

# ADAPTATION OF BLIND BROWN BEARS TO A NEW ENVIRONMENT AND ITS RESIDENTS: STEREOTYPY AND PLAY AS WELFARE INDICATORS

PAUL KOENE, Animal Husbandry/Section Ethology, P.O. Box 338, 6700 AH Wageningen, the Netherlands, email: paul.koene@etho.vh.wau.nl

**Abstract:** Fourteen European brown bears (*Ursus arctos*) were confiscated in Turkey in October 1993. Three bears—1 female and 2 males—were blind and showed mainly stereotypies and behavior toward others that was passive, aggressive, or both. These blind bears were transported to the Zoo in the Netherlands and placed in an enclosure with 8 resident wolves and 7 resident bears, all with normal vision. Problems were expected concerning the adaptation to the new environment and the interactions with other animals. Three ethological studies were done in 3 phases: (1) experimental behavioral study during release, (2) behavioral description in the stable phase following release, and (3) detailed description of play behavior of blind and other bears. The blind bears had very few contacts with the electric fencing. After such a contact the bears immediately returned to the quarantine facility and stayed there for a long period. The female bear sometimes showed stereotypies during the first 6 stages of the release, but they were not observed after stage 6. Bears played much of the time in phases 2 and 3. The decrease in stereotypies and the increase in playing behavior may reflect improved welfare of the blind bears. However, comparison between individual reactions of the bears suggested different coping styles, as is found in other species. The 2 male bears developed an active coping style with many playful interactions with other bears, whereas the female showed a more passive coping style.

*Ursus* 10:579–587

**Key words:** adaptation, animal welfare, blind brown bear, play behavior, stereotypy, *Ursus arctos*.

Keeping European brown bears (*Ursus arctos*) has been illegal in Turkey since 1967. Despite this, gypsies continued to use these animals as a source of income—tourists pay for photographs of themselves with European brown bears, also known as dancing bears. Bears were nightly chained to trees by the gypsies. On 5 October 1993, 14 of these bears were confiscated and transported temporarily to the University of Bursa, Turkey. There are probably thousands of dancing bears in the world, and failure or success of this project may determine future actions. The outcome of this project is therefore crucial for future confiscations of dancing bears. Herein, I give special attention to bears with particular problems (i.e., 3 blind bears). Transportation of the blind bears from Turkey to the Netherlands allowed us to monitor the adaptation of these bears to the new environment. Because the animals showed mainly stereotypies and passive or aggressive behavior toward others in Turkey (Koene 1994), we expected problems concerning the adaptation to the new environment and the interactions with other animals. As adaptation occurs, abnormal behavior such as stereotypies decreases and behaviors such as play are expected to increase. The aim of this research is to describe the behavioral adaptation of the 3 blind bears to their new environment and its residents.

Although welfare *per se* is not measurable, the behavior of animals may indicate their state. Investigation of (abnormal) behavior coupled with physiological measures are most relevant (Wiepkema et al. 1993). Stereotypies are well-known abnormal behaviors, repeatedly performed, of fixed form, apparently purposeless, and characteristic or specific to the individual (Lawrence and

Rushen 1993). In captive bears these behaviors occur often (Meyer-Holzappel 1968) and can sometimes be reduced by environmental enrichment (Carlstead et al. 1991). The apparent purposelessness is, however, questionable, as the animals may reduce their stress by performing this behavior (Wechsler 1991, Schouten and Koene In Press) by releasing endorphins contingent on the performance of this behavior (Cronin 1985, Schouten and Rushen 1992).

Under natural (Van Oortmerssen et al. 1985) and artificial (Schouten and Wiepkema 1991) conditions animals can react to stressful events in 2 ways, so-called behavioral strategies or coping styles. In general, the active coping style is characterized by a fight or flight response (i.e., increased heart rate, blood pressure, and routine-like behavior). The passive coping style is characterized by a freeze response (i.e., lowered heart rate and blood pressure and a more extrinsic organization of behavior [Benus et al. 1990]). The different responses in a stressful environment complicate the interpretation of behavior alone. Animals showing passive behavior may be relaxed or have a passive coping style; this indicates that this type of behavior alone is not a reliable indicator of welfare. Physiological measures or changes in other behavior may reflect the state of welfare.

Individuals that form a stable social group may significantly protect each other against stress (Wiepkema et al. 1993). Play behavior in a social group reflects environmental conditions (Fagen 1981). Further, there are indications that stressed animals play less, play differently, or do not play at all (Fagen and Fagen 1990). In this sense the presence of play behavior may indicate welfare

of the animals (Fagen and Fagen 1990). Young bears show most play behavior (Bekoff 1972, Henry and Herrero 1974), although extensive adult play behavior is found under natural conditions of abundant food (Egbert and Stokes 1976, Murie 1985) and no competition (Latour 1981) and also in captivity (Colmenares and Rivero 1983, Ames 1993). The occurrence of play behavior is thus relevant for interpretation of behavior in terms of welfare of the bears. Furthermore, the blindness of the bears may hamper interpretation because play behavior will likely differ between bears that can see and bears that cannot see. Detailed analysis of the play behavior can reveal qualitative differences and can add to the precise interpretation of behavior.

