International Zoo News Vol. 51, No. 3 (2004), pp. 140–146

A PRELIMINARY EVALUATION OF THE EFFECTS OF BEHAVIOURAL ENRICHMENT ON STEREOTYPICAL BEHAVIOUR OF COATIS

BY M.D. WILLEMSEN, P.J. VAN DEN BRINK AND J.H. VAN WEERD

Introduction

In zoos behavioural enrichment is often used as a tool to increase the opportunities for a captive animal to perform its species-specific behaviours, by making the captive environment more complex and variable (Carlstead, 1996). It is known that behavioural enrichment can decrease abnormal and stereotypic behaviour and increase normal natural behaviour by fulfilling basic behavioural needs (Shepherdson, 1989; Powell, 1995). Behavioural enrichment can also educate the visitors and enhance the image of a 'wild' animal, by showing it performing natural behaviours (Hutchins *et al.*, 1984; Mellen *et al.*, 1981). Furthermore, the more natural behaviour the animal shows, the higher the appreciation of the public will be (Reade and Waran, 1996).

Artis Zoo, Amsterdam, the Netherlands, houses two captive-born white-nosed coatis (*Nasua narica*), a male and female (aged respectively five and 11 years), in the same enclosure. This pair display only a few natural behaviours. Most of their observed behaviours are unnatural: the female is resting most of the time and the male performs a stereotypic behaviour, a 'head toss' (Smith, 1980), throughout the day. The aim of this pilot study was to identify the impact of various behavioural enrichment items on the stereotyped behaviour of the male coati. Furthermore, two different observational methods of analyzing this impact on the male's behaviour were compared.

Methods

The study was concentrated on the male coati, who displayed a stereotypic head toss. Observations were done three days a week (200 minutes a day); six days of control observations and 1–2 days for each separate enrichment item. Table 1 summarizes the enrichment items used and the sensory modification and observation periods involved. Two observation methods were used to record the behaviour (see Table 2 for short description) of the male coati: (1) A continuous sampling concentrating on the stereotyped head toss during the observation period. This data set is expressed as the number of recorded stereotyped behaviours per minute. (2) A time-sampling method with one-minute intervals for all behaviours (i.e. the stereotyped behaviour and the favoured behaviours). At one-minute intervals it was recorded whether the behaviour occurred or not. This data is expressed as a fraction of the total amount of observations.

Table 1. The enrichment items used during this study, the type of enrichment, the days the enrichment items were observed, and the total days observed.

Enrichment item	Type	Days observed
Browse of Carolina allspice (*Calycanthus floridus*)	olfactory	2
Burlap (sacking) with heather	olfactory	1
Burlap with curry powder	olfactory	1
Burlap with lemon oil	olfactory	2
Branch with valerian extract	olfactory	1
Bowl of water with splash of peppermint mouthwash and mint (*Mentha spicata*) twigs	olfactory	2
Hamster ball with one grasshopper and several mealworms	food-related	1
Hamster ball with one rose-beetle larva and several mealworms	food-related	1
Total days observed		11

Table 2. The behaviours observed, with short descriptions.

Behaviour	Description
Active	walking
Inactive	resting
Stereotypic behaviour	head toss
Social behaviour	interaction between male and female
Enrichment response	interaction with enrichment item
Favoured natural behaviour	a. self-grooming b. grubbing

A log-normal distribution of the data was assumed. This distribution was initially chosen because of the left limit of the data (observations < 0 are not possible). Before analysis it was checked whether the data were log-normal distributed using the Kolmogorov-Smirnov test (Sokal and Rohlf, 1981). The cumulative distribution of the data was analyzed using log-logistic regression (see e.g Aldenberg and Slob, 1993, for an example). The cumulative distribution was plotted and the 10th, 50th and 90th percentiles of this distribution and their uncertainty were calculated. These cumulative distributions of the favoured behaviours (summation of grubbing and self-grooming) and stereotyped behaviour (for both observation methods) were calculated for both the control and enrichment data set. The placement of the distribution of the 'enrichment' observations versus the distribution of the 'control' distribution indicates whether the enrichment as a total had an effect on stereotyped and favoured behaviour. For each separate enrichment item, its placement within the control distribution could be calculated. This percentage indicates how extreme each enrichment observation is compared to the control observations.

Results

Figure 1 shows that enrichment as a whole had a slight decreasing effect on the number of times the male displayed stereotypic behaviour per minute, recorded according to the continuous observation method. In the 50% and 90% level of the cumulative distribution this difference was even significant, the confidence intervals of both distributions showed no overlap (Table 3). Half of the observations had to be deleted because the animals were resting too much (i.e. inactive for five minutes or more). It must be noticed that the most extreme control observation (2.4 stereotypic behaviours per minute in Figure 1) was determined on a day when the animals were extremely inactive (resting 34% of the time).

Figure 1. Cumulative distribution of the control and enrichment data for the stereotyped behaviour of the male coati recorded with the continuous sampling method, expressed in the number of recorded stereotyped behaviours per minute.

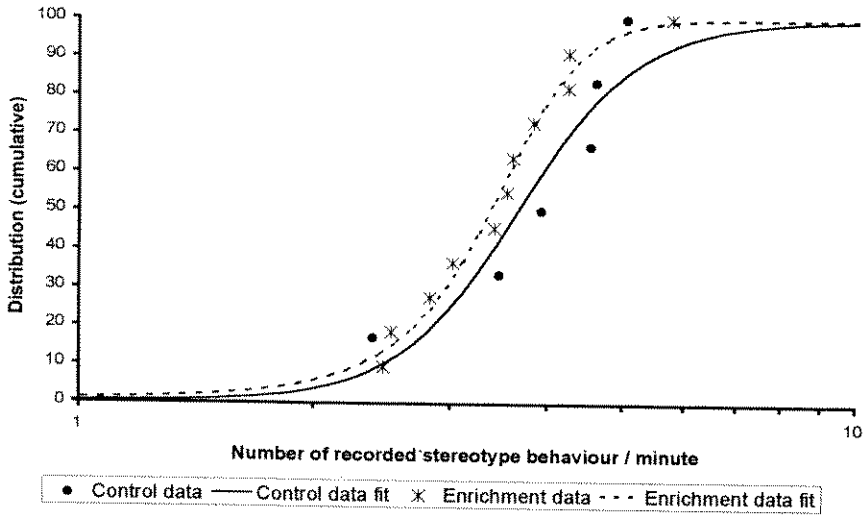


Table 4 shows the placement of the individual enrichment data within the control distribution. The browse of Carolina allspice is the enrichment item placed most extremely in the control distribution, and is hereby indicated to be associated with the lowest amount of stereotypic behaviour. Although not placed very extremely within the control distribution (not within 5% level), an indication of a decreasing influence on stereotypic behaviour is present, because also the second best observation was done when the browse was present. When the extreme control observation is left out of consideration, the upper four enrichment observations fall within the 5% level of the control observations and are thus indicated to have significantly reduced the

Table 3. 10%, 50% and 90% level of the distribution (respectively expressed as number of recorded stereotyped and favoured behaviour per minute) and their 95% confidence interval of the control and enrichment data for the stereotypic behaviour of the male coati recorded with the continuous sampling method (method 1) and time sampling method (method 2) and the favoured behaviour recorded with method 2.

Stereotyped behaviour: continuous sampling method (1)

Level	*Control*	*Enrichment*
10%	2.2 (1.9–2.3)	2.2 (2.1–2.3)
50%	3.7 (3.6–3.8)	3.4 (3.3–3.4)
90%	6.3 (5.7–6.9)	5.2 (4.9–5.5)

Stereotyped behaviour: time sampling method (2)

Level	*Control*	*Enrichment*
10%	0.08 (0.07–0.09)	0.09 (0.08–0.09)
50%	0.13 (0.13–0.14)	0.13 (0.13–0.13)
90%	0.22 (0.20–0.24)	0.19 (0.18–0.20)

Favoured behaviour: time sampling method (2)

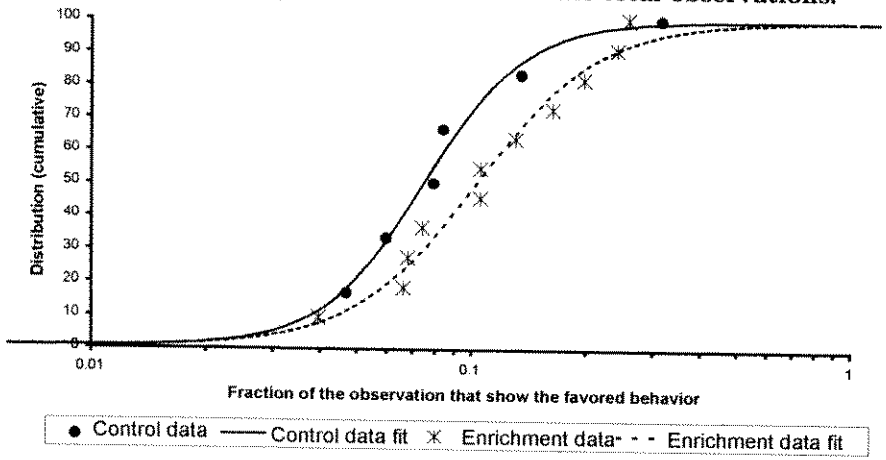
Level	*Control*	*Enrichment*
0%	0.03 (0.03–0.04)	0.03 (0.03–0.04)
50%	0.08 (0.07–0.08)	0.10 (0.10–0.11)
90%	0.19 (0.16–0.23)	0.31 (0.27–0.36)

Table 4. Placement of the enrichment items observations within the control distribution for the stereotypic behaviour of the male coati recorded with the continuous sampling method. N.B. Some items were observed on two days (see Table 1).

Enrichment	*% level*
Browse of Carolina allspice	10
Browse of Carolina allspice	11
Burlap with heather	19
Branch with valerian extract	25
Bowl of water with splash of mouthwash (mint) and mint twigs	40
Hamster ball with 1 living grasshopper and mealworