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## The effect of penning versus picketing on stereotypic behavior of circus elephants

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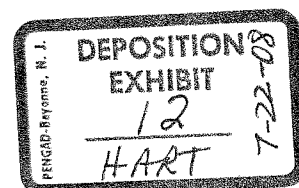
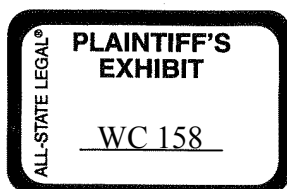
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### Abstract

The behavior of nine female Asian (*Elephas maximus*) elephants who performed two shows each day with a circus that traveled to a new location (40 to 250 km from the previous day's lot) daily or every two days was studied during the 1996 and 1998 seasons. When not performing or working, the elephants were picketed during 1996 in the traditional fashion in two separate groups of 8 and 9 elephants each. During the 1998 season, the same elephants were maintained exclusively in small (approximately 52 m<sup>2</sup> per elephant) portable electric pens. Camera and time-lapse recorders were used to videotape the behavior of each elephant, while picketed or penned, for three ~24 h periods during the 1996 and 1998 seasons. The behavior of each focal elephant was recorded at 5 min intervals. The amount of time the elephants spent stereotypic weaving was significantly decreased ( $P = 0.009$ ) by keeping the elephants in pens when compared to picketing. The incidence of all stereotypic behavior (weaving, head bobbing and trunk tossing) was also significantly decreased ( $P = 0.019$ ) when the elephants were kept in pens. The total amount of time spent performing all stereotypic behaviors (weaving, head bobbing and trunk tossing) was negatively correlated with age when the elephants were picketed in 1996 ( $r = -0.71$ ,  $P = 0.031$ ,  $N = 9$ ) and somewhat less correlated with age when penned in 1998 ( $r = -0.66$ ,  $P = 0.053$ ,  $N = 9$ ). Time spent performing all stereotypic behavior was not correlated with time spent eating ( $P > 0.11$ ) or time spent lying ( $P > 0.24$ ) when the elephants were picketed or penned. Portable electric pens are preferred over picketing because of reduced stereotypic behavior, the elephants are reportedly calmer when out of the pens for work or performances, and the elephants can be kept cleaner. © 1999 Elsevier Science B.V. All rights reserved.

**Keywords:** Elephant; Stereotypies; Circus; Housing

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## 1. Introduction

There is considerable interest among some circuses in North America to maintain their elephants in portable electric pens. The electric pens usually consist of two or three strands of wire electrified by a livestock fence charger. The picket line, however, is the traditional method of restraining elephants in circuses. Picketing an elephant involves chaining one front and the diagonal rear leg to parallel cables or chains. 'Chaining' diagonal legs is a very common form of restraint used by small exhibitors, zoos, and other facilities throughout the world. A picketed elephant can take approximately one step forward and one backward, but can readily interact with their immediate neighbors if any are present. Research with continuously picketed elephants found that performance of stereotypic behavior in picketed elephants varied greatly from one elephant to the next, while the behavior of individual elephants was highly correlated (ranging from  $r = 0.78$  to  $0.83$ ,  $P < 0.001$ ) from one year to the next (Friend, 1999). Stereotypic behavior was found to greatly increase in apparent anticipation of access to water, receiving hay and performances in those elephants.

Schmid (1995) found that keeping circus elephants temporarily in paddocks reduced stereotypic behavior. In her study, the elephants had only temporary access to paddocks (from 0.3 h to 8.2 h per day). Also, those elephants were chained inside a small tent on wooden flooring. Thus, there is a degree of confounding because the paddocks were outside while chaining occurred while inside a tent on wooden flooring.

There are no data comparing the effects of continuous picketing and continuous penning of elephants under similar conditions on stereotypic or other behavior. Also, some elephant trainers had expressed concern that shackling or chaining is a useful means of asserting dominance over elephants (also mentioned in Schmid, 1995) and that keeping elephants continuously in pens may reduce their motivation to perform.

The objective of this study was to characterize the stereotypic behavior of a group of circus elephants while they were kept exclusively on picket lines (data reported in Friend, 1999) with the behavior of the same elephants when they were maintained exclusively in small portable electrified pens. The trainers' assessments regarding changes in the motivation and attitude of the elephants after the elephants became accustomed to the pens was also obtained.

