

An Evaluation of Exercise Pen Use by Circus Tigers (*Pathera tigris tigris*)

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This study quantified the behavior of 11 tigers during periodic access to an exercise pen throughout the day and night. The study determined the amount of time spent in the pen and the percentage of time spent performing stereotypic pacing, normal locomotor behavior, and lying down while in the pen. Average access to the exercise pen was 10 hr 49 min overnight and 5 hr 30 min during the day. At night, the tigers spent 29.1% of their time in the exercise pen, during which they paced 19.6% and performed normal locomotor behavior for 23.1% of that time. By day, they spent 40.4% of their time in the exercise pen, during which they paced 10.0% and performed normal locomotor behavior 35.7% of that time. The tigers spent the rest of the time in the pen lying down. Overall, tigers will utilize an exercise pen, spending a greater percentage of time in the pen during the day than at night and also performing less stereotyped pacing than at night.

A majority of studies relating to reduced cage size and abnormal behavior suggest that the two are directly correlated. While discussing nonhuman animals in circuses and zoos in general, Hediger (1968) was one of the first to assert that extreme manifestations of boredom are noticeably less frequent in larger enclosures. Kiley-Worthington (1990) observed that circus tigers spent less time pacing while in a larger exercise yard (7.5 min/hr) than in smaller mobile home

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cages housed in a wagon (8.4 min/hr). Tigers in zoos with relatively large enclosures also averaged more normal activity and were more active (Lyons, Young, & Deag, 1997).

Tigers used in circus acts are often kept in home cages with anywhere from 2.2 to 24.4 m² of floor space (Nevill, Friend, & Toscano, 2004). In addition, when stopped at a venue, many circuses and tiger acts supplement their home cages by providing their animals with an exercise pen. These exercise pens, often as large as 10 m in diameter, provide enrichment by offering more space, containing objects with which the tigers can play (logs, balls, or a pool containing water), and by allowing the tigers to interact socially when released in groups. However, because tiger acts in circuses can consist of 6 to 17 individuals (Nevill & Friend, 2006), every tiger cannot be given unlimited access to the pen. Instead, placed into small groups, they often are given access to the exercise pen on a rotating basis for several hours at a time.

It is important to determine both how long a tiger, given extended access, will freely choose to remain in an exercise pen and what behaviors the tiger will display while in an exercise pen. There is some controversy as to whether exercise pens are actually utilized by tigers. Some trainers believe that tigers will carry out a relatively standard amount of locomotor behavior either by normally moving about the cage or by stereotypically pacing and then lie down, regardless of the amount of time that the cat has access to the pen. Others believe that exercise pens are not necessary as training and performances provide adequate stimulus and time out of the home cages. Access by circus tigers to an exercise pen for 20 or 40 min a day did not statistically decrease pacing in their home cage (Nevill & Friend, 2006). However, there was an inverse correlation between the linear distance covered by the tigers in the exercise pen and the amount of pacing they exhibited in their home cage. It was concluded that 20 to 40 min a day may not have been enough time for a circus tiger to have access to an exercise pen to reduce pacing in their home cages. The purpose of this study was twofold: (a) to determine how much time a tiger will spend in an exercise pen when given ad libitum access and (b) to quantify the major types of behaviors the tigers exhibit while in the exercise pen.

METHOD

General

Observations were conducted on Bengal tigers belonging to Dr. Josip Marcan, who was traveling with Ringling Brothers, Barnum & Bailey, Blue Unit. Initial data were collected during the summer of 2000 and quasireplicated in the summer of 2003. No changes were made in the management of the tigers being

studied during either replication. They were grouped, given access to an exercise pen, and participated in performances and training sessions as they would in the normal course of events.

Year 2000

Three pairs of tigers were continuously videotaped for 72 hr while they had periodic access to an exercise pen 10 m in diameter. The tigers were divided into three social groups. Group 1 contained a 4-year-old male (No. 1) and a 3-year-old female (No. 2), Group 2 contained a 3-year-old male (No. 3) and a 3-year-old female (No. 4), and Group 3 contained two 2-year-old males (No. 5 and No. 6). In addition to the aforementioned tigers, Group 3 contained another male and female whose behavior was not quantified due to the difficulty in telling those tigers apart on the video.