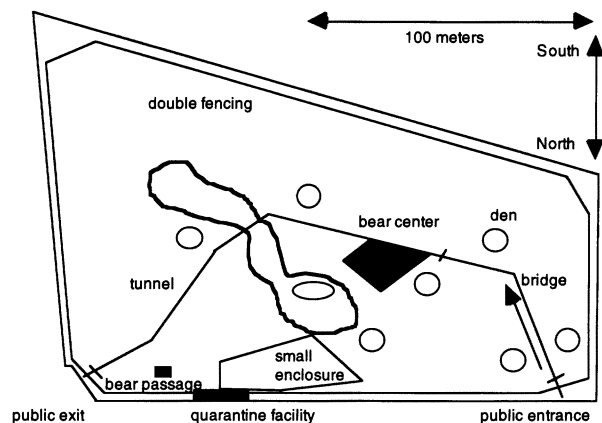
Special thanks are owed to Ouwehands Zoo and to Saskia Ruven and Nicoline Kamphorst, who initiated behavior research in Turkey. Annie Woudstra, Sybrand Ariëns, and Brigitte Maas did most observations on which this research is based. Funding for the project and the travel to the Tenth International Conference on Bear Research and Management in Fairbanks in 1995 came from the International Bear Foundation in The Netherlands.

## STUDY AREA

The refuge for bears created by the International Bear Foundation (Baars 1994) is near Ouwehands Zoo in Rhenen, the Netherlands, and is called the "Bear Forest". This refuge (Fig. 1) houses former zoo bears, circus bears, dancing bears of Turkey, and war victims (bears) of Bosnia. In this 2-ha area, bears with different histories lived with 8 European wolves (*Canis lupus*). The area was triple fenced: a 3.5-m high double fence (3 m apart) electrified on top and a low electric fence (1 m) was inside the double fence. The enclosure included 2 ponds connected by a waterfall. The area was bisected by a public walkway, elevated (a bridge), to the Bear Center then declining to a low route (tunnel; Fig. 1). There were 3 bear passages beneath the tunnel and bridge. The dens were in the enclosure; animals were out all day and could be seen from the public walkway. The enclosure included a quarantine facility for veterinary care and a temporary small enclosure—enclosed by 1-meter high electric fencing in front of the quarantine facility.

## METHODS

In September 1993 (before confiscation) brown bears tethered to trees in a park in Istanbul were observed for 10 hours. In October, 14 bears were confiscated and observed in Bursa, Turkey. Three of the bears—all blind



**Fig. 1.** Map of the study area in Ouwehands Zoo, Rhenen, the Netherlands.

—were transported to Ouwehands Zoo in the Netherlands and were studied until June 1995. These 3 bears were 2 males, named Koröglü and Bora, and 1 female named Fiona. The males were castrated to prevent reproduction, which can influence their behavior by making them less aggressive. After arrival, the blind bears were gradually habituated to their new environment; we were particularly concerned about the electric fencing and the ponds posing physical problems and other bears and the wolves posing social problems. Bears were fed pellets at 0815, apples at 1300, and bread and sometimes meat at 1530.

Observations were done by graduate students in ethology from the Wageningen Agricultural University with the help of an extended ethogram—with detailed description of stereotypic and play behavior—using standard ethological methods (Martin and Bateson 1993), a Psion Organizer, and the Observer Software (Noldus 1991). Data were analyzed with the Means and Frequency procedure (SAS Inst., Inc. 1990).

The activities of the blind bears were recorded to evaluate changes in behavior in these animals (Koene 1995) during the following periods:

1. Release in the new enclosure: experimental behavioral study during the release in 8 chronologic stages with special attention to stereotypies.
2. Daily life: description of individual behaviors in the stable phase following release.
3. Play: detailed description and quantification of play behavior of blind and other bears.

## Release: September–December 1994

The blind bears were allowed into the small enclosure (Fig. 1) alone or in groups with varied combinations of

**Table 1. Daily release program for blind bears, Ouwehands Zoo, the Netherlands.**

Stage	Acclimation to	Subjects <sup>a</sup>	Other animals <sup>b</sup>	Enclosure	Start	Sampling method <sup>c</sup>	Observation periods
pre	general	K / F	-	quarantine facility	13 Sep 94	sts 60	
1	electric fence	K / F / (B)	-	small	22 Sep 94	fcs	12,10,1
2	1 bear, electric fence	K + F	-	small	24 Oct 94	fcs <sup>d</sup>	3, 2
3	1 bear, electric fence	K + F	-	small	31 Oct 94	sts 30	9
4	blind bears	K + F + B	-	small	11 Nov 94	sts 30	8
5	water, large enclosure	K + F + B	-	large	22 Nov 94	sts 300	3
6	other bears	K + F + B	NM1	large	29 Nov 94	sts 300	6
7	other bears	K + F + B	NM1 + NM2	large	13 Dec 94	sts 300	2
8	all bears + wolves	K + F + B	all + wolves	large	15 Dec 94	sts 300	2

<sup>a</sup> a / or + between initials indicates bears were enclosed separately or together, respectively. K = Koröglû, F = Fiona, B = Bora.