## 2. Materials and methods

### 2.1. General

The elephants used in this study were among the 13 to 14 Asian (*Elephas maximus*) and 2 to 3 African (*Loxodonta africana*) elephants who traveled with a five-ring tented circus and who were the subject of an earlier publication (Friend, 1999). The elephants ranged in age from 13 to 51 years. The circus usually moved to a new location every day or two and set up in fields or occasionally in paved parking lots. Each new location, as well as inclement weather, was a source of variation for both people and animals.

Prior to and during 1996, the elephants were picketed in two groups of 8 to 9 individuals each. The heavy cables that formed the picket lines were anchored to two

parallel trailers in which the elephants were transported. The trailers were parked approximately 25 to 30 m apart.

During the 1997 season, the circus frequently used electric pens on an experimental basis. During the 1998 season, the design and layout of the electric pens were largely perfected and the pens were used exclusively. The electric pens consisted of two or three horizontal 2 mm diameter steel cables supported by metal poles. Three cables were used with elephants who tended to get loose or to reduce the range that certain elephants could reach outside their pens with their trunks. The metal support poles for the electric pens were insulated from the ground by positioning the poles on several pieces of truck tire tread. Electrifying the support poles was necessary to prevent certain elephants from pulling them up, as happened during the 1997 season when the posts were driven into the ground. The support poles were anchored by cables with glass insulators to the trailers that formed the elephant compounds (Fig. 1). Some elephants were in group pens while others were maintained individually, depending on how well they got along with other elephants (Fig. 2). The basic routine and management of the elephants remained the same over many years and was described in detail in (Friend, 1999).

When the circus moved to a new location, the elephants were removed from the picket line or electric pens and loaded 3 to 4 in each of five semi trailers between 05:00 and 06:00 in the morning. They spent 2 to 4 h per day in a trailer while being transported 40 to 250 km to the new lot. The elephants were routinely picketed or placed

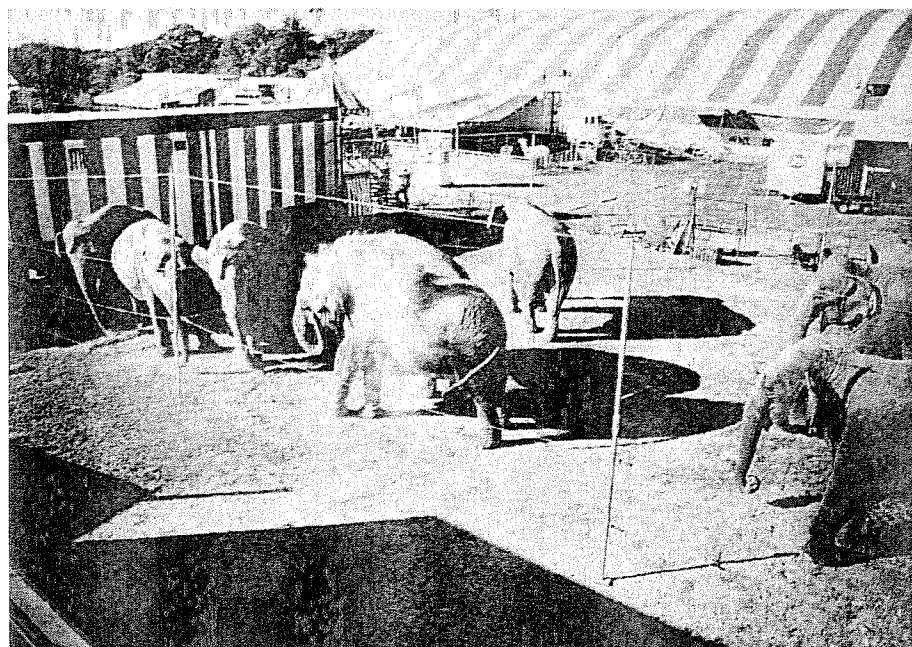


Fig. 1. Some of the elephants in their electric pens. The photograph was taken from the roof of the rear trailer, looking toward the midway. The elephant in the foreground just threw some dust on her back using her trunk. A white plastic chain was placed on the legs of several of the elephants to aid in identification of individuals when the video tapes were analyzed.