The three groups of tigers were housed in a pair of wagons that contained an array of cages interconnected by sliding doors. The groups of tigers were routinely rotated between the two wagons, with Groups 1 and 2 in half sections of one wagon and Group 3, composed of the four tigers, given access to the entire other wagon. They were typically rotated between the wagons each time they returned from a rehearsal, performance, or other event. Utilizing the sliding doors, the conformation of the wagons was easily changed to accommodate either the two pairs or the single, larger group. Attached to the end of one of the wagons was the 10 m exercise pen. When the tigers were given access to the exercise pen, they could also choose to remain in their home cages. The exercise pen was on asphalt, bedded with fresh wood shavings and cleaned regularly. There were no logs, balls, or other toys in the exercise pen when this research was conducted. The pen was constructed of open, welded rod panels that allowed the tigers a clear view of their surroundings. The wagons and exercise pen were situated in the parking lot outside the Oakland (California) Sports Arena within constant sight of other animals who were used in the show (including zebras, cattle, llamas, and elephants). In addition to access to the exercise pen, the tigers participated in their standard routine of four performances and a rehearsal over the course of the 72-hr observation period. The animals were given water *ad libitum*, and feeding occurred at night after the last performance. Having just had access to the exercise pen for an extended period of time the day preceding the start of this project, Group 1 was not given access again until the second 24-hr period that observations were collected. As a result, there were no data for Group 1 on Day 1.

A Panasonic WV-BP312 closed-circuit camera was mounted on a tripod approximately 1.37 m outside the exercise pen to record the behavior of the tigers while they were in the pen. Video was recorded at the rate of 24 hr per 2-hr tape (2.3 frames/s) and taken continuously for 72 hr. Because of the

frequent shifting of the tigers between wagons and the necessity of keeping the area in the vicinity of the wagons clear for transport cages, observations of the tigers while in the wagons were not possible.

Year 2003

The same three pairs of Bengal tigers were once again used in a quasireplication, and a fourth group of young tigers was also utilized. The previously used tigers were now 2 years older, and the fourth group consisted of three 1-year-old males (Nos. 7, 8, and 9) and one 1-year-old female (No. 10). Another 6-year-old male (No. 11) was housed with tigers No. 5 and No. 6.

The same wagons were used to house the tigers in the second replication; however, they were parked inside the air-conditioned Alamodome in San Antonio, Texas. Wagon configuration also changed slightly. Instead of both wagons being connected together with the exercise pen at one end, the exercise pen was positioned between the two wagons, allowing for two doors to open into the pen. Tigers were rotated in a similar pattern as before, and only one group of tigers had access to the pen at a time. The rotation resulted in tigers No. 3 and No. 4 being allowed out only during the day while observations were being recorded. The exercise pen was once again bedded with wood shavings; however, in this replication, the trainers added enrichment in the form of tree branches with foliage, stumps, a large plastic ball, and a performance pedestal. In addition to those changes, the circus also initiated a program in which ticketed spectators had access to the area in which the animals were housed for 1.5 hr prior to the performance.

The same closed-circuit camera was mounted on a tripod immediately outside the exercise pen, and another was added that overlooked the exercise pen from a higher viewpoint. Video was recorded at 1.1 frames per second (48 hr per 2-hr tape) for 96 hr, and the percentage of time that the tigers performed the three activities was calculated.

Video Data Analysis

Video data were quantified using the Etholog Program (Ottoni, 2000). The percentage of time that the tigers actually spent in the exercise pen, given access ad libitum, was first determined. Of that percentage, the percentage of time that each tiger spent pacing, lying, and performing normal locomotor behavior while in the exercise pen was then calculated. The behavior data for individual tigers were assumed to be independent for the following reasons:

1. Mature tigers are inherently independent in nature;

2. The tigers were specifically placed in groups in which individuals did not interfere with each other; and
3. During our observations, there was no indication that the behavior of one tiger influenced the behavior of another in a way that would be meaningful to the results of this experiment.