<sup>b</sup> NM1 = Niki and Mascha, NM2 = Nelly and MacKenzie.

<sup>c</sup> sts # = scan time sampling every # seconds, fcs = focal continuous sampling.

<sup>d</sup> Behavior of only 1 subject is recorded.

bears and wolves outside the small enclosure (Table 1); either 1 blind bear, 2 blind bears, or 2 sighted bears were outside the small enclosure and all other bears in the northern part of the large enclosure or all bears and the wolves were in the large enclosure (Table 1). In this way the blind bears were gradually acclimated to the electric fence, water, other bears, and wolves. Behavior was recorded in three 1-hour sessions (between 0900–1200), after which animals returned to the quarantine facility. Although we recorded behavioral elements, for presentation and practical purposes the behavior is categorized as stereotypy, passive (lie, stand, sit, sleep), active (groom, play, walk, run, etc.), exploration (sniff, look, but also some behavior related to shock), and other behavior. In the case that only 1 bear was present, focal continuous sampling (fcs) was done; when more bears were present scan time sampling (sts) with an interval of 30 (2 bears) or 300 (more bears) seconds was done (Martin and Bateson 1993). Bora had an eye operation after the first 3-hour session in stage 1 and was observed again starting in stage 4.

### Daily Life: January–April 1995

During this phase the behavior of the blind bears in relation to other inhabitants of the study area was recorded. This phase was divided into 3 periods when (1) the bear passages were closed, (2) the bear passages were open, and (3) 2 new bears were released into the enclosure. We focused our research on the development of behavior in relation to temperature, public, and other animals. The sampling was planned (i.e., focal continuous sampling recordings of 15 minutes duration), and sampling was equally distributed over 3 animals at three 15-minute periods/hour, in 3 blocks of 1 hour according to a Latin Square design. For each animal, 8 behavioral sampling

periods/day were made. Behavioral elements were divided in categories and included stereotypy, passive behavior (sleep, sit, stand), active behavior (mainly feeding, drinking, grooming), exploration (alert, solo play, play alone with objects, search), social behavior (play, sniff other bear, aggression) and other behavior.

### Play: May–June 1995

For analysis of the play behavior, the 2 male blind bears (Koröglû and Bora) and 2 bears that could see (Battir and MacKenzie) were selected for observation. The choice was based on sex, appearance, age, and playfulness. Battir (21 years old) and MacKenzie (5 years old) both played with the 2 blind male bears Koröglû (18 years old) and Bora (4 years old) in the previous phase. Observations were made in which a fifth individual “other bear” was recorded as actor and recipient of behavior. A specific ethogram focused on the behavioral elements during play (approach, strike, hold, bite, retreat), but also included some global behavioral categories. The continuous sampling was focused on multiple subjects during half-hour periods using the Observer software (Noldus 1991).

## RESULTS

### Release

During the 8 stages of the release procedure, the behavior of the blind bears was recorded during 58 sessions, 3-hours each. The blind bears had very few contacts with the electric fencing of the small enclosure; a maximum of 1 shock was received during a session of 3 hours. Koröglû received 7 and Fiona 5 shocks in total; the number of shocks Bora received is unknown. When released

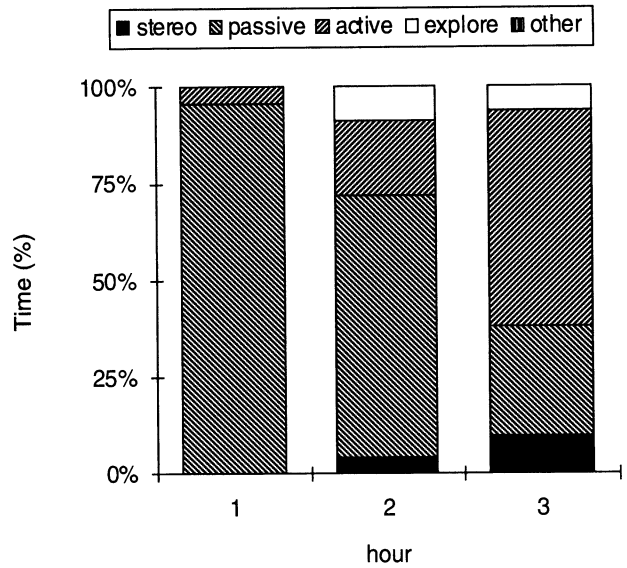
in the small enclosure, these bears showed opposite reactions (Fig. 2); omitting sessions without shocks, Koröglü increased his time to initial shock and Fiona decreased time to initial shock.

