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Behavior of picketed circus elephants

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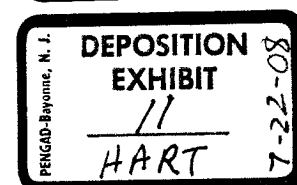
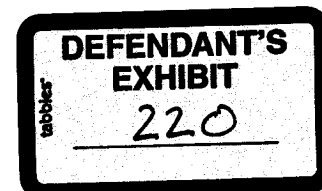
Abstract

The behavior of 14 female Asian (*Elephas maximus*) and 3 female African (*Loxodonta africana*) 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 was studied. When not performing or working, the elephants were picketed in the traditional fashion in two separate groups of 8 and 9 elephants each. While they were picketed, a separate camera and time-lapse recorder videotaped the behavior of members of each group for four ~ 8-h periods during the 1995 season, and three ~ 24-h periods during 1996 season. The behavior of each member of the focal groups was recorded at 5-min intervals. In 1995, stereotypic weaving accounted for 15.9% (range 0.0 to 41.0%), and head bobbing accounted for 2.8% (range: 0.0 to 14.5%) of observations in eight of the elephants. In 1996, stereotypic weaving accounted for 14.3% (range: 0.0 to 33.2%) and head bobbing accounted for 2.9% (range: 0.0 to 33.0%) of observations in 12 of the elephants. The behavior of individual picketed elephants in 1995 was highly correlated (ranging from $r = 0.78$ to 0.83 , $P < 0.001$) with their behavior patterns in 1996, despite season and location differences. The elephants spent an average of $33 \pm 1.2\%$ of observations eating in 1996. Stereotypic behavior increased in the 15-min period immediately prior to water, performances and hay, when compared to their frequency during the three preceding 15-min periods indicating 'anticipation' of water and performances, and a lack of substrate to manipulate or eat in regards to hay. Time the elephants spent off the picket line (performing, working, giving rides, etc.) tended to be negatively correlated with weaving ($r = -0.48$, $P = 0.12$, $N = 12$). © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Elephant; Stereotypic behavior; Welfare; Time budget

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1. Introduction

Circuses in North America range from small, one-ring shows with no elephants, to five-ring shows with 18 or more elephants. Elephants are considered by many circuses to be their most important asset in drawing spectators. Circuses may perform under tents and move to a new location daily, or set up in coliseums in large cities for a week or more. There is no objective database available regarding the care, housing, or work schedules of elephants in circuses in North America.

The picket line (Fig. 1) 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 through out the world. The elephants can only take approximately one step forward and one backward, but can readily interact with their neighbors if any are present. The elephants used in this study normally spend between 50 to 80% of their time on the picket line each day, although they may spend much more time on the line during rare occasions when performances are not scheduled, on days when the circus does not move to a new location, or during winter quarters. It is not uncommon for bull elephants to be chained continuously for over 4 months in Sri Lanka (Lehnhardt, 1995), but no data are available on the health or behavior of such elephants.

The objective of this study was to characterize the behavior of circus elephants while on picket lines, determine the repeatability of their behavior over time, and to characterize changes in their behavior prior to the elephants receiving feed, water, and being removed from the picket line for performances.

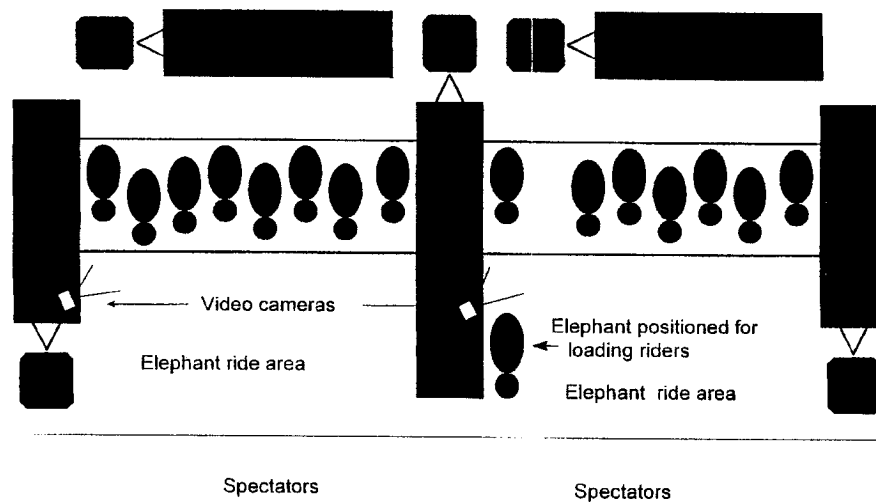


Fig. 1. A drawing of the picket lines and arrangement of the trucks to form the elephant compound. The elephants were transported in the trucks that formed their compound. One front and the diagonal rear leg were attached to the picket lines by approximately 1.2 m long chains.

