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Behavioral Abnormalities in Captive Nonhuman Primates

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In this study, we dealt with 11 species of nonhuman primates across 10 zoos in India. We recorded behavior as instantaneous scans between 9 a.m. and 5 p.m. In the study, we segregated behaviors for analyses into abnormal, undesirable, active, and resting. The 4 types of abnormal behavior exhibited included floating limb, self-biting, self-clasping, and stereotypic pacing. In the study, we recorded 2 types of undesirable behavior: autoerotic stimulation and begging. Langurs and group-housed macaques did not exhibit undesirable behaviors. A male lion-tailed macaque and a male gibbon exhibited begging behavior. autoerotic stimulation and self-biting occurred rarely. Males exhibited higher levels of undesirable behavior than did females. Animals confiscated from touring zoos, circuses, and animal traders exhibited higher levels of abnormal behaviors than did animals reared in larger, recognized zoos. The stump-tailed macaque was the only species to exhibit floating limb, autoerotic stimulation, self-biting, and self-clasping. Our results show that rearing experience and group composition influence the proportions of abnormal behavior exhibited by nonhuman primates in captivity. The history of early social and environmental deprivation in these species of captive nonhuman primates probably is critical in the development of behavioral pathologies. Establishing this will require further research.

The topics of boredom and stress and their effects on captive nonhuman animals are intriguing subjects receiving much discussion in the field of zoo biology today. Captivity imposes on animals in the wild an environment that differs vastly from that in which they have evolved. To thrive in captivity, a species must accommodate these differences. The ability of a species to respond to captive conditions with behavior from its normal repertoire depends on the degree to which the particular captive condition resembles its natural environment (Carlstead &

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Shepherdson, 1994). In relatively stark zoo environments, behavioral abnormalities such as stereotyped movements, self-mutilatory behaviors, deviant sexual activities, and abnormal maternal care are commonly observed (Markowitz, 1982).

Abnormal behavior may be due to the lack of sensory input (Mason, 1991). Sensory input from natural environments promotes the display of a normal behavioral repertoire, whereas low levels of sensory input from suboptimal environments hinder development of normal behavioral patterns. In the absence of proper environmental and social stimuli, captive animals develop behavioral pathologies (Anderson & Chamove, 1980, 1985; Chamove, Anderson, & Nash, 1984; Marriner & Drickamer, 1994; Rendall & Taylor, 1991). A variety of factors influence the early development of behavioral pathologies in captive animals. Disruption of early rearing experience in captive nonhuman primates also influences the exhibition of abnormal behavior (Anderson & Chamove, 1980, 1985; Chamove et al., 1984; Erwin & Deni, 1979; Marriner & Drickamer, 1994; Monte & Pape, 1992; Mootnick & Baker, 1994; O'Neill, Novak, & Suomi, 1991; Rendall & Taylor, 1991).

In their study on eight species of gibbons (*Hylobates*), Mootnick and Baker (1994) found that removal of offspring from the mother at an early age and hand rearing them without conspecific contact for at least 2 years of infancy could result in autoerotic stimulation and other abnormal sexual behaviors. Self-aggression and other self-directed behaviors develop when physical contact is restricted or deprived during the first months of life (Anderson & Chamove, 1985; Erwin & Deni, 1979). Captive-reared individuals confined to small enclosures early in life exhibit other abnormal behaviors such as stereotypic pacing (Erwin & Deni, 1979).

Of all the taxa maintained in captivity, the behavioral repertoires of carnivores and primates have been most affected (Boorer, 1972). In this study, we aimed to quantify the proportions of abnormal behavior exhibited by captive nonhuman primates in Indian zoos, investigate their causal factors, and suggest methods of reducing stress in these and other such individuals who exhibit behavioral pathologies.

METHOD

Subjects and Housing

In this study, we recorded the behavior of 11 species of primates found in India: 5 species of macaques, 5 species of langurs, and 1 species of ape housed in 10 zoos in India (Table 1). The primates were housed differently, ranging from single to group housing. Enclosure sizes varied between 7 m^2 and 700 m^2. Enclo-

TABLE 1
Information on the Group Composition and Enclosure of Exhibits Housing 11 Species of Captive Primates in 10 Indian Zoos (November 1999 to June 2000)