After electric shock the bears immediately returned to the quarantine facility and stayed there for a long period (Bora was an exception, going to the center of the small enclosure after shock). The female bear often showed stereotypies during the first 6 stages of the release. They were mainly performed in the quarantine facility, especially after prolonged exploration or after receiving a shock (example of a 3-hour session in Fig. 3).

Fiona's stereotypies disappeared suddenly after stage 6 and never reappeared (Fig. 4). The sudden change in behavior pattern coincided with den occupation. Although the male bears showed stereotypic behavior in Turkey, they never showed it in the study area. During the 8 stages, Fiona was active and explored first, then increased stereotypies to almost 80% of the time and sudden stopped stereotyping. In the last stage she was 94% passive, 1% active, and explored 5% (Fig. 4).

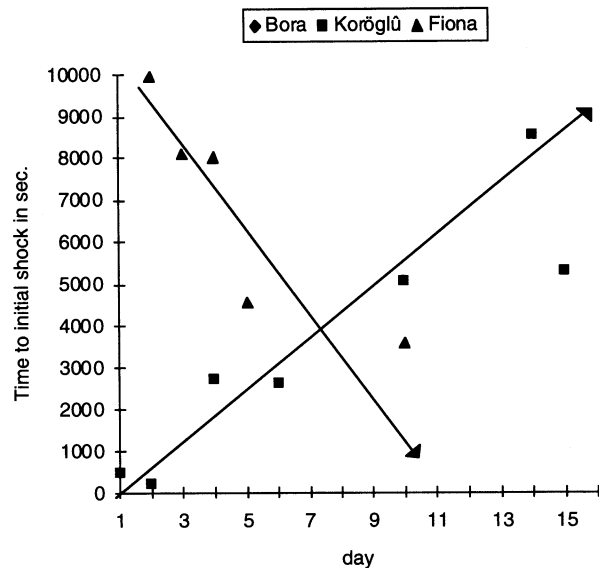
Koröglü first explored, then increased passive behavior, and had a constant time budget in the last stages of the release (Fig. 5).

Bora — starting in stage 4 — showed first passivity, then an increase in exploration, and finally a stable time budget of 57% passive, 21% active behavior, and 21% exploration (Fig. 6). During the first confrontations with

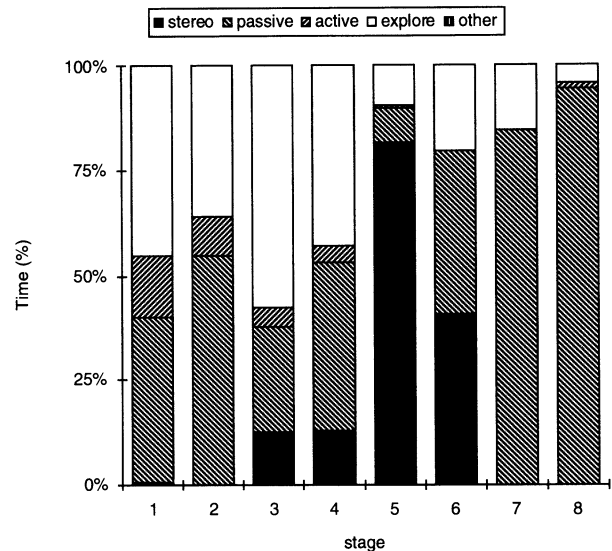


**Fig. 3.** An example of a 3-hour observation of a blind brown bear in the Ouwehands Zoo, the Netherlands, 1994. Fiona increased activity in the first stage, but returned to the quarantine facility after an activity period or shock, where she performed a number of stereotypies.

the other bears, they briefly growled at each other then primarily sniffed each other. All blind bears were at least once attacked by the group of wolves, but the bears did not react and the attack stopped.



**Fig. 2.** Time to initial shock in each session of 3 hours for 2 blind brown bears in the Ouwehands Zoo in the Netherlands, 1994. Arrows drawn by hand.



**Fig. 4.** Time budget of Fiona, a female blind brown bear at the Ouwehands Zoo, The Netherlands, during the 8 release stages, 1994.

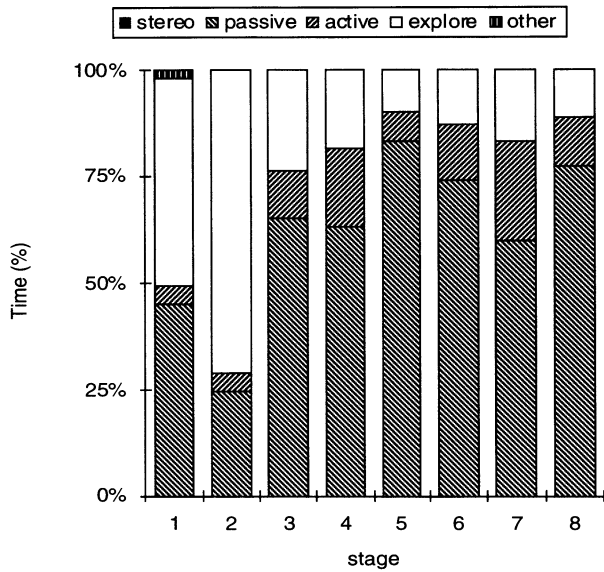


Fig. 5. Time budget of Koröglü, a male blind brown bear at the Ouwehands Zoo, the Netherlands, during the 8 release stages, 1994.