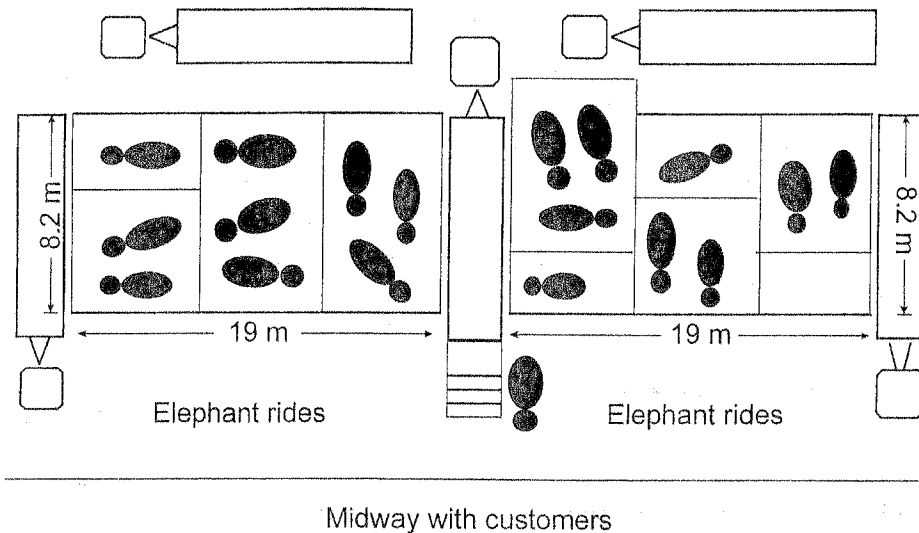


Fig. 2. Arrangement of one of the sets of electric pens.

in the electric pens by 10:00, except for three or four who were used to raise the 120 m  $\times$  45 m tent. The elephants usually remained picketed or penned until two were released to give elephant rides. 1 h prior to the start of the afternoon and evening performances.

The main elephant act involved fitting the elephants with a head harness and arranging the elephants into 5 herds of three to four individuals, each with a dominant or lead cow. These herds mimicked the natural tendency of Asian elephants to form matriarchal herds and were the basic unit by which the elephants were managed. Each herd then performed a series of stunts in their ring. The elephants were off the picket line for an average of 20 min for the main act.

The elephants were fed grain once each day, offered water several times a day from a trough that was brought to them, and had almost continuous access to hay. The elephant handlers usually waited until the elephants had depleted their supply of edible hay before the handlers brought out additional hay. Individuals or herds were removed from the picket line for grooming, health care, training, baths, and other reasons. A variable number of elephants were also used occasionally for pulling vehicles out of the mud during rainy weather. The electrical generators were shut down and the entire show, with the exception of the elephants, horses, and some other animals, was packed by approximately 23:30 h and ready for the next morning's move. At approximately 05:30, the elephants and other animals were loaded and departure for the next location occurred by 06:30.

## 2.2. 1996—Picketed

The following observations were obtained in 1996 and are reported in (Friend, 1999). Briefly, the continuous day and night video observations were obtained at 7-day

intervals on 12 of the Asian elephants traveling with this circus at three different locations in Texas during April, 1996. On the first two occasions, the circus played the same location for two days so that a full 24 h of useful data were obtained. At the third location, observations were stopped and the video equipment taken down at 05:30 in the morning, when the trainers started to load the elephants into the trucks for transport to a new lot. The weather during all three samplings was partly cloudy with high temperatures averaging 29°C and lows of 21°C.

Once the third location taping session was cut short, the circus began moving away from our area and there were several weeks of 1-day stands scheduled. Therefore, another full 24-h observation could not be made. Including the 18-h long third observation period was preferable, however, to either not including it in the data and analyzing only two observation periods, or reducing the length of the two full 24-h observation periods.