Species Sampled	*Zoo Site (India)*	*Group Compositions (n)*[a]	*Size (m^2)*	*Hours Studied*	*Diet*
Common langur, (*Semnipithecus entellus*)	Assam	0:1	31.36	7	Folivorous
	Hyderabad	0:1:1[b]	144.0	7	
	Kolkata	1:0, 1:1:1[b]	44.03	7.5	
	Mumbai	1:0, 2:1:1[b]	67.5	7	
	Vishakapatnam	0:1	809.6	7	
Capped langur (*Trachypithecus pileatus*)	Agartala	1:0, 1:2:1[b]	707.5	7	
	Assam	1:0	49.45	7	
	Hyderabad	1:2	310.0	7	
	Kanpur	0:1	16.79	5	
Golden langur (*Trachypithecus geei*)	Agartala	0:1	707.5	7	
	Assam	1:1:1[b]	135.0	7	
	Hyderabad	1:2	310.0	7	
	Kanpur	0:1	238.0	7	
Nilgiri langur (*Trachypithecus johnii*)	Kanpur	0:1	16.79	5	
	Vishakapatnam	1:1	810.0	7	
Phayrei's leaf monkey (*Trachypithecus phayrei*)	Agartala	4:1	707.5	7	
Lion-tailed macaque (*Macaca silenus*)	Agartala	0:1	18.26	7.5	Omnivorous
	Assam	0:1	49.05	7	
	Hyderabad	1:0	12.96	7	
	Kanpur	1:2	707.1	7	
	Kolkata	1:0	12.33	7	
	Pune	1:0	10.23	7.5	
Pig-tailed macaque (*Macaca nemestrima*)	Agartala	4:6:1[b]	707.5	7.5	
	Assam	1:1, 2:1:1[b]	36.75	7	
	Kanpur	0:1	16.79	5	
	Kolkata	1:0	52.86	7	
	Lucknow	0:1	7.28	7	
Stump-tailed macaque (*Macaca arctoides*)	Assam	1:0, 1:0, 1:1 2:0	49.45	7	
	Kanpur	1:0	16.79	7	
	Lucknow	1:0, 1:1, 0:1:1	7.48	7	
Assamese macaque (*Macaca assamensis*)	Agartala	5:3:1[b]	707.5	7	
	Assam	1:0	31.36	7	
Bonnet macaque (*Macaca radiate*)	Assam	1:0	31.36	7	
	Kanpur	4:0, 1:1:2	16.79	5	
Hoolock gibbon (*Hylobates hoolock*)	Agartala	0:1	18.26	7	Frugivores
	Assam	1:0	30.00	7	
	Lucknow	1:1	96.84	7	

[a]Numer of males:number of females in a group. [b]Number of males:number of females:number of young in a group.

sures varied in their complexity from suboptimal barren cages to moated exhibits with shrubs and trees.

All individuals of the 11 species housed at the 10 zoos were studied except for some who were housed in overcrowded enclosures. In some zoos, urban macaques who have been a menace to human settlements are captured and maintained in overcrowded enclosures in zoos until they are reintroduced into forest pockets outside city limits. As these macaques were housed temporarily in zoos, they were not included in the study.

Procedures and Statistical Analyses

Observations were conducted between November 1999 and June 2000. Individuals were observed on all days of the week except on zoo holidays, which differed from zoo to zoo. This was done to maintain a constant presence of visitors during observation periods.

Primates were observed each day from 9 a.m. to 5 p.m.—from the time the zoo opened until it closed. The behavior was recorded using instantaneous scans every 5 min during each sampling period (Altmann, 1974; Martin & Bateson, 1986).

Mann–Whitney *U* test was used to test the differences between the sexes, age classes, and rearing experience (Siegel & Castellan, 1988). Individuals under approximately 3 years of age were categorized as young animals, whereas those older than 3 years were regarded as adults for analyses. To analyze the differences with primate families, species, and group sizes, Kruskal–Wallis test was used (Siegel & Castellan, 1988). The nonparametric Spearman rank order correlation coefficient test was used to test for correlation between floating limb and self-clasping (Zar, 1984). All the statistical tests performed were two-tailed.

RESULTS

Captive primates were found to exhibit four types of abnormal behaviors and two types of undesirable behaviors (Table 2). Because autoerotic stimulation and self-biting rarely were exhibited and hence were not instantaneously recorded or analyzed, only begging, floating limb, self-clasping, and stereotypic pacing were recorded for analyses.

Macaques and gibbons exhibited undesirable behavior, whereas langurs did not; Kruskal–Wallis test, $\chi^2(2, N = 3) = 12.090$, $p = .002$; $n = 22$, 3, and 17, respectively. The gibbons only exhibited begging. Abnormal and undesirable behaviors were exhibited only by macaques and gibbons who were kept in isolation or as male–female pairs, $\chi^2(2, N = 2) = 8.664$, $p = .034$; $n = 15$ and 6, respectively (4 groups—singly-housed animals, male–female pairs, single-sex pairs, and groups). All were housed in barren cages.