Daily Life

No significant differences in the behavior of the 3 blind bears were found between the periods 1 (bear passages closed), 2 (bear passages open), and 3 (new bears). In the beginning of the Daily Life phase, there was some aggressive behavior between the blind and other bears.

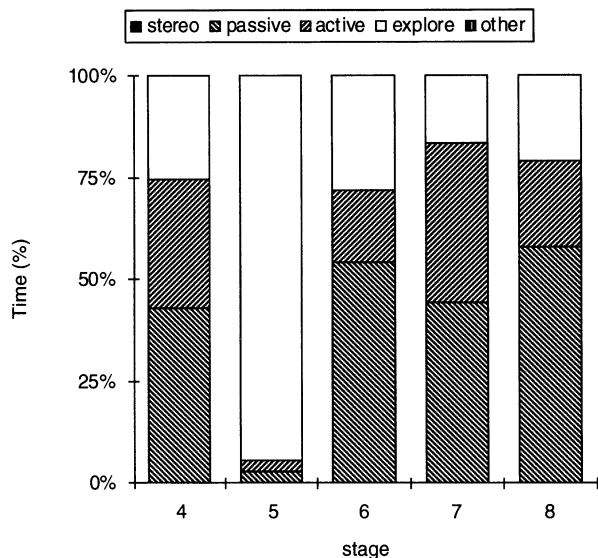


Fig. 6. Time budget of Bora, a male blind brown bear at the Ouwehands Zoo, the Netherlands, during the last 5 release stages, 1994.

This declined gradually. A young female bear first initiated play behavior with Bora. Other young bears avoided the blind bears. In the course of weeks the blind bears played more with bears that could see (Fig. 7).

The bears that could see usually initiated the play; first identification took place by smelling and then the play behavior started. Playful interactions with the wolves were observed 5 times. The blind bears were restricted to the northern part of the enclosure because they did not discover the passages between the northern and southern part of the enclosure. Individual behavioral characteristics were strikingly different from sighted bears (Fig. 8). The blind bears spent much time sleeping. Koröglü spent about half the time on food searching and feeding as the other bears, and Fiona totally lacked social behavior.

No stereotypes were found. Passive behavior consisted mainly of sleep: Fiona slept more (55.9%) than Bora (46.4%), who slept more than Koröglü (38.6%). Active behavior consisted mainly of feeding: Koröglü spent less time feeding (11.0%) than Bora (20.0%) and Fiona (16.7%). Exploration was done most by Bora (29.2%) compared to Fiona (26.1%) and Koröglü (23%). Koröglü spent more time on social behavior (17.7%) than Bora (11.3%) and Fiona (0%).

During the first part of 1995 the amount of social behavior displayed by the 2 male blind bears was substantial and increased; play behaviour gradually developed (Fig. 7). The female did not show any social behavior except aggressive interactions over food (she found and

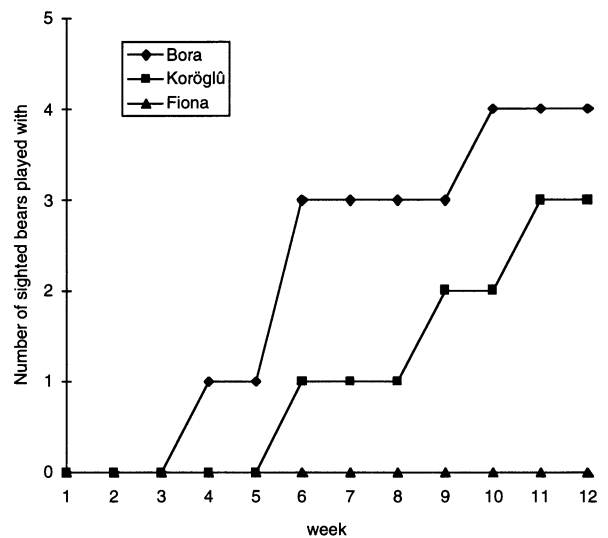


Fig. 7. Number of other bears played with during the course of weeks for the daily life phase of acclimating 3 blind brown bears to other bears at Ouwehands Zoo, the Netherlands, 1995.