### 2.3. 1998—*Penned*

Continuous day and night video observations were obtained at two different locations in Texas on 9 of the Asian elephants traveling with this circus during April, 1998. The circus played for two days at the first location. Therefore, one 24-h observation period was made the first night, and the second night of observation was terminated at 04:25. At that time, preparations started to load the elephants into their trailers and the circus started to move to the next lot. This was very similar to one of the observations periods in 1996. At the next location, approximately 26 h of continuous observations were made. The extra 2 h of observations were included to compensate for the truncated second observation period. The weather during all three samplings was partly cloudy with high temperatures averaging 29°C and lows of 22°C.

This set of observations used the same video equipment (Panasonic WV-BP312 camera with 2.8 mm lens and a Panasonic AG-1070DC video recorder) generator (1500 W) and lights (two to three 150 W halogen per compound) that were used in the 1996 observations. Although the cameras were sensitive to 0.06 lx, the lights were used in 1996 and 1998 to reduce back lighting problems from street or other lights, and to provide a small amount of supplemental light at very dark locations.

As in 1996, the video recorders were set to record 24 h of observations on a 2 h videotape (2.22 frames/s). The video cameras were again mounted on the roofs of the trailers that formed the elephant compound (Fig. 1).

### 2.4. *Video analysis*

The video tapes from 1998 were first examined to determine which elephants could be clearly seen and had complete data. The arrangement of the elephants in the pens did not approximate their arrangement when picketed in previous years. Nine elephants with comparable data from 1996 were selected.

Occurrences of the behaviors listed in Table 1 were recorded for each focal elephant from the 1998 video tapes at 5 min intervals. The same procedures and definitions had been used in 1996. All of the behaviors were coded as being mutually exclusive, with

Table 1  
Behaviors quantified from videotapes at 5 min intervals

Off picket line—not chained on picket line for any reason	Standing <sup>b</sup> —standing idle (not performing other behaviors)
Weaving—swinging to-and-fro movement of body or head	Lying—not supported by legs, included resting on sternum
Head bobbing—repetitive vertical movement of head	Eating—obtaining, chewing and ingestion of food
Chain pulling, trunk <sup>a</sup>	Drinking—trunk in water or transferring water to mouth
Chain pulling, foot <sup>a</sup>	Trumpeting <sup>a</sup> —display of mouth open and trunk up
Trunk tossing—repetitive extension of trunk	Dust bathing—gathering and throwing dust, usually on back
Bumping other elephant with trunk, leg, or body <sup>a</sup>	Contacting other elephant with tip of trunk <sup>a</sup>
Pawing <sup>a</sup>	Other <sup>c</sup>

<sup>a</sup>Included in 'other' because of infrequent occurrence.

<sup>b</sup>Standing idle was not used in 1995 data due to its infrequent occurrence that year.

<sup>c</sup>Other includes not visible and handler working with elephant.

stereotypic behaviors given preference if it appeared a subject was performing another behavior simultaneously. Weaving, head bobbing, chain pulling, trunk tossing, trumpeting, pawing, and bumping were considered to be stereotypic behavior, provided a subject was performing them for more than 5 s immediately prior to the time of the sample, and in a stereotyped manner. If a subject was engaged in another activity (e.g., tossing hay or touching another elephant with her trunk) while weaving, for example, it was coded as weaving. The definition of weaving of Schmid (1995) was used. Trumpet refers to the display of mouth open and trunk up, rather than vocalization. Vocalizations were not recorded on the sound track of the video tape. The category standing was used in 1996 and 1998 to describe a subject standing still and performing no other obvious behaviors.

### 2.5. Time budgets

The 1996 and 1998 observation data sets were used to calculate relative time budgets for the periods of observation. The raw counts were converted to 'percentages of observations'. The activity of the focal elephants used in the time budgets was also summarized from 24:00 to 04:00 to determine the incidence of the various behaviors during a period when the elephants were not subjected to disturbance by people and were expected to be resting.

### 2.6. Statistics

There are probably few animal enterprises that are subjected to more variation than a traveling tented circus (Friend, 1999). We do not have data from a simultaneous control group available; all of our comparisons are across years. However, all of the animals

observed were mature elephants who have been traveling with this circus for 22 to 48 years. Our earlier study with these elephants found their behavior to be relatively stable from one year to the next. Despite all of the variation, studying the behavior of elephants under these conditions has value.