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. The elephants ranged in ages from 12 to 50 years old and were all female. The circus usually moved to a new location each day and set up in fields or occasionally paved parking lots. Inclement weather was a recurring event and a source of variation for both people and animals.

The elephants were picketed in two groups of 8 and 9 individuals (Fig. 1). The heavy cables that formed the picket lines were anchored to two parallel trailers in which the elephants were transported that were parked approximately 25 to 30 m apart. When the circus moved to a new location, the elephants were released from the picket line and loaded 3 to 4 in each of five semi-trailers between 0500 and 0600 h each morning. They spent 2 to 4 h per day in a trailer while being transported 40 to 250 km to the new lot and waiting for the picket lines to be set up. They occasionally spent additional time in the trailers because the trailers also served as temporary shelter during cold or inclement weather. The elephants were routinely picketed by 1000 h, except for three or four who were used to raise the 120 m × 45 m tent. After the tent was laid out and staked by 0900 h each morning, the three to four elephants were fitted with a harness and traveling abreast inside the tent, pulled the tent's support posts erect using a chain attached to the harness. The elephants usually remained picketed until two were released to give elephant rides 1 h prior to the start of the afternoon and evening performances. A variable number of elephants were also used occasionally for pulling vehicles out of the mud during rainy weather and for other activities.

Approximately 12 elephants participated in a parade that was held in the tent shortly after the beginning of each show. The parade was a slow walk around the inside track, resulting in the elephants being loose approximately 15 min for brushing, costume fitting and the parade. The parade was occasionally canceled, however, if conditions were wet or muddy to protect the elaborate costumes or if the show was running late.

The main elephant act involved fitting the elephants with a head harness and arranging the elephants into five 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 then combined into one herd and mounted each other twice in a long single file line down each side of the track in front of the spectators. The entire act was conducted at a fast pace, with the trainers jogging along side the elephants when they were circling the five rings on the inside track. 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 while they were picketed and they were occasionally released from the picket line and taken to water, and had almost continuous access to hay. Individuals or herds were also removed from the picket line for grooming, health

care, training, baths and other reasons. Immediately after the final show (at approximately 2200 h on weekdays and 1700 h on weekends) 2 to 4 elephants were used to take down the tent by pushing out the base of the tent poles and then they also pulled up the stakes. The stakes were pulled by placing a padded chain over the elephant's neck and after a trainer had flipped the loose end of the chain around a stake several times, the elephant raised its neck and shoulders pulling the stake out. The electrical generators were shut down and the entire show was packed and ready for the next morning's move except for the elephants, who returned to the picket line for the remainder of the night at approximately 2330 h.

The elephant grooms, trainers and the head of the elephant division literally lived and traveled with the elephants. The grooms and trainers had small sleeping compartments that were built into the rear portion of the elephant trailers, or slept in the sleeper compartments of the tractors that pulled the trailers. Because the picket lines were anchored to the trailers, the trainers could feel or sense changes in the elephants' behavior even when they were in their bunks. What little time the personnel of the elephant division were not working was often spent relaxing by watching the elephants with the company of other circus people.

2.2. Observations

Observations were taken at different locations and(or) at 7-days or longer intervals so that when the data were combined, the sampling would yield data that could be considered representative of the general behavior of these elephants, and not too heavily biased by a particular location, set of weather conditions, or other sources of variation. However, extremes in weather that would greatly alter their normal behavior were avoided.

2.2.1. 1995 daylight hours

Behavioral data were collected on eight elephants in October 1995 at four different locations. The first two locations were consecutive in Mississippi while the second two were consecutive locations 14 days later in the eastern Gulf Coast area of Texas. The weather was relatively consistent during each period, with a range of 23 to 30°C for the first two locations, and 19 to 25°C at the second two locations.