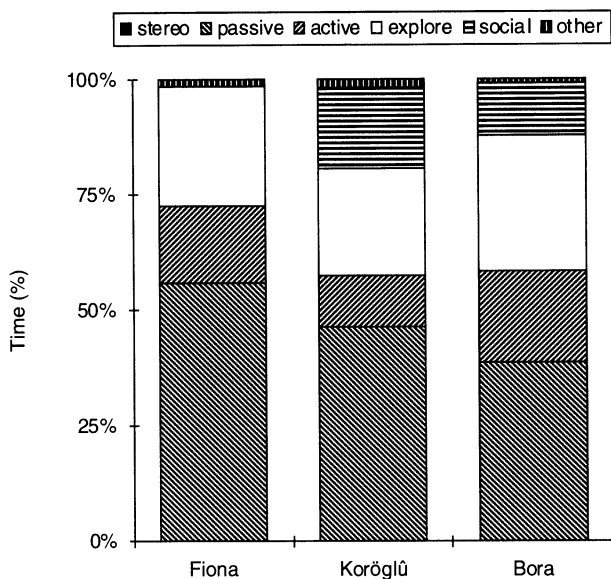


Fig. 8. Time budget of 3 blind bears during daily life at the Ouwehands Zoo, the Netherlands.

ate food more slowly than the males). The blind bears mostly played with each other and with some other male bears. Both blind male bears showed peaks in social behaviors around 1000 and around 1400 (Fig. 9). These peaks followed feeding in the morning (0815) and afternoon (1300).

### Play

During 29.5 hours of the total of 73.5 hours of observation, at least 2 bears played in the Bear Forest (Table 2). Bora played 9.8% of the time, Koröglü, 7.1%, MacKenzie, 13.8%, and Battir, 6.2%.

Koröglü and Bora both played for a considerable amount of time with the other male bears, Battir and MacKenzie. Most playing bouts were initiated by

Table 2. Total number, total duration, and mean duration of play interactions/bear for a total observation period of 265,060 sec (73.5 hr). Bora and Koröglü are blind brown bears; all others are sighted. Bears were held at the Ouwehands Zoo, the Netherlands, 1995.

	Number of interactions	Total duration in sec	Mean duration in sec	Time (%)
Bora	148	26,091	176	9.8
Koröglü	121	18,700	155	7.1
MacKenzie	212	36,680	173	13.8
Battir	88	16,315	185	6.2
Other bear	295	40,440	137	15.3
All bears	432	69,113	160	26.1

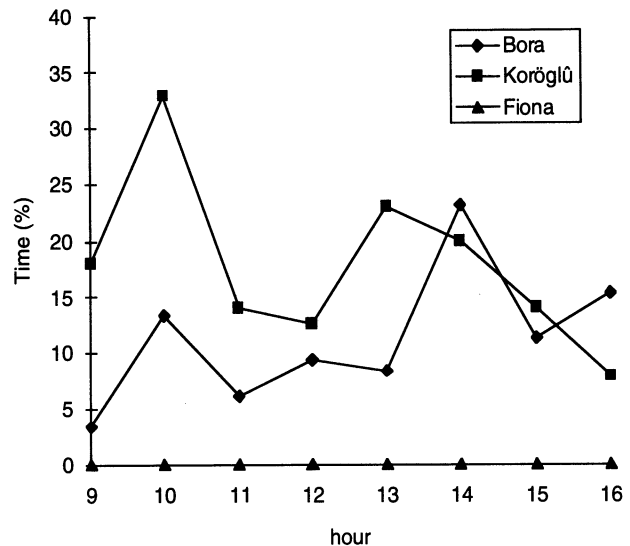


Fig. 9. Social behavior of the 3 blind brown bears during the average day at the Ouwehands Zoo, the Netherlands, 1995.

approach behavior, followed by holding then striking and biting each other. The approach behavior was followed by play in 64.6% of the cases in blind bears, while in bears that were not blind it was followed by play in 41.8% of the cases and by retreat in 58.2% of the cases. Analysis of behavioral transitions showed large differences in the play behaviour of the 4 subjects, but minor differences between blind bears and bears that could see.

## DISCUSSION

In the park in Istanbul 9 of 10 bears showed stereotypic behavior (Koene 1994). After confiscation many bears started to show stereotypies again in Bursa, Turkey (Koene 1994). The circus bear (Battir) and other problem bears (MacKenzie) showed many stereotypies in quarantine facility (approximately 60% of time). After their release in the Bear Forest, they initially showed a large amount of stereotypies, continuing previous behavior. Thereafter, in all bears a sharp decrease in stereotypies was found within 1–2 months.

### Release

The different reactions of the blind bears to the electric fence were possibly the result of different coping styles in these bears. Such differences are often reflected in exploration behavior (i.e., passive coping animals explore their environment more intensely than active coping ani-

mals [Benus et al. 1990]). Translating this to the bears, one can interpret the behavior of Koröglü as active coping, in which he learns about the electric fence in time and increases his time to initial shock. Conversely, Fiona has a passive coping style; she explored from a fixed point, slowly increasing known area bit by bit as the environment became more familiar. She contacted the electric fence in less time as she became familiar with more area. Different ways of walking through the enclosure also illustrated this: Koröglü walked and bumped against trees, while Fiona always made 2 steps on a spot, an exploration step, then the real step. The way in which the electric fence is represented to the animal is unclear. The bears have not gone to the southern part of the enclosure. They have kept a very large safety area, which has prevented shocks, but also prevented discovering the bear passages. All 3 blind bears discovered the pond and often use this for cooling or as a playground.