All statistical procedures were performed using the program SAS (1989). The Spearman rank correlation procedure was used to determine whether time spent performing stereotypic behaviors was correlated with time spent out of the pen. Spearman correlations were also used to determine whether age of the elephants was correlated with the amount of time they spent engaged in stereotypic behaviors.

Three elephants (Barbara, Becky, and Minnie) weaved less than 1% of the time. The data from those animals were therefore excluded so that the data set would be normally distributed. An analysis of variance using the GLM procedure of SAS (1998) was used to determine whether time spent weaving was influenced by housing method (1996 vs. 1998). A second analysis of variance was used to determine whether all stereotypic behaviors combined decreased from 1996 to 1998. All elephants performed some type of stereotypic behavior, so those data were normally distributed without having to delete any subjects.

### 3. Results

Some of the behaviors quantified from the video tape occurred at a very low frequency. Those behaviors, stereotypic chain pulling using either their trunk or foot, stereotypic bumping, stereotypic pawing and stereotypic trumpeting, and contacting (or grooming) other elephants with their trunk, were incorporated into the 'other' category (Table 1).

#### 3.1. *Time budgets—continuous observations*

The elephants who were off the picket lines in 1996 for 4.9 to 7.3% (1.2 to 1.8 h per day) of the observations were removed only for the regular performances (Tables 2 and 3). The elephants Barbara, (Table 2), Minnie, and Susie (Table 3) were also taken off the picket line for other duties, such as putting up and take down the tent. Susie, who was off the picket line the most (28% of the time; 6.7 h), was also used to give elephant rides for approximately 1 h prior to each show.

When the electric pen system was used in 1998, much of the brushing and costuming of the elephants prior to performances that used to require releasing the elephants from the picket line were conducted in the pens, thus the elephants spent less time 'out of pen' in 1998 than they spent off line in 1996. Isa was not used in the 1998 performances because of her advancing pregnancy. Lilly was also kept out of the performances to keep Isa company so that she would not become agitated when the other elephants left for performances. Isa and Lilly, however, were removed occasionally from the pens for baths and general husbandry procedures (e.g., foot care). As in 1996, Barbara, Minnie, and Susie were taken out of the pens for other duties. Susie was out of the pen the most

Table 2

Behavior patterns (% of observations) of 5 elephants with three comparable 24-h data sets from 1996 (picketed) and 1998 (penned)

Behavior	Barbara (51 <sup>a</sup> )		Becky (28)		Bunny (30)		Isa (27)		Kelly (28)	
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
Off line/out of pen	10.9	11.6	7.3	2.6	4.9	5.5	5.1	0.3	7.3	3.9
Weaving	0.9	0.0	0.1	0.4	16.9	3.2	15.8	5.4	33.2	15.8
Head bobbing	0.0	0.0	33.0	23.3	0.0	0.0	0.0	0.0	0.0	0.0
Trunk tossing	7.4	0.7	0.9	0.0	2.6	0.0	2.6	0.0	1.0	0.8
Standing	8.8	30.9	3.7	8.7	14.4	9.7	7.8	31.9	7.8	10.7
Lying	18.5	7.4	19.0	18.4	10.9	21.7	20.6	5.4	13.4	14.2
Eating	29.9	39.4	28.1	27.1	35.3	47.5	37.9	41.1	28.4	34.1
Drinking	3.0	1.1	0.5	0.9	0.3	1.1	0.2	0.8	0.3	1.2
Dust bathing	4.0	1.2	0.2	1.4	0.7	0.7	0.8	0.5	0.5	1.5
Other	19.0	7.7	7.0	17.2	13.8	10.6	9.1	14.5	8.0	17.8

<sup>a</sup>Age (in years) in 1998.

because she was used for elephant rides. Time spent out of the pen was negatively correlated ( $r = -0.71$ ,  $P = 0.031$ ,  $N = 9$ ) with incidence of stereotypic behavior.

