect of the enrichment on the animals' behavior. Catnip appears to have elicited no significant difference in the stereotypic pacing before, during, or after the enrichment (Friedman: $X^2 = 2.69$; $p = .260$). The results highlight the potential use of cinnamon as a method of environmental enrichment for small captive-housed cats.

Professor Gelson Genaro served as the lead author's advisor in this study.

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The oncilla is the smallest Brazilian cat. Males are generally larger than females, and body weight varies from 1.75 to 3.5 kg and length varies from 40 to 50 cm (Oliveira & Cassaro, 1999). Although information from the field and captivity indicates that the species is nocturnal (Oliveira, 1994), some food items identified in specimens from northeastern Brazil indicate a high degree of daytime activity (Olmos, 1993). The species is classified as vulnerable by the International Union for Conservation of Nature (Oliveira et al., 2008), little studied, and rarely seen in nature. Genaro, Moraes, Silva, Adania, & Franci (2007) stated that oncilla reproduction in captivity is poor because of several factors, of which stress is probably the most important.

Maintenance of endangered populations in captivity is essential in environmental education and research programs (Law, MacDonald, & Reid, 1997) and constitutes preservation of an important genetic legacy (Dobson & Smith, 2000). However, inappropriate environments adversely affect nonhuman animal behavior, mainly because of the lack of stimuli (Boere, 2001). In captivity, animals may not have the motivation, opportunity, or need to exhibit some behaviors considered normal for the species (McPhee, 2002). Under these conditions, many individuals develop stereotypical pacing seen, for cats, as a manifestation of captivity stress. Various environmental enrichment techniques can improve their welfare.

A large number of papers have described specific techniques for enrichment for cats. These include the use of substrates, whole carcasses, alternative methods of feeding, and the addition of suspended toys (Bashaw, Bloomsmith, Marr, & Maple, 2003; Law, 1991; McPhee, 2002; Pitsko, 2003; Saskia & Schmid, 2002; Skibiel, Trevino & Naugher, 2007). Studies using scents as olfactory enrichment are scarce (Bradshaw, 1992; Pearson, 2002; Powell, 1995; Schuett & Frase, 2001; Wells & Egli, 2004). Nevertheless, olfactory stimulation influences the behavior of a wide variety of species and is now considered a useful form of environmental enrichment for many captive animals (Graham, Wells, & Hepper, 2005; Wells, 2009).

The purpose of this study was to evaluate the efficiency of cinnamon and catnip in reducing the stereotypical pacing of *Leopardus tigrinus* in captivity.

METHODS

The subjects of this study were 8 adult felids (*Leopardus tigrinus*) kept at the Reproduction Center for Small Felids in the Rio de Janeiro Zoo. Animals were placed in four enclosures, grouped as follows:

1. 2 males;
2. 1 male and 1 female;

3. 2 males; and
4. 1 male and 1 female.

All animals were born in the wild and have been in captivity 7–12 years. Enclosures (15 m^2) are made of stone masonry walls, with the exception of the front, a mesh-screen panel. The interior of these enclosures consists of land and concrete substrate, plants, and tree trunks displayed randomly; a wooden box measuring 64.000 cm^3 is located in the upper part, used as a shelter. The animals remain in a restricted area and have contact only with their caregivers and technicians.

Behavioral data were collected in May and June 2007. Each animal was observed for 360 hr totaling 2880 hr of observation. We conducted baseline observations (Phase I) for 3 consecutive days with the aim of establishing the behavioral categories displayed by individuals and their frequencies before the introduction of scents. This phase served as the baseline for the two experimental conditions (the addition of cinnamon and the addition of catnip).

During Phase II, we introduced 1 g of dried cinnamon individually into the cats' environment between wood chippings and dry alfalfa (*Medicago sativa*) for 3 consecutive days, always at 17:00 hr. Postenrichment baseline observations (Phase III) were made for 3 consecutive days to analyze the possible persistence of the second-phase results (Figure 1).

Thirty days after Phase III, we then introduced 1 g of dried catnip powder individually into the cats' environment between wood chippings and dry alfalfa for 3 consecutive days, always at 17:00 hr (Phase IV). Postenrichment baseline observations (Phase V) followed for 3 consecutive days.

During the study, we recorded the animals' behavior 24 hr per day through two microcameras (CCD Sharp) installed inside the enclosure. Four 40-kW red lamps aided nocturnal image recording. The records were analyzed using the focal-animal method (Altmann, 1974). A single observer scored all behavioral data reported.