The percentage of time that the tigers spent in the exercise pen given access ad libitum was compared between the first and second replications and for day against night using a Student's *t* test (Kirkman, 1996). Individual values for each tiger for each year and for daytime and nighttime access data (time in pen and individual behaviors) were averaged together by animal for statistical comparison. Arcsine transformation was employed to approximate normality in the data presented as percentages of time. The same statistical analysis was applied to compare the amount of pacing with the amount of normal locomotor behavior exhibited while the tigers were in the exercise pen during the day, during the night, and overall. The overall percentage of time that the tigers spent pacing, lying down, and performing normal locomotor behavior in the exercise pen in 2000 versus 2003 was compared as well as the percentage of time spent performing those behaviors in the exercise pen during daytime access as opposed to nighttime.

Behavior Definitions

Pacing. A tiger who walked repetitively on a fixed route within the exercise pen was considered to be pacing. A minimum of two consecutive laps or cycles between the same two points in the cage was necessary to be considered one bout of pacing.

Lying. A tiger who assumed sternal or lateral recumbency was considered to be lying. Any eating or grooming done while in a sternal or lateral recumbent position was also considered part of lying. A tiger who rose to sit on the haunches was still considered lying until the tiger was supported by all four legs.

Normal locomotor behavior. Normal locomotor behavior consisted mainly of any nonstereotypic walking. In addition, if the tigers stopped and stood still for any length of time, this was considered normal locomotor behavior. Any activity carried out while standing (elimination) was placed into this category due to its infrequency and short duration. Rearing up on the hind legs was also considered normal locomotor behavior. Another primary component of normal locomotor activity was social interaction with other tigers in the pen. This often occurred as bouts of chasing and play fighting.

RESULTS

During the course of this experiment, only one animal, tiger No. 5, chose not to enter the exercise pen during one period when the tiger was given access, Day 5 in 2003. For the purposes of this study, Day 5 for tiger No. 5 was omitted from the statistical analysis because of the effect a zero has on measures of variation.

Access to the exercise pen overnight was always preceded by a performance and feeding and lasted an average of 10 hr 48 min (Table 1). The tigers spent an average of $29.1 \pm 7.0\%$ (3 hr 9 min) of this time actually in the exercise pen, with lying down being the predominant behavior exhibited. Normal locomotor behavior followed, comprising approximately one quarter of the tigers' time budgets at night. There was considerable variation between tigers with percentage of time spent pacing ranging from 0 to 77.5%, the mean being $19.6 \pm 4.7\%$. Although not quantified, much of the pacing tended to occur during the early morning before dawn.

TABLE 1
Summary of Data for Tigers Having Overnight Access to the
Exercise Pen During 3 Nights of Observations in 2000 and 4 Nights in 2003

					<i>Behavior While in Exercise Pen</i>		
<i>Tiger</i>	<i>Year</i>	<i>Night</i>	<i>Access (min)</i>	<i>Time in Pen (%)</i>	<i>Pacing (%)</i>	<i>Lying (%)</i>	<i>Normal Locomotor (%)</i>
1	2000	3	668	28.2	77.5	8.9	13.6
	2003	2	903	8.1	10.9	54.4	34.7
2	2000	3	668	15.8	64.8	17.7	17.5
	2003	2	903	19.4	30.7	52.0	17.3
5	2000	1	918	27.9	24.0	50.1	25.9
		2	1,046	27.6	33.7	50.8	15.5
	2003	1	479	18.5	57.6	34.5	7.9
4		543	5.7	38.0	19.1	42.9	
6	2000	1	918	5.9	0.0	25.3	74.7
		2	1,046	8.3	12.3	40.0	47.7
	2003	1	479	12.3	0.0	89.8	10.2
		4	543	9.5	0.0	49.4	50.6
7	2003	3	388	100.0	2.6	93.0	4.4
8	2003	3	388	99.9	0.0	96.0	4.0
9	2003	3	388	43.8	0.0	83.8	16.2
10	2003	3	388	73.9	0.0	89.4	10.6
11	2003	1	479	16.4	0.0	87.9	12.1
		4	543	2.0	0.0	90.9	9.1
Mean			649.3	29.1	19.6	57.4	23.1