Weaving was the most common stereotypic behavior in the elephants regardless of whether they were picketed or penned. One elephant (Becky) performed only head bobbing, and trunk tossing was infrequent in all of the elephants. Although not statistically analyzable, head bobbing decreased by 30% when Becky was maintained in a pen, as compared to her behavior when picketed. In order to determine if maintaining elephants in pens resulted in a significant decrease in weaving, the three elephants (Barbara, Becky and Minnie) who weaved less than 1.0% of the time were deleted from the data set. The amount of time the remaining 6 elephants spent weaving significantly decreased ( $P = 0.009$ ) an average of 69% when the elephants were penned, as compared

Table 3

Behavior patterns (% of observations) of 4 elephants with three comparable 24-h data sets from 1996 (picketed) and 1998 (penned)

Behavior	Lilly (31 <sup>a</sup> )		Minnie (52)		Susie (46)		Tracy (28)	
	1996	1998	1996	1998	1996	1998	1996	1998
Off line/out of pen	5.1	0.3	10.8	8.8	28.0	22.2	7.3	4.1
Weaving	24.4	5.7	0.0	0.0	12.1	1.1	25.9	14.5
Head bobbing	0.2	2.6	2.0	3.2	0.0	0.1	0.2	0.0
Trunk tossing	0.8	0.0	0.8	0.1	2.2	0.5	0.6	0.5
Standing	6.0	14.1	26.9	26.0	15.1	9.6	2.0	10.6
Lying	20.1	16.0	9.1	4.7	1.0	16.2	23.3	18.3
Eating	30.7	43.3	36.9	45.6	27.8	38.8	33.8	32.6
Drinking	0.6	1.2	0.3	1.4	0.2	0.7	0.3	0.9
Dust bathing	0.6	0.5	0.7	0.4	0.5	0.5	0.1	0.7
Other	11.4	16.4	12.6	9.7	13.1	10.2	6.2	17.9

<sup>a</sup>Age (in years) in 1998.

Table 4

Behavior patterns (% of observations) of 5 elephants with three comparable data sets (2400–0400) from 1996 (picketed) and 1998 (penned)

Behavior	Barbara		Becky		Bunny		Isa		Kelly	
	1996	1998	1996	1998	1996	1998	1996	1998	1996	1998
Weaving	0.7	0.0	0.0	0.0	54.4	0.0	0.0	0.0	44.9	9.5
Head bobbing	0.0	0.0	5.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Trunk tossing	0.7	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Standing	8.8	38.8	4.1	6.8	1.4	10.2	5.4	63.3	2.7	17.0
Lying	62.6	21.8	59.2	68.7	21.1	61.9	72.8	13.6	27.9	40.1
Eating	9.5	29.9	27.2	10.2	9.5	19.7	19.0	7.5	15.0	20.4
Dust bathing	0.7	0.7	0.0	0.7	0.7	0.0	0.7	0.0	0.0	0.7
Other	16.9	8.9	4.2	12.3	12.2	8.1	2.1	15.7	9.6	12.3

to picketed. When the performance of all stereotypic behavior (weaving, head bobbing and trunk tossing) and all 9 elephants were included in the analysis, keeping the elephants in pens still resulted in a significant decrease ( $P = 0.019$ ) in stereotypic behavior that averaged 57%.

The total amount of time spent performing all stereotypic behaviors (weaving, head bobbing and trunk tossing) was negatively correlated with age when the elephants were picketed in 1996 ( $r = -0.71$ ,  $P = 0.031$ ,  $N = 9$ ) and somewhat less correlated with age when penned in 1998 ( $r = -0.66$ ,  $P = 0.053$ ,  $N = 9$ ). Although there is a trend for increased stereotypic behavior when the elephants ran out of hay, time spent performing all stereotypic behavior was not correlated with time spent eating ( $P > 0.11$ ) or time spent lying ( $P > 0.24$ ) when the elephants were picketed in 1996 or when penned in 1998.