Fiona's behavior of returning to the quarantine facility after a shock and performing stereotypies illustrated the possible reassuring function of stereotypies. A circus bear in the Bear Forest still showed such a sequence of behavior after 2 years in the Bear Forest. After an aggressive interaction, a shock, or the sound of an airplane, this bear often showed very fixed and regular stereotypies, giving the impression that the animal calmed herself by lowering her heart rate as is found in tethered sows (Schouten and Koene In Press). The switch from stereotypies to passive behavior indicates the passive coping style; passive copers need a safe place to start other behavior. After the dancing bears were confiscated, behavioral studies done in Bursa, Turkey, also showed individual differences between bears that could be interpreted in terms of different coping styles. Many of the captive Bursa bears had a time budget dominated by stereotypies, but other bears had a time budget dominated by passivity (Koene 1994). Thus, measurement of bear welfare in terms of behavior alone is complicated, because passive behavior could be quiet rest and sound sleep, but it could also be passive behavior due to stress. Measurement of heart rate or other physiological parameters could resolve this dilemma. However, such measurements are impractical.

Interactions with the wolves were quickly settled, and no problems or interactions occurred after the first attacks. Although in the wild these species interact strongly around food (the bear wins, the wolf is too fast to get hurt), both species avoid each other in other contexts.

### Daily Life

The strong individual differences found in the release phase remained in the daily life phase. Fiona slept more,

was less alert, was not social, and appeared very different from Bora or Koröglü. Sex differences could explain part of the observations, but other female bears were much more active and playful than Fiona.

During the average day, behavior changes were most strongly related to the presence of food. During the morning all bears feed for about 1 hour, and after 1530 most animals also fed for 1 hour. Between times, social behavior was seen in all animals, especially Koröglü and Bora, with peaks after feeding at 1000 and 1400. Wild adult bears often play after successful salmon (*Oncorhynchus* spp.) fishing (Egbert and Stokes 1976). The time budgets of the male blind bears during daily life show social behavior, and play may indicate good welfare. In the female blind bear, the lack of social behavior may indicate suboptimal welfare.

### Play

The playing bouts of the bears in the study area were often difficult to distinguish, because often >2 animals played in short, alternating bouts. However, it was obvious that much time was allocated for playing. From the preliminary data, no clear-cut preference of blind bears and other bears as playing partners was seen. There were, however, strong individual preferences (data not shown). Differences in behavioral transitions and communication between pairs of playing partners must be investigated in more detail to discover the basis of these preferences.

A small difference in play behavior pattern of the blind and other bears was found. The difference points to the possibility that tactile contact is essential for blind bears to continue the play.

### General

Transportation of the blind bears from Turkey to the Netherlands gave the opportunity to monitor the adaptation of these bears to a new environment. Vision in bears appeared to be less essential for survival under captive conditions than initially thought. The male blind bears interacted socially with wolves and other bears. The behavior of the female bear was less easy to interpret in terms of welfare because individual animals can differ in their coping styles (Schouten and Wiepkema 1991); she can have a coping style in this environment that differs from other bears. The amount of her stereotypies increased and decreased drastically during the release phase, but this type of behavior does not reliably indicate reduced welfare when the consequence of reduction is an increase in passive behavior. Play behavior is possibly a better indicator of the welfare of bears (Fagen 1981, Fagen and Fagen 1990), especially when it occurs in

adult brown bears (Colmenares and Rivero 1983). The division in 3 phases for the study of the bear behavior was rather successful, although the release could have been done faster in initial stages and somewhat more thoroughly in later stages when the blind bears were confronted with other animals. In fact, too few data were collected concerning interactions between blind bears and bears that can see and between blind bears and wolves. Further, a more detailed and individually directed approach could reveal more about the adaptation of the blind bear to new stimuli. The observation of the blind bears continues at Ouwehands Zoo.

## MANAGEMENT IMPLICATIONS

Captive management of blind former dancing bears seems to be easy. Gradual release in well-considered stages and evaluation of the reactions of the blind bears and other residents in the enclosure determines the steps forward. No special precautions seem to be necessary. Only occasionally food must be given in front of them when competition with wolves and other bears is intense. Use of the whole enclosure is prevented by the way the blind bears remember the fencing; the bears use only a portion of the northern part of the enclosure. Thus we cannot determine their home-range and optimal enclosure size. It appears that the male blind bears were well adapted to their new environment and its residents.

## CONCLUSION

Blind brown bears were able to adapt to a large bear enclosure with an electric fence, ponds, other bears, and wolves. A decrease in stereotypies and an increase in play behavior was found that may indicate improved welfare. However, individual differences hampered the interpretation, as interpretations were based only on overt behavior. Physiological measures and a more detailed analysis of play behavior are necessary to get better insight in the welfare of these bears.

## LITERATURE CITED

- AMES, A. 1993. The behaviour of captive polar bears. Universities Federation for Anim. Welfare. Animal Welfare Res. Rep. 5. Univ. Fed. Anim. Welfare, Herts, U.K.
- BAARS, G. 1994. International Bear Foundation. Pages 23–25 in G.M. Dorrestein and M. Kahraman, eds. Proc. Int. Conf. Aspects of Bear Conserv. in Bursa, Turkey. Wild. Res. Cent., Bursa, Turkey.
- BEKOFF, M. 1972. The development of social interaction, play, and metacommunication in mammals: an ethological perspective. *Q. Rev. Biol.* 47:412–434.
- BENUS, R.F., S. DEN DAAS, J.M. KOOLHAAS, AND G.A. VAN OORTMERSSEN. 1990. Routine formation and flexibility in social and non-social behaviour of aggressive and non-aggressive male mice. *Behaviour* 112:176–193.
- CARLSTEAD, K., J. SEIDENSTICKER, AND R. BALDWIN. 1991. Environmental enrichment for Zoo bears. *Zoo Biol.* 10:3–16.
- COLMENARES, F., AND H. RIVERO. 1983. Male–male tolerance, mate sharing and social bonds among adult male brown bears living under group conditions in captivity. *Acta Zool. Fenn.* 174:149–151.
- CRONIN, G.M. 1985. The development and significance of abnormal stereotyped behaviors in tethered sows. Ph.D. Diss., The Agric. Univ. of Wageningen, The Netherlands. 146pp.
- EGBERT, A.L., AND A.W. STOKES. 1976. The social behavior of brown bears on an Alaskan salmon stream. *Int. Conf. Bear Res. and Manage.* 3:41–56.
- FAGEN, R. 1981. Animal play behavior. Oxford Univ. Press, New York, N.Y. 684pp.
- , AND J. FAGEN. 1990. Play behavior of brown bears (*Ursus arctos*) and human presence at Pack Creek, Admiralty Island, Alaska. *Int. Conf. Bear Res. and Manage.* 8:315–319.
- HENRY, J.D., AND S.M. HERRERO. 1974. Social play in the American black bear: its similarity to canid social play and an examination of its identifying characteristics. *Am. Zool.* 14:371–389.
- KOENE, P. 1994. The ex-dancing bears in Bursa: behavioral problems. Pages 73–84 in G.M. Dorrestein and M. Kahraman, eds. Proc. Int. Conf. Aspects of Bear Conserv. in Bursa, Turkey. Wild. Res. Cent., Bursa, Turkey.
- . 1995. The use of time budget studies in captive propagation and zoo biology. Pages 272–284 in U. Ganslosser, J.K. Hodges, and W. Kaumanns, eds. Research and captive propagation. Filander Verlag (GmbH), Fuerth, Germany.
- LATOUR, P.B. 1981. Interactions between free-ranging, adult male polar bears (*Ursus maritimus* Phipps): a case of adult social play. *Can. J. Zool.* 59:1775–1783.
- LAWRENCE, A.B., AND J. RUSHEN. 1993. Stereotypic animal behaviour: fundamentals and applications to welfare. Cent. for Agric. and Biosci. Int., Wallingford, U.K.
- MARTIN, P., AND P.P.G. BATESON. 1993. Measuring behaviour. Cambridge University Press, Cambridge, U.K.
- MEYER-HOLZAPFEL, M. 1968. Abnormal behavior in zoo animals. Pages 476–503 in M.W. Fox, ed. Abnormal behavior in animals. W.B. Saunders Company, Philadelphia, Pa.
- MURIE, A. 1985. The grizzlies of Mount McKinley. Univ. Wash. Press, Seattle. 251pp.
- NOLDUS, L.P.J. 1991. The observer: a software system for collection and analysis of observational data. *Behav. Res. Methods Instruments and Computers* 23:415–429.
- SAS INSTITUTE, INC. 1990. SAS/ETS user's guide, version 6. SAS Inst., Cary, N.C.

- SCHOUTEN, W.G.P. AND P. KOENE. In Press. Heart rate and development of stereotypies in tethered pigs. *In* W.G.P. Schouten, and V. Wiegant, eds. Stress, welfare and pathology. Section of Ethology, Wageningen, The Netherlands.
- , AND J. RUSHEN. 1992. Effects of naloxon on stereotypic and normal behaviour of tethered and loose-housed sows. *Appl. Anim. Behav. Sci.* 33:17–26.
- , AND P.R. WIEPKEMA. 1991. Coping styles of tethered sows. *Behav. Proc.* 25:125–132.
- VAN OORTMERSEN, G.A., I. BENUS, AND D.J. DIJK. 1985. Studies in wild house mice: genotype-environment interactions for attack latency. *Netherlands J. Zool.* 35:155–169.
- WECHSLER, B. 1991. Stereotypies in polar bears. *Zoo Biol.* 10:177–188.
- WIEPKEMA, P.R., W.G.P. SCHOUTEN, AND P. KOENE. 1993. Biological aspects of animal welfare: new perspectives. *J. Agric. Environ. Ethics* 6:93–103.