A camera (Panasonic WV-BP312 with 2.8 mm lens) and time-lapse recorder videotaped the behavior of four members of each picket line from approximately 1100, until the start of the second show, approximately 1900 h. The video recorders (Panasonic AG-1070DC) were set to record 24 h of observations on a 2 h videotape (2.22 frames per sec). The video cameras were mounted on the roofs of the trailers that formed the elephant compound (Fig. 1). The focal groups consisted of the four elephants closest to the camera because the view of elephants further away was occasionally obstructed by their neighbors. Thus, 4 days of observations were collected on the same eight elephants. A total of 67.25 h of video tape (8.4 h/day/camera) were analyzed.

The occurrence of the behaviors listed in Table 1 were recorded for each member of the focal groups from the video tapes at 5 min intervals. All of the behaviors were coded as being mutually exclusive, with stereotypic behaviors given preference if it appeared a

Table 1
Behaviors quantified from videotapes at 5 min intervals

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

^aIncluded in 'other' because of infrequent occurrence.

^bStanding idle was not used in 1995 data due to its infrequent occurrence that year.

^cOther includes not visible and handler working with elephant.

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. Schmid's (1995) definition of weaving was used. Trumpet refers to the display of mouth open and trunk up, rather than the vocalization because vocalizations were not recorded on the sound track of the video tape. The category standing was used in 1996 to describe a subject standing still and performing no other behaviors, but it was not used in 1995 due to its low frequency.

2.2.2. 1996 continuous observations

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 2 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 0530 h in the morning when the trainers started to load the elephants into the trucks for transport to the new lot where the circus performed later that day. The weather during all three samplings was partly cloudy with high temperatures averaging 29°C and lows of 21°C.

This set of observations used the same video equipment in a similar fashion as in the daylight observations. However, the video cameras were moved further out by mounting them on the cabs of the trucks that formed the left and right sides of the elephant compound. Moving the cameras further out improved visibility so that the number of

focal animals per camera could be increased to six. Also, a portable generator was used to power the time-lapse video equipment when the circus turned off its main generators late at night. Although the cameras were sensitive to 0.06 lux, two 150-W halogen lights were used to provide supplemental lighting for each picket line to reduce back lighting problems from street or other lights as some locations, and to provide a small amount of supplemental light at very dark locations.

The third observation period had to be terminated at 0530 h in the morning because the circus moved to a new location that morning. Because the circus was rapidly moving away from our area and there were several weeks of 1-day stands scheduled, another full 24-h observation could not be made. Including the 18-h long observation period was preferable, however, to not including it in the data and reducing the amount of data to only two observation periods, or reducing the length of the two full 24-h observation periods.

2.3. Time budgets

The 1995 and 1996 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 2400 to 0400 h to determine the incidence of the various behaviors during a period when the elephants were not subject to disturbance by the activity of people.

2.4. Repeatability of behavior

In order to determine the consistency of the behavior of these elephants, observations covering the identical time periods in both 1995 and 1996 were extracted. The time periods covered by each data set were: 1115 to 1710 h; 1415 to 2030 h; and 1230 to 1830 h. Although the 1995 data were based on four observation periods, one of those periods was chosen at random to be deleted to make it comparable to 1996. Because the location of some of the elephants on the picket lines changed, and some of the elephants from 1995 were traveling with another smaller circus in 1996, comparable data sets existed for only four elephants.

2.5. Behavior prior to certain events

In order to determine if the occurrence of stereotypic behavior increased prior to feeding hay, performances and giving the elephants water, behavior for 1 h prior to each of those events was examined. Only 1-h periods in which nothing had occurred that would greatly influence the behaviors being recorded were used. For example, if the elephants were given hay 30 min prior to their receiving water, that 1-h period prior to watering was not used. Although the elephants were fed grain twice a day, they were usually watered shortly before the grain. Thus, no periods existed during which the elephants were not disturbed prior to the grain feeding. The 1-h periods were divided into 15-min subunits (three 5-min scan samples) to show trends over time.

2.6. Statistics

There are probably few animal enterprises that are subjected to more variation than a traveling tented circus. Tented circuses are very sensitive to changes in weather, but they are also subjected to vehicle breakdowns on the road and no two locations where they set up and perform are the same. Despite all of the variation, studying the behavior of elephants under these conditions has value.