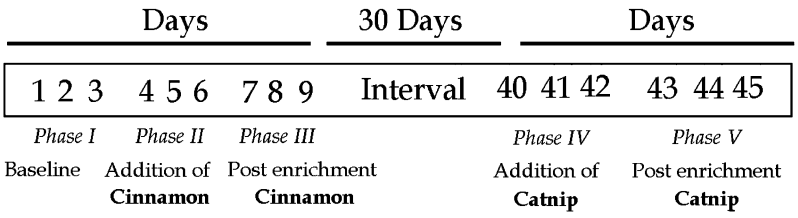

FIGURE 1 Experimental design adopted for the experiments at the Reproduction Center for Small Felids during the month.

TABLE 1
List of Behaviors Displayed by *Leopardus tigrinus* Kept in the Center for Small Felids, RIOZOO Foundation

Inactive or Resting Behaviors	
Lying	Subject is resting on haunches, fully extended on the ground, and may have eyes open or closed
Inside the box	Animal inside a wooden box
Sitting	Subject in bipedal position, with front legs resting against vertical surface
Active Behaviors	
Jumping	Subject leaps from one point to another, either vertically or horizontally
Pacing	Repetitive walking without apparent aim
Locomotion	Movement toward a specific direction with an aim
Exploring	Animal moving attentively, normally sniffing the ground and the walls
Vigilant	Alert, attentive standing or sitting
Drinking	Animal drinking water
Eating	Grinding an object, usually with canines
Hunting	All the behavioral acts involved in hunting, lurking, stalking, and killing the prey
Sharpen claws	Front claws are used to scratch on object
Cheek rub	Cheek is rubbed against an object or another cat
Urinating	Animal urinating; this can be related to territory demarcation
Defecating	Animal releasing feces
Scratching body	Animal uses the claws of hind legs to rub
Playing	Usually the individual interacts with the food (prey alive), throwing it into the air and chasing it.

Instantaneous sampling of state behaviors (Table 1) occurred at 5-min intervals totaling 12 scans per hour for each individual. The proportion of scans, the number of scans an animal was performing a certain behavior in relation to total number of scans per hour ($n = 12$), was reported. Then we calculated the mean for all hours of the day (24 hr). Time of interaction was defined as the number of scans that the animal exhibited interacting with the enrichment divided by the total number of scans. All behaviors were classified as active with the exception of lying inside the box and sitting.

Because the behavioral data recorded were not normally distributed, nonparametric statistics were used for data analyses. Friedman's test was used to analyze differences in behavior between the phases. If the Friedman's test was significant, a post hoc Wilcoxon signed rank test was performed to determine significant pairwise relationships, corrected for multiple comparisons with a Bonferroni correction (dividing the p value by the number of comparisons). Significance level after the Bonferroni correction was 0.016. SPSS (Version 8.0) was used to conduct the statistical analyses.

RESULTS

During the course of the experiment with cinnamon, significant differences emerged in the proportion of scans spent in pacing across the three phases (Phase I, Phase II, and Phase III; Friedman: $X^2 = 13.71$; $p < .001$). The stereotyped behavior was significantly higher before (Phase I; 1.38 ± 0.16) than during the enrichment (Phase II; 0.85 ± 0.12; Wilcoxon: $Z = 3.14$; $p = .002$; Figure 2).

Similarly, in a comparison of the proportion of pacing before (Phase I) and after enrichment (Phase III), we found a significant difference with a higher proportion in Phase I (1.38 ± 0.16) than after the enrichment (Phase III; 0.88 ± 0.08; $Z = 3.16$; $p = .002$). There was no significant difference between the proportion of pacing during enrichment (Phase II; 0.85 ± 0.12) and after enrichment (Phase III; 0.88 ± 0.08; $Z = 0.609$; $p = .542$). In addition, we observed no significant difference in the stereotypic pacing across the three phases (Phase I, Phase IV, and Phase V) during the experiment with catnip (Friedman: $X^2 = 2.74$; $p = .254$; Figure 2).

Neither enrichment protocol elicited significant differences in the average proportion of activity before, during, and after enrichment (catnip: Friedman: $X^2 = 2.69$; $p = .260$; cinnamon: Friedman: $X^2 = 2.53$; $p = .290$), indicating that enrichment did not affect the animals' activity/rest pattern.