Access to the exercise pen during the day was much shorter in duration than overnight access, lasting an average of 5 hr 30 min. Tigers chose to freely spend $40.4 \pm 5.4\%$ (2 hr 12 min) of that available time in the pen. Although lying down while in the pen was still the predominant behavior during the day, occurring an average of 54.3% of the time, normal locomotor behavior occurred an average of 35.7% of the time that the tigers were in the pen (Table 2). Pacing occurred $10.0 \pm 3.9\%$ of the time during the day, nearly half the percentage of time that the tigers spent pacing at night.

TABLE 2
Summary of Data for Tigers Having Daytime Access to the
Exercise Pen During 3 Days of Observations in 2000 and 4 Days in 2003

Tiger	Year	Day	Access (min)	Time in Pen (%)	Behavior While in Exercise Pen		
					Pacing (%)	Lying (%)	Normal Locomotor (%)
1	2000	2	85.0	5.3	0.0	0.0	100.0
2	2000	2	85.0	13.4	0.0	13.4	86.6
3	2000	1	38.0	79.4	1.6	67.8	30.6
		2	133.0	76.8	59.8	36.7	3.5
		3	267.0	69.2	80.8	11.9	7.3
	2003	1	121.0	33.5	39.5	27.2	33.3
		3	489.0	1.1	0.0	36.7	63.3
4	2000	1	38.0	50.1	9.8	57.3	32.9
		2	133.0	14.9	0.0	75.0	25.0
		3	267.0	29.7	0.4	91.9	7.7
	2003	1	121.0	3.2	0.0	0.0	100.0
		3	489.0	7.9	30.8	34.6	34.6
5	2000	3	180.0	38.7	0.0	89.8	10.2
6	2000	3	180.0	7.3	4.2	52.8	43.0
	2003	5	355.0	4.1	13.8	6.9	79.3
7	2003	1	294.0	59.7	1.7	70.7	27.6
		2	561.0	53.7	0.0	77.5	22.5
		4	489.0	84.9	0.7	83.2	16.1
8	2003	1	294.0	54.6	0.0	82.6	17.4
		2	561.0	45.3	0.0	81.9	18.1
		4	758.0	88.3	6.0	82.1	11.9
9	2003	1	294.0	64.1	1.6	63.7	34.7
		2	561.0	65.4	0.5	72.7	26.8
		4	758.0	63.5	8.7	66.4	24.9
10	2003	1	294.0	41.6	7.3	68.9	23.8
		2	561.0	15.5	0.0	59.8	40.2
		4	489.0	18.7	3.3	53.6	43.1
Mean			329.4	40.4	10.0	54.3	35.7

The difference between the 2 years when comparing the percentage of the allotted access time that the tigers actually spent in the exercise pen was insignificant ($t = .496$, $p = .63$), as was the difference between the percentage of time spent in the exercise pen when comparing daytime access with nighttime ($t = .377$, $p = .71$). The overall percentage of time that the tigers spent pacing while in the exercise pen was significantly less than the amount of time they spent performing normal locomotor behaviors ($t = -5.46$, $p < .01$). The same was true when comparing the two behaviors during the day and the night ($t = 6.99$, $p < .01$ and $t = -2.15$, $p = .05$, respectively).

In a comparison of the individual behaviors between 2000 and 2003, there was no significant difference between any of the behavioral categories quantified. Comparing daytime access with nighttime, the percentage of time spent performing normal behavior was significantly higher during the day ($t = 2.65$, $p = .02$). Percentage of time spent pacing or lying down, however, was not influenced by daytime or nighttime access ($t = .703$, $p = .49$ and $t = 1.36$, $p = .19$, respectively). Significant results from statistical analysis of the data are summarized in Table 3.