Because of the variation in the number of animals for certain comparisons, the lack of a true control for other comparisons, and the high amount of variation between elephants for the performance of many of the behaviors that are of special interest, i.e., some subjects never weaved while others weaved 40% of the observations, this is largely a descriptive study. The Spearman rank correlation procedure (SAS, 1989) was used to estimate the correlation of behavior between 1995 and 1996 and the correlation between the time spent off the picket line and stereotypic behaviors (total weaving and head bobbing). Because much of the data are skewed, medians were used to summarize data across 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—1995 daylight hours

The elephants who were off line from 2.1 to 3.7% of the observations (Table 2) were only used in the main elephant act. The rest were used in the main act as well as the

Table 2

Ages and time budgets (% of observations) of eight focal elephants for 4 days from approximately 1100 h until the start of the second show at 1900 h during 1995

Behavior	Becky (25 ^a)	Delrita (24)	Kelly (25)	Kristie ^b (13)	Margaret (26)	Rosie (26)	Toni ^b (12)	Tracy (25)	Median
Off line	7.6	2.1	7.6	3.7	2.4	36.6	3.7	7.6	5.7
Weaving	0.0	5.1	19.6	15.5	0.0	16.3	29.4	41.0	15.9
Head bobbing	14.5	0.5	0.0	0.0	7.8	0.0	0.0	0.0	0.0
Lying	3.6	11.5	5.3	3.7	3.5	2.3	1.3	0.8	3.6
Eating	63.4	73.8	54.7	69.8	79.4	37.2	62.0	41.0	62.7
Drinking	1.8	1.9	1.8	1.6	1.9	0.8	1.3	1.5	1.7
Other	9.3	5.1	11.0	5.7	5.1	6.9	2.2	8.2	6.3

^aAge in years.

^bAfrican (*L. africana*) elephants.

Table 3
Ages and time budgets (% of observations) of six focal elephants for three ~ 24-h periods in 1996

Behavior	Barbara (49 ^a)	Bunny (28)	Isla (25)	Lilly (29)	Minnie (50)	Susie (44)	Median
Off line	10.9	4.9	5.1	5.1	10.8	28.0	8.0
Weaving	0.9	16.9	15.8	24.4	0.0	12.1	14.0
Head bobbing	0.0	0.0	0.0	0.2	2.0	0.0	0.0
Trunk tossing	7.4	2.6	2.6	0.8	0.8	2.2	2.4
Standing	8.8	14.4	7.8	6.0	26.9	15.1	11.6
Lying	18.5	10.9	20.6	20.1	9.1	1.0	14.7
Eating	29.9	35.3	37.9	30.7	36.9	27.8	33.0
Drinking	0.3	0.3	0.2	0.6	0.3	0.2	0.3
Dust bathing	4.0	0.7	0.8	0.6	0.7	0.5	0.7
Other	19.0	13.8	9.1	11.4	12.6	13.1	12.9

^aAge in years.

'spectacular parade'. The elephant who was off line the most, Rosie, was also used to give elephant rides for an hour before each show began.

Two elephants, Margaret and Becky, were never observed to weave. Those two, however, were the only two observed to engage in stereotypic head bobbing during this time period. The two Africans in the group, Toni and Kristie, were not markedly different from the Asian elephants, which is consistent with Schmid's observations (1995).

3.2. Time budgets—1996 continuous observations

The elephants who were off the picket lines 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 3 and 4). The elephants Barbara, Minnie, Susie (Table 3) and Rosie (Table 4), were also taken off the

Table 4
Ages and time budgets (% of observations) of six focal elephants for three ~ 24-h periods in 1996

Behavior	Becky (26 ^a)	Isla (28)	Kelly (26)	Opal (28)	Rosie (27)	Tracy (26)	Median
Off line	7.3	6.9	7.3	6.5	11.7	7.3	7.3
Weaving	0.1	18.8	33.2	16.1	7.9	25.9	17.5
Head bobbing	33.0	0.0	0.0	0.0	0.0	0.2	0.0
Trunk tossing	0.9	2.0	1.0	0.5	4.2	0.6	1.0
Standing	3.7	4.0	7.8	12.6	7.9	2.0	5.9
Lying	19.0	24.8	13.2	18.5	23.1	23.3	21.1
Eating	28.1	33.2	28.4	36.1	39.4	33.8	33.5
Drinking	0.5	0.6	0.3	0.8	0.6	0.3	0.6
Dust bathing	0.2	0.0	0.5	0.1	0.2	0.1	0.2
Other	7.0	9.7	8.0	8.7	4.9	6.2	7.5

^aAge in years.