### 3.2. Time budgets—24:00 to 04:00

Consistent with previous observations, behavior was highly variable across elephants even during this time period (Tables 4 and 5). Although the data was too sporadic and

Table 5

Behavior patterns (% of observations) of 4 elephants with three comparable data sets (2400–0400) from 1996 (picketed) and 1998 (penned)

Behavior	Lilly		Minnie		Susie		Tracy	
	1996	1998	1996	1998	1996	1998	1996	1998
Weaving	12.9	0.7	0.0	0.0	38.1	2.0	0.0	2.0
Head bobbing	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0
Trunk tossing	0.0	0.0	0.7	0.0	0.0	0.0	0.7	0.0
Standing	0.7	17.0	42.2	49.7	20.4	3.4	0.7	5.4
Lying	69.4	55.1	30.6	5.4	5.4	51.0	65.3	57.1
Eating	11.6	10.9	17.0	27.2	19.0	30.6	29.3	14.3
Dust bathing	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	4.8	16.3	9.6	15.6	17.1	13.0	4.1	21.1

skewed to analyze statistically, it is readily apparent from visual examination that stereotypic behavior was greatly diminished when the elephants were maintained in pens. Time spent standing, lying, and eating when picketed or penned varied greatly within and across elephants.

#### 4. Discussion

The behaviors of the elephants in this circus were consistent with the observations of Kiley-Worthington (1990) of elephants in 15 circuses and 8 zoos in Europe and North America, and the observations of Schmid (1995) of 29 elephants in 4 circuses in Germany and Switzerland. The significant reduction in stereotypic behavior observed in these elephants was consistent with the observation of Schmid (1995) that elephants performed less stereotypic behavior when released into paddocks. There are some important differences between the study of Schmid (1995) and this study, however, that influence the ability to make direct comparisons. The paddocks that Schmid studied were much larger, ranging from 114 m<sup>2</sup> to 304 m<sup>2</sup> and they were kept in the paddocks from 0.3 h to 8.2 h per day. When not in the paddocks, those elephants were chained in a manner similar to the method used by this circus when the elephants were picketed prior to 1998, but Schmid's elephants were chained on wooden floors in small tents. In contrast, the elephants in this study were kept in much smaller pens, but the pens were at the same location (outside on grass or dirt) as when they were chained, and the pens were their primary housing.

Comparing the behavior of elephants in 1996 with the same elephants in 1998 may be confounded with age. Although age was negatively correlated with stereotypic behavior ( $r = -0.71$  in 1996 and  $r = -0.66$  in 1998), we believe that advancing age had little to do with the reduction in stereotypic behavior observed when the elephants were maintained in pens in 1998. We believe that advancing two years in age has negligible impact on animals that range from 27–52 years of age. In addition, our earlier study (Friend, 1999) with these same elephants found their individual behavior patterns to be very consistent from one year to the next.

In addition to the significant decrease in stereotypic behavior, the elephant trainers reported that they favored the pens over picketing for the following reasons: the elephants seemed to be more relaxed in general and during performances, yet their motivation to perform or work was not reduced; the elephants were easier to keep clean prior to performances; their rear feet were healthier because their rear legs were no longer positioned over the area where they voided urine/feces (although urine and feces were almost immediately removed by the trainers/grooms who were on duty); and the daily cleaning of the elephant area was easier. The more relaxed behavior of the elephants in general and the concurrent decrease in stereotypic behavior may be due to a decrease in the general arousal that is reported in animals maintained under chronic close confinement (e.g., Craig, 1918; Lorenz, 1981). Their hyper behavior during performances when they were picketed (chained) may be related to the increased motivation for locomotor behavior readily observed in species kept in close confinement (e.g., Brownlee, 1954; Fraser, 1983; Dellmeier et al., 1985; Dellmeier, 1989). Chroni-

cally unsatisfied motivation can result in increased general arousal, stereotypies, learned helplessness and pathological physiological responses (Dellmeier, 1989).

The trainers also reported that the elephants rarely got out of the electric pens during the 1998 season. Elephants frequently got out or changed pens during the 1997 season while management was experimenting with the design of the pens. When an elephant did get out of a pen, they also occasionally got loose when picketed, the escapees always stayed in the immediate vicinity of the rest of the herd until someone spotted the elephant and easily returned her to her proper pen or spot on the picket line. During the times that an elephant got loose when the authors were with the circus, the elephant did not stray more than 8 m away from the other elephants. In several cases, a loose elephant alerted the trainers by either playing with the door to the trainer/groom quarters, which were in the rear of the trailers that formed the elephant compounds, or reached into the trainer/groom quarters through doors that were left open during warm weather in an attempt to remove items belonging to the trainers/grooms.