TABLE 2
Ethogram of Abnormal Behaviors Exhibited by Captive Nonhuman Primates Observed in 10 Indian Zoos (November 1999 to June 2000)

Behavior	*Description*
Undesirable	
autoerotic stimulation	Self directed sexual activity and masturbation
Begging	Forelimb stretched out toward visitor(s); visitor is usually carrying an edible item that is visually tracked before the behavior is exhibited
Abnormal	
Floating limb	Unusual movement pattern of a limb; after visually tracking for a short time, the floating limb is often attacked viciously by oneself
Self-clasping	Use of hands or feet to hold onto part of the body by oneself
Self-biting	Hands, legs, arms and/or torso bitten in a stereotyped fashion by oneself
Stereotypic pacing	Repetitive pacing along the same path

There was a significant difference between the level of abnormal and undesirable behaviors exhibited by male and female macaques and gibbons ($U = 44.500$, $p = .051$; $n = 11$ and 6, respectively). Males exhibited higher levels of these behavior patterns than did females. Animals confiscated from touring/mobile, small unrecognized zoos and circuses exhibited higher levels of abnormal behaviors than animals reared in larger, recognized zoos ($n = 16$ and 9, respectively). An individual's rearing experience thus had a significant influence on the proportion of abnormal behaviors exhibited ($U = 23.000$, $p = .001$). See Figure 1.

The stump-tailed macaques were the only species observed to exhibit floating limb, self-clasping, self-biting, and autoerotic stimulation (Table 3). A significant positive correlation was recorded between levels of floating limb and self-clasping exhibited (Spearman's rank order correlation coefficient test, $\lambda = 0.660$, $p = .000$, $n = 26$). A male lion-tailed macaque and a male gibbon exhibited begging. Stereotypic pacing was exhibited only by the omnivores (pig-tailed, stump-tailed, bonnet, and Assamese macaques; $n = 2$, 3, 3, and 1, respectively) of whom the bonnet macaques were found stereotypically to pace the most, Kruskal–Wallis test, $\chi^2(5, N = 5) = 12.535$, $p = .028$.

DISCUSSION

In this study, we determined the influence of rearing history and group composition on the proportion of undesirable behavior exhibited by nonhuman primates. Of all the studied captive nonhuman primates, the stump-tailed macaque was the

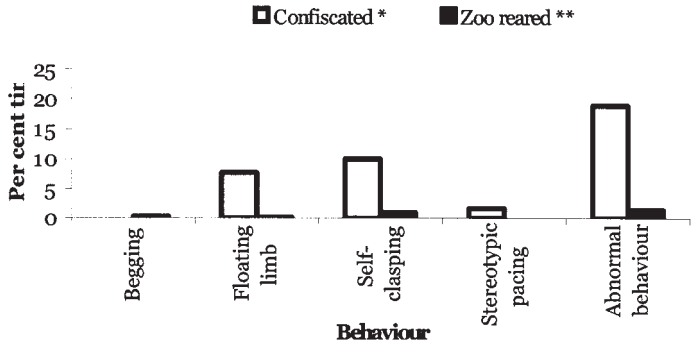

FIGURE 1 Influence of rearing history on behavior of captive primates (November 1999 to June 2000). *Conficasted from touring zoos. **Reared in large zoos.

TABLE 3
Proportion of Abnormal Behavior (in Percentages) Exhibited by Singly and Pair-Housed Omnivores and Frugivores Observed at 10 Indian Zoos (November 1999 to June 2000)

Species	*N*	*Begging ± SE*	*Stereotypic Pacing ± SE*	*Floating Limb ± SE*	*Self-Clasping ± SE*
Lion-tails	5	0.54 ± 1.05	0.00	0.00	0.00
Pig-tails	4	0.00	0.87 ± 0.87	0.00	0.00
Stump-tails	8	0.00	1.39 ± 2.03	8.93 ± 8.85	1.28 ± 1.48
Bonnets	1	0.00	47.76	0.00	0.00
Assamese	1	0.00	4.76	0.00	0.00
Hoolocks	3	0.60 ± 1.17	0.00	0.00	0.00

only species to exhibit floating limb, autoerotic stimulation, self-biting, and self-clasping—the last three exhibited only by individuals who exhibited floating limb. Levels of floating limb and self-clasping were correlated with each other. Although this data organization is unable to determine any causal connection between these behaviors, one of us (Avanti Mallapur) observed that correlation possibly rose because events of floating limb tended to be followed immediately by acts of self-clasping.

Stereotypic pacing was exhibited by pig-tailed, stump-tailed, bonnet, and Assamese macaques, whereas begging was exhibited by a lion-tailed macaque and a gibbon. Although most behaviors mentioned previously were categorized as abnormal (behaviors exhibited in captivity but not in the wild), begging might be an intelligent adaptive response, whereas autoerotic stimulation could simply be occurring at higher frequencies than in the wild. However, it also is true that

both behaviors could be considered undesirable from the perspective of zoo managers because both serve to stimulate equally undesirable responses from visitors.