Table 5
Ages and time budgets (% of observations) of six focal elephants over three periods from 2400 to 0400 h in 1996

Behavior	Barbara (49 ^a)	Bunny (28)	Isa (25)	Lilly (29)	Minnie (50)	Susie (44)	Median
Weaving	0.7	54.4	0.0	12.9	0.0	38.1	6.8
Trunk tossing	0.7	0.7	0.0	0.0	0.7	0.0	0.4
Standing	8.8	1.4	5.4	0.7	42.2	20.4	7.1
Lying	62.6	21.1	72.8	69.4	30.6	5.4	46.6
Eating	9.5	9.5	19.0	11.6	17.0	19.0	14.3
Dust bathing	0.7	0.7	0.7	0.7	0.0	0.0	0.7
Other	16.9	12.2	2.1	4.8	9.6	17.1	10.9

^aAge in years.

picket line for other duties, such as putting up and take down the tent. Susie (Table 3), 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. Time spent off the picket line tended to be correlated with weaving ($r = -0.48$, $P = 0.12$, $N = 12$), but was not correlated with any other stereotypic behavior (all $P > 0.45$).

3.3. Time budgets—2400 to 0400 h

Consistent with previous observations, behavior was highly variable across elephants even during this time period (Tables 5 and 6). Six of the elephants displayed no stereotypic weaving, although one of those displayed head bobbing. Bunny (Table 5) and Kelly (Table 6) spent half of this period weaving. The proportion of time spent lying was approximately twice what it was during the whole 24-h period, indicating that they do tend to lay down more late at night when there is also minimal disturbance. Susie, the elephant who spent only 1% (14.4 min) of her time per 24 h lying down, did most of her lying (13 min) during this period.

Table 6
Ages and time budgets (% of observations) of six focal elephants over three periods from 2400 to 0400 h in 1996

Behavior	Becky (26 ^a)	Isla (28)	Kelly (26)	Opal (28)	Rosie (27)	Tracy (26)	Median
Weaving	0.0	0.0	44.9	0.0	0.7	0.0	0.0
Head bobbing	5.4	0.0	0.0	0.0	0.0	0.0	0.0
Trunk tossing	0.0	0.0	0.0	0.0	0.7	0.7	0.0
Standing	4.1	2.0	2.7	17.0	4.1	0.7	3.4
Lying	59.2	71.4	27.9	51.7	63.3	65.3	61.3
Eating	27.2	19.0	15.0	26.5	31.3	29.3	26.9
Other	4.2	7.5	9.6	4.8	0.0	4.1	4.5

^aAge in years.

Table 7
Behavior patterns (% of observations) of four elephants with comparable data sets from 1995 and 1996

Behavior	Becky		Kelly		Rosie		Tracy	
	1995	1996	1995	1996	1995	1996	1995	1996
Off line	8.5	13.6	8.5	13.6	35.2	23.1	8.5	13.6
Weaving	0.0	0.5	22.5	34.8	18.6	8.1	42.7	37.6
Head bobbing	10.7	40.3	0.0	0.0	0.0	0.0	0.0	0.0
Trunk tossing	0.0	1.4	0.0	2.3	0.0	0.0	0.0	0.9
Standing	*	5.0	*	6.8	*	13.1	*	1.8
Lying	3.3	0.9	1.6	1.4	0.0	0.0	1.0	0.0
Eating	66.8	28.5	54.7	29.4	40.4	45.7	37.8	34.8
Drinking	1.6	0.9	1.6	0.9	0.7	0.9	1.6	0.9
Dust bathing	0.0	0.5	0.0	1.8	0.0	0.5	0.0	0.0
Other	9.2	8.7	11	9.1	5.2	4.1	8.4	10.6

* Standing idle was not used in 1995 due to its infrequent occurrence that year.