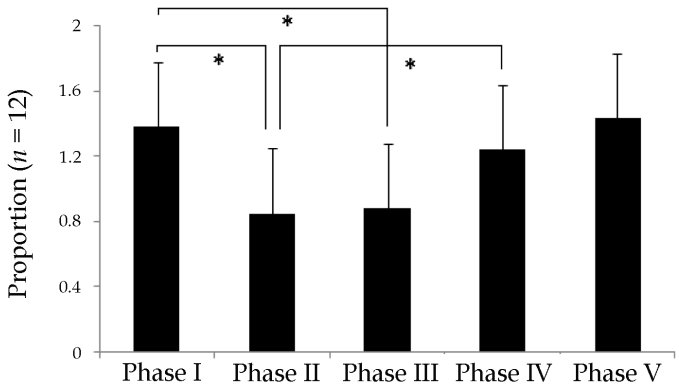

FIGURE 2 Proportion of stereotyped behavior (pacing) displayed by individuals *Leopardus tigrinus* in the Phase I (baseline observations), Phase II (addition of cinnamon), Phase III (postenrichment-cinnamon), Phase IV (addition of catnip), and Phase V (postenrichment-catnip). Each stage had duration of 3 consecutive days in the period from November 2006 until June 2007. Reproduction Center for Small Felids, RIOZOO Foundation. Statistically significant at the $*p \leq .05$.

In a comparison of the efficiency of the two scents, the results showed that despite the animals presenting similar time spent interacting with cinnamon (0.34 ± 0.25) and catnip (0.26 ± 0.21; Wilcoxon: $Z = -1.06$; $p = .280$), the proportion of pacing was statistically lower during the enrichment with cinnamon (0.85 ± 0.63) than during the enrichment with catnip (1.24 ± 0.65; Wilcoxon: $Z = -2.89$; $p = .004$).

DISCUSSION

Environmental enrichment is a process designed to enhance the quality of care for captive animals by the use of environmental stimuli necessary for the improvement of their psychological and physiological well being (Shepherdson, 1998). Cats are more likely to respond to poor environmental conditions by becoming inactive and by inhibiting normal behaviors—such as self-maintenance, exploration, or play—than by actively showing abnormal behavior (Rochlitz, 1999). Therefore, criteria for assessing their welfare before, during, and after the enrichment were pacing reduction and standard activity patterns.

We identified a significant difference between the proportion of pacing before, during, and after the enrichment with cinnamon, confirming the beneficial effect of the odor for stereotypical behavior. These results are in agreement with those of Skibiel et al. (2007), who observed a reduction in the time spent pacing in felids when cinnamon, chili powder, and cumin (*Cuminum cyminum*) were provided. Furthermore, we also found a significant reduction in the proportion of pacing in the period after the enrichment, indicating its prolonged effect. Examining enrichment effects after removal of the item is important in behavior studies because only long-term changes indicate an improvement in underlying behavioral patterns (Bashaw et al., 2003). Although some of these olfactory enrichments may be biologically meaningless to many animals, work has shown that essential oils and other plant-derived odorants might improve the welfare of certain species (Wells, 2009).

During the enrichment with catnip, no significant difference emerged in the average time spent in pacing across the three phases. These data were unexpected because catnip plays a variety of roles in species-specific behaviors (increased diversity of natural behaviors such as moving, grooming, and exploring; Wells & Egli, 2004). Whereas the time interval (36 days) between the baseline and the catnip treatment could be partly responsible for this result, it also works as a wash-out period between treatments, thus reducing the possibility of overlapping effects. Differences in response to olfactory enrichment between species or individual differences within species arising from gender or age also may explain the results. Furthermore, Wells, Hepper, Coleman, and Challis (2007) suggested that the form of enrichment provided (odor-impregnated cloths, powder form, or diffused into the air) can influence the response.

In general, our results show that odor does not interfere with the balance between activity and resting. These results conflict with those of Schuett and Frase (2001), who reported a reduction in inactivity of lions (*Panthera leo*) exposed to cinnamon, chili powder, ginger (*Zingiber officinale*), and zebra (*Equus* sp.) feces. Accordingly, Wells and Egli (2004) reported a reduction of inactivity in *Felis nigripes* when treated with nutmeg (*Myristica fragrans*), catnip, and prey odor (quail *Coturnix coturnix*). It must be pointed out that these enrichments were provided during the day, when these animals are naturally inactive. An increase in activity during the day in cats during environmental enrichment may be unnecessary and not natural (Hutchins, Hancocks, & Crockett, 1984). In the current study, we chose to expose the animals to enrichment when their activity frequency was at its peak. Thus, we expected the enrichment to change the way these animals used their time of activity, decreasing pacing and encouraging natural behaviors. We found that the balance between activity and rest was not an efficient variable for measuring the welfare of the animals in this case, even as pacing proved useful as a measure.

This study shows that providing captive felids with inexpensive, easy-to-administer enrichment objects can have profound effects on their behavior. Use of cinnamon reduced pacing during and after the enrichment, indicating its potential for environmental enrichment for felids.

CONCLUSIONS

This study highlights the potential use of cinnamon as a method of environmental enrichment for small captive-housed cats. Because our study showed that the odor of catnip does not influence stereotypical pacing, the use of catnip should be investigated.

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