Our results suggest that only captive omnivorous primates such as macaques and gibbons exhibited undesirable behavior, whereas folivores such as langurs, unlike the macaques and gibbons—irrespective of their rearing history and housing—did not exhibit any type of behavioral abnormality. Differences in levels of undesirable behavior could be due to variance in diet and food acquisition techniques they use in the wild. Marriner and Drickamer (1994), in their study on stereotypy in captive primates, suggested that omnivores spend more time foraging, especially for insects, in comparison to folivores. In captivity, in the absence of insects and a variety in the diet, the time spent foraging by omnivores could be as low as that of folivores. This could have resulted in the exhibition of undesirable behavior by the omnivores in this study.

Another possibility is that the types of abnormal behavior and the levels to which they are displayed could depend on the cognitive sophistication and communicative abilities of the different taxa (A. Sinha, personal communication, May 6, 2003); in fact, social complexity and cognitive abilities are believed to have coevolved to different levels and are known to vary across primate groups (Byrne, 1995). Hence, captivity may not significantly affect langurs—whether housed in isolation or in social groups—in terms of their cognitive abilities and individual expression. On the other hand, given the complexity that characterizes their societies and individual relations, macaques and gibbons may be affected more profoundly by social isolation.

Macaques housed in groups did not exhibit undesirable behavior; individuals housed singly or in male–female pairs did exhibit such behavior. Free ranging nonhuman primates live in complex social groups in the wild (Coe, 1991). Housing these primates in groups of abnormal compositions or in isolation, therefore, gives rise to abnormalities in their behavioral repertoire (Anderson & Chamove, 1980; Reinhardt, Houser, Eisele, & Champoux, 1987; Reinhardt, Liss, & Stevens, 1996; Rendall & Taylor, 1991).

In this study, we found that animals who were confiscated from touring zoos and circuses exhibited higher levels of undesirable behavior than did animals who were reared in recognized zoos. This could be due to a history of early social and environmental deprivation in circus and touring zoo-reared animals. Disruption in early rearing experience could be the probable factor influencing the exhibition of behavioral pathologies such as floating limb, self-biting, self-clasping, and autoerotic stimulation (Anderson & Chamove, 1980; Erwin & Deni, 1979; Mootnick & Baker, 1994). According to Erwin and Deni (1979), total isolation also affects reproductive behavior, aggression, maternal behavior, exploration, play, learning, and eating and drinking.

Similarly, Anderson and Chamove's (1980) study on self-aggression and social aggression in laboratory-reared stump-tailed macaques further strengthens our argument against depriving zoo primates of conspecific contact during the first few years of their lives. Their study proved that behavioral abnormalities exhibited by the experimentally reared monkeys were influenced by social restriction experienced during the first year of life. Experimentally reared monkeys exhibited high levels of self-aggression in groups as adults, whereas feral-reared and group-reared animals did not exhibit this behavior.

Within the omnivores, the stump-tailed macaques exhibited a higher variety of undesirable behaviors than did the other species of macaques. Stump-tailed macaques could be more prone to developing these behavioral patterns. In their study on self-aggression in captive macaques, Anderson and Chamove (1985) explained how the stump-tailed macaques housed in conditions similar to those of the rhesus continued to exhibit self-aggression, whereas the rhesus macaques (*Macaca mulatta*) did not.

The diversity in undesirable behavior and the proportion to which they were exhibited was higher in males. Males deprived of early conspecific contact who were housed with normal females continued to exhibit undesirable sexual behavior. The repeated presentation of the females failed to arouse their curiosity or interest. Rare occasions were observed when the male would push or pull the female's tail aside and inspect her genitals. The males spent considerable proportions of their time exhibiting undesirable behavior. A study (Mitchell, 1979) on early social restriction in captive rhesus monkeys showed that males exhibited higher levels of undesirable behavior than did females.

CONCLUSIONS

With reference to this study, the factors that significantly influence the exhibition of undesirable behaviors by captive nonhuman primates are rearing history and group composition.

Housing in species-specific group compositions tends to play an important role in the development of a naturalistic behavioral repertoire in a captive primate. This is especially true for infants and juveniles in which isolation and disruption in early rearing experience influences the exhibition of self-mutilatory behaviors in adulthood. Hence, it would be advisable to maintain primates in appropriate group sizes and sex ratios so as to avoid development of undesirable behavioral patterns. Social enrichment may be desirable in some cases of single housing. Structural enrichment could be administered to enclosures housing primates in isolation due to the inability of acquiring a companion for these animals. The most commonly used structural enrichment are logs and sleeping boxes, which when administered at dif-

ferent levels in the enclosures would provide the captive individuals with access to the vertical dimension. There are numerous published papers (e.g., Monte & Pape, 1992) on structural enrichment, information from which could help to renovate primate exhibits. Omnivores spend a considerable proportion of their time in foraging for food. Multiple feeding through the day and providing a variety of small palatable food items are known to promote normal foraging behavior, especially when the food is scattered or hidden all through the enclosures.

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