3.4. Repeatability of behavior

The behavior of each of the four elephants for which comparable data are available were remarkably similar (Table 7), even though the 1995 data were obtained in the Fall and the 1996 data were obtained in the Spring. Meaningful correlations between 1995 and 1996 data could not be calculated, however, due to the low occurrence of many of the behaviors and the large influence that management had on some other behaviors (i.e., off line, drinking and eating).

Becky was the only one of the four elephants who performed head bobbing. Most of her variation from 1995 to 1996 (Table 7) was probably due to the difficulty in coding behavior as either head bobbing or eating. She performed a considerable amount of head bobbing while eating and elephants do perform elements of head bobbing during normal eating.

Table 8
Time budgets (% of observations) of elephants for four 15-min periods 1 h prior to feeding hay

Behavior	1995				1996			
	60–46 min	45–31 min	30–16 min	15–0 min	60–46 min	45–31 min	30–16 min	15–0
Weaving	29.2	27.6	33.6	50.0	21.8	40.3	36.3	45.2
Head bobbing	0.9	1.7	3.5	8.2	4.9	6.3	6.2	8.2
Trunk tossing	0.0	0.0	0.0	0.0	9.7	5.6	8.9	3.4
Lying	1.8	0.0	0.0	0.0	4.8	4.9	3.4	1.4
Eating	49.6	48.3	44.8	28.2	49.2	33.3	30.8	21.9
Drinking	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dust bathing	16.8	18.1	18.1	13.6	3.2	2.8	2.7	2.7
Other	1.7	4.3	0.0	0.0	6.4	6.9	11.7	17.1

Table 9
Time budgets (% of observations) of elephants for four 15-min periods 1 h prior to a performance

Behavior	1995				1996			
	60–46 min	45–31 min	30–16 min	15–0 min	60–46 min	45–31 min	30–16 min	15–0 min
Weaving	7.4	5.7	14.1	14.9	25.5	27.7	33.0	34.5
Head bobbing	2.2	3.6	6.3	8.5	7.5	10.3	10.7	8.6
Trunk tossing	0.0	0.0	0.0	0.0	2.0	2.6	3.1	4.3
Lying	7.4	2.1	0.7	0.7	0.5	0.0	0.0	0.0
Eating	69.9	75.0	71.1	52.5	55.5	51.8	48.7	36.8
Drinking	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dust bathing	8.1	3.6	5.6	1.4	2.0	1.5	0.5	1.9
Other	5.2	10.0	2.1	22.0	7.0	6.2	4.0	14.9

3.5. Behavior prior to certain events

3.5.1. Hay

A total of eight data sets were found in which nothing disruptive happened 1 h prior to feeding hay in 1995 and 1996 (Table 8). Weaving and head bobbing increased prior to feeding hay. However, eating decreased an almost identical amount. Thus, much of the increase in stereotypic behavior could be due to the unavailability of edible hay rather than 'anticipation' of being fed fresh hay.

3.5.2. Performances

A total of 13 data sets were found in which nothing disruptive happened 1 h prior to a performance in 1995 and 1996. The amount of weaving and head bobbing similarly increased as the time for a performance neared (Table 9). The elephants generally had an abundant supply of fresh hay, which also served as their bedding, prior to the gates being opened and customers entering the midway 30 min prior to the start of a show and 1.5 h prior to the elephants performing. Hence, a lack of edible hay was probably not a factor in the increased incidence of stereotypic behavior prior to performances.

3.5.3. Water

Because the elephants were frequently fed and/or their area cleaned shortly prior to watering, however, only four 1-h periods could be identified in 1995 and two in 1996 in

Table 10
Time budgets (% of observations) of elephants for four 15 min periods 1 h prior to water

Behavior	1995				1996			
	60–46 min	45–31 min	30–16 min	15–0 min	60–46 min	45–31 min	30–16 min	15–0 min
Weaving	6.4	6.3	12.8	41.3	11.9	26.2	45.7	54.1
Head bobbing	0.0	2.1	0.0	6.5	2.4	4.8	8.6	5.4
Trunk tossing	0.0	0.0	0.0	0.0	14.3	19.1	22.9	13.5
Lying	2.1	18.8	10.6	6.5	14.3	4.8	0.0	0.0
Eating	85.1	72.9	76.6	43.5	42.9	28.6	11.4	2.7
Dust bathing	0.0	0.0	0.0	0.0	7.1	3.4	2.9	8.1
Other	6.4	0.0	0.0	2.2	7.2	14.4	8.6	16.2

which significant disturbances did not occur prior to the picketed elephants receiving water in the troughs (Table 10). Weaving and head bobbing greatly increased prior to the elephants being watered. It was very evident that the seven-fold increase in weaving was due to the anticipation of being watered rather than a reduction in edible hay because all of the elephants rose, their attention was focused in the direction of the water truck and then to the elephants who first received water, and there were frequent excitement vocalizations (chirping and trumpeting).