DISCUSSION

On average, a slightly greater proportion of time was spent in the exercise pen by the tigers who had access for shorter periods during the day than when they had extended overnight access. More than half of all behaviors exhibited while in the exercise pen, during both day and night, consisted of lying down. This is consistent with species-typical patterns of behavior. In the wild, tigers rest and sleep during most of the daylight hours, especially during the hotter portions of the day (Schaller, 1967). This can account for 16–18 hr of their daily time budget.

TABLE 3
Summary of Statistically Significant Comparisons of Behavior

<i>Overall and for Daytime Versus Nighttime Access</i>	<i>t statistic</i>	<i>p value</i>
Overall percentage of time spent pacing vs. performing normal locomotor behavior	-5.46	<.01
Percentage of time spent pacing vs. performing normal locomotor behavior, day	6.99	.01
Percentage of time spent pacing vs. performing normal locomotor behavior, night	-2.15	.05
Percentage of time spent performing normal locomotor behavior, day vs. night	2.65	.02

Overall, there was a significantly higher frequency of normal locomotor behaviors exhibited in the exercise pen than stereotyped locomotor behaviors. However, while the tigers were in the exercise pen overnight, the percentage of observations spent pacing nearly doubled. Time spent lying down during the night was not different from daytime access, whereas time spent performing normal locomotor behavior decreased at night. The increase in arousal seen overnight, illustrated by the increase in pacing, is not unexpected; tigers are nocturnal predators, covering up to 10 to 20 miles (16.1 to 32.2 km) of territory in one night (Schaller, 1967). This is done, typically, in an effort to hunt for food and patrol territory. Interestingly, the younger tigers used in this study, those only 1 year old, spent the greatest percentage of time in the exercise pen but exhibited very little pacing.

CONCLUSIONS

Although there were individual differences among animals, tigers will utilize an exercise pen for a considerable amount of time when given several hours of access. The tigers in this study choose to remain in the exercise pen approximately one third of the time that they had access. There was not a significant difference in the performance of stereotypic and normal locomotor behaviors during night access; however, a significantly greater proportion of normal locomotor behaviors were performed by tigers when in the exercise pen during the day. Giving tigers rotating shifts of 4 to 5 hr of access to an exercise pen during the day and night is useful in promoting more normal behavior. However, at this time, a basis for a recommendation regarding the number of times per day circus tigers should have access to an exercise pen has yet to be determined.

ACKNOWLEDGMENTS

We thank the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Animal Care Program for partially funding this research. We also thank Dr. Josip Marcan for his expertise and access to his tigers. His time and patience were greatly appreciated. Finally, we thank Feld Entertainment, Inc. (Ringling Brothers, Barnum & Bailey Circus) for allowing us to travel with the circus and conduct our research.

REFERENCES

- Hediger, H. (1968). *Psychology and behavior of animals in zoos and circuses*. New York, NY: Dover.

- Kiley-Worthington, M. (1990). *Animals in circuses and zoos: Chiron's world?* Harlow, Essex, UK: Little Eco-Farms.
- Kirkman, T. W. (1996). Student's t-test. *Statistics to use*. Retrieved from <http://www.physics.csbsju.edu/stats/>
- Lyons, J., Young, R. J., & Deag, J. M. (1997). The effects of physical characteristics of the environment and feeding regime on the behavior of captive felids. *Zoo Biology*, 16, 71–83.
- Nevill, C. H., & Friend, T. H. (2006). A preliminary study on the effects of limited access to an exercise pen on stereotypic pacing in circus tigers. *Applied Animal Behavior Science*, 101, 355–361.
- Nevill, C. H., Friend, T. H., & Toscano, M. J. (2004). Survey of transport environments of circus tigers (*Panthera tigris*). *Journal of Zoo and Wildlife Medicine*, 35, 167–174.
- Otoni, E. B. (2000). EthoLog 2.2—A tool for the transcription and timing of behavior observations sessions. *Behavior Research Methods, Instruments & Computers*, 32, 446–449.
- Schaller, G. B. (1967). *The deer and the tiger*. Chicago, IL: University of Chicago Press.