The Head of the Elephant Division of the circus found electric fencing to be so useful that the elephants were placed in an approximately 6.8 hectare exercise area during the 1997–1998 winter quarters, when weather permitted. Erecting a physical barrier for elephants that enclosed that much area would have been prohibitively expensive. These elephants were accustomed to electric fencing, therefore costs could be reduced by utilizing one to two strands of electrified tape for the construction of the exercise area.

This circus first started experimenting with an electric pen during the 1994–1995 winter quarters. The initial pen was constructed approximately 50 m away from where the elephants were traditionally picketed. That experiment was considered a failure because one or more of the elephants quickly figured out that they could pull up the metal posts without being shocked. Although the elephants were placed in the pen in their herd groups, they became agitated because they were not accustomed to being away from the main herd and without being under the control of people. There was considerable motivation displayed by the elephants to return to the picket line.

The first major experiment with pens while the circus was traveling occurred during the spring of 1996. A large 'exercise' pen that measured approximately 40 × 40 m was comprised of two strands of 1 cm wide orange electric fence tape that were held off the steel posts using plastic insulators. The pen was approximately 50 m from the semi-trucks and trailers that formed the back of the elephant compound. Some of the herds of elephants were very nervous once they were released into the exercise pen. The more nervous groups formed a defensive star with their rumps together and each elephant nervously scanning its quadrant of the perimeter and occasionally trumpeted. None of the elephants ran through the electrified tape. They approached it cautiously and when shocked on their chest, trunk or head, displayed a relatively mild reaction of backing up a meter or two. Several elephants also backed into the electrified tape and received a mild shock. Informal observations noted that not all of the elephants had to be shocked in order to learn to 'respect' the fence. They readily learned by watching a colleague's reaction to being shocked. The fence charger was a standard cattle-type charger of medium power.

Some herds of elephants became so nervous and agitated when released in the exercise pen that the trainers had to enter the pen and establish control over the

elephants by having them line up. The trainers then had the elephants perform a few basic tricks to help calm them down. When the elephants were taken out of the pen and started back toward the picket lines, the trainers had to slow them down, or they would have run back to the picket line. Placing electric pens in the same location where the picket lines had been was much more successful because there was no motivation to return to the herd and to a location with which they were familiar. As with livestock species, it is best to introduce animals to electric fences in an area in which the animals are familiar.

The negative correlation between time spent out of the pen and stereotypic behavior ( $r = -0.71$ ,  $P = 0.031$ ,  $N = 9$ ) should be interpreted with caution. That correlation may be partially driven by the older elephants being the ones that were used more often for work and giving elephant rides, and the strong correlation ( $r = -0.71$  and  $r = -0.66$ ) for older elephants to perform less stereotypic behavior.

## 5. Conclusion

The amount of time the elephants spent weaving was significantly decreased an average of 69% by keeping the elephants in pens when compared to picketing. The incidence of all stereotypic behavior (weaving, head bobbing and trunk tossing) also decreased an average of 57% when the elephants were kept in pens. The total amount of time spent performing all stereotypic behaviors (weaving, head bobbing and trunk tossing) was negatively correlated with age when the elephants were picketed in 1996 ( $r = -0.71$ ) and somewhat less correlated with age when penned in 1998 ( $r = -0.66$ ). The significant decreases in stereotypic behaviors found in this study cannot reasonably be accounted for by increasing age of the elephants, as only 2 years evolved. Therefore, it appears that penning circus elephants instead of picketing them has a positive effect on their well-being, in the form of fewer stereotypic behaviors exhibited. Electric pens were more easily accepted by customers, who sometimes feel that picketing restricts the well-being of captive elephants. The elephant trainers/grooms also preferred the pens over picketing because of reduced stereotypic behavior, the elephants appeared calmer when taken out of the pens for performances and work, and ease in keeping the elephants clean. The practice of picketing or chaining elephants, however, cannot be totally abandoned because there are occasions when a more secure form of restraint is needed and there are also occasions when electric pens cannot be used. Even with the occasional use of chaining, our experience concurs with the conclusions of Kiley-Worthington (1990) that the physical and psychological welfare of circus elephants is not as a rule inferior to that of other animal husbandry systems in zoos, stables, kennels, or farms.

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