Although both 1995 and 1996 data are presented in Tables 8–10, only trends within a year should be considered because different elephants were used each year. Table 5 showed that an individual's behavior is highly repeatable from one year to the next, but there is more variation from 1995 to 1996 in Tables 8–10 because different elephants were used each year.

4. Discussion

4.1. Time budgets—1995 daylight hours

These data cover a time period comparable to what other researchers studying behavior in circus elephants used (Schmid, 1995) and the time period during which the general public is most likely to observe the elephants. All of the elephants with this circus displayed stereotypic behaviors during daylight hours. This is consistent with the observations of Kiley-Worthington (1990) of elephants in 15 circuses and 8 zoos in Europe and North America, and Schmid's observations of 29 elephants in 4 circuses in Germany and Switzerland.

Overall, these elephants spent less than half the time performing weaving during roughly comparable time periods than elephants in five smaller European circuses studied by Schmid (1995). One possible reason for the difference could be that because the elephants Schmid was studying were turned loose daily into paddocks, their tendency to weave when chained may have greatly increased. Another reason could be that European circuses tend not to change their location as frequently as the circus in this study, and hence, the European circus elephants may have been subjected to less stimuli and greater boredom. Schmid did not include specifics regarding the number of times the circuses she studied changed location. Also, Schmid's observations were only taken when the elephants were either chained or in paddocks, whereas our data include time when the elephants were off line. If time spent off line is eliminated from our data, the percentage of observations our elephants spent weaving increases from 15.9% to 17.3%, still considerably less than the weaving observed in Schmid's (1995) subjects who ranged from means of 38% to 55%.

4.2. Time budgets—1996 continuous observations

Weaving was the most common stereotypic behavior. However, the occurrence of weaving was highly variable; one elephant, Kelly (Table 4), spent 33% of her time weaving, while Barbara, Minnie, (Table 3) and Becky (Table 4) virtually never weaved.

Although Becky rarely weaved, she head bobbed 33% of the time. One elephant (Minnie, Table 3) spent almost 27% of her time simply standing idle.

An interesting observation was that Susie spent only 1% of her time lying down. There appears to be no physical reason for her reluctance to lay down because she was very capable of carrying out a number of acrobatic activities during performances. Not lying down at all is common in elephants that are very old (Hediger, 1968).

It is important when comparing these results with the daylight observations (Table 2) to realize that those observations concentrated on the time period when the elephants were fed and the most active, and ended at the start of the second show. Thus, being off line for the second elephant act was not included in Table 2, as well as time spent taking down the tent.

4.3. Time budgets—2400 to 0400 h

Although 2400 to 0400 h is the one time period when these elephants are relatively free from external stimulation caused by people, a large proportion of elephants in the groups were still active at any one time. Hediger (1968) observed that circus elephants lay down shortly after midnight and that they rose every 1 to 2 h to urinate or defecate. He also estimated that Indian elephants spent an average of 2 h and 19 min asleep. No attempt was made to differentiate sleep from lying in this study.

4.4. Repeatability of behavior

Although meaningful correlations between 1995 and 1996 data could not be calculated, there was considerable consistency within elephants. The elephant who head bobbed did so each year. Also, the relative amount of weaving an elephant performed stayed approximately the same. During the interim, the elephants had gone through 3 months of winter quarters during which their housing, management and routine was very different from when they were on the road. The four elephants on which the repeatability data are based, however, were in their mid twenties and they had probably been traveling with this circus for approximately 20 years.

4.5. Behavior prior to certain events

From unpublished experiments conducted with this circus, it appears that these elephants find performing their acts highly reinforcing. During those experiments performing groups of three to four elephants were deliberately kept on the picket line and not brought into the tent for their regular act. Those elephants were highly agitated, repeatedly oriented toward the tent and vocalized, and attempted to perform their act to music cues from the main tent while still chained.

The increased incidence of stereotypic behavior prior to feeding hay, performances and watering was well known to the trainers and grooms who knew these elephants. They anthropomorphically described the increase in stereotypic behavior as if the elephants 'were acting like children jumping up and down anticipating something they wanted to do.' There is no literature on the causation of stereotypic behavior in

elephants, although it has been shown that there is a dramatic decrease when elephants are placed in paddocks (Schmid, 1995). One common anecdotal explanation is that weaving is necessary as a replacement for walking to help pump blood out of the feet of the animal. That is questionable because there are a number of picketed elephants who virtually never weave (but head bob instead) and they do not have apparent circulatory problems. It is impossible to obtain detailed histories of the early lives of these elephants to look for possible causal factors due to turnover of personnel. There are, however, numerous anecdotal accounts of how zoo elephants who had never been chained developed stereotypic behaviours. It commonly arose when a young elephant was frustrated by, for example, being left in a pen when its companions were led off, or when an elephant was not fed at the expected time and elephants in other pens were fed.

The model frequently applied to swine that links feed restriction (not reaching satiation) to stereotypic behavior (e.g., Lawrence and Terlouw, 1993) does not directly apply in this situation because these elephants were offered an excess of hay and were offered water until they drank their full. However, the elephants were not allowed to play with the water prior to the trough being removed to avoid the formation of mud where the elephants had to stand. When conditions and time permitted, the elephants were released from the picket line and taken to a location where they were hosed down with fire hoses and encouraged to play with the water.

Reduced incidence of stereotypic behavior in horses is related to horses having visual and tactile contact with other horses, being bedded on straw, and having a large proportion of their diet consisting of forage (Houpt, 1995; McGreevy et al., 1995). The elephants in this study had contact with their immediate neighbors, were bedded on hay or straw, and they were on a high forage diet.

4.6. General

This circus is starting to experiment with the use of electric fences to create portable pens into which the elephants are released for varying periods of time when conditions permit. When these elephants were first introduced in small groups to an approximately 0.5-ha electric pen, they were highly agitated, confused and some started to weave. When they were escorted out of the pen, the trainers had difficulty slowing the elephants as they walked back to the 'security' of the picket line. These elephants were in their herds of three to four elephants so isolation from the rest of the herd was not a major cause of the agitation. Many European circuses utilize electric pens on a regular basis (Schmid, 1995). Electric pens were found to reduce the incidence of stereotypic behavior and to offer increased opportunities for elephants to satisfy their behavioral needs (Schmid, 1995). Anecdotal evidence also suggests that regular use of electric pens and taking elephants for walks and baths improve their 'attitude,' but this has yet to be confirmed.

Picketing or chaining of elephants is defended by circuses as the best method to ensure the safety of both people and the elephants. Chaining is also thought to aid keepers in demonstrating their dominant positions (Dittrich (1988) as cited in Schmid, 1995). Until circuses have more experience with electric pens and there is a consensus

regarding their reliability and security, electric pens will not replace picketing as the predominant method of restraint.

5. Conclusion

The single most common stereotypic behavior observed was weaving (rocking). The weaving of elephants is different from that observed in other species, such as other zoo animals or stalled horses, because elephants may perform a range of other behaviors while also weaving. For example, while weaving, elephants will frequently throw hay or dust on their backs, groom a neighbor with their trunk, or eat some hay. The amount of time elephants spent off the picket line showed only a slight tendency ($r = -0.48$, $P = 0.12$, $N = 12$) to be negatively correlated with weaving and head bobbing, the major stereotypic behaviors. The consistency of the time budgets from one year and season to the next were repeatable.

Stereotypic behavior greatly increased prior to the elephants receiving water, prior to performances and prior to the feeding of fresh hay. This increase in stereotypic behavior observed prior to water and performances probably reflects elements of arousal (Rushen et al., 1993) and motivation (Lawrence and Terlouw, 1993) that indicate 'anticipation.' The increase in stereotypic behavior prior to the feeding of hay probably reflects the absence of edible hay and the diversion hay creates more than 'anticipation' of receiving hay.

After traveling with this circus and studying its elephants on numerous occasions over 3 years, this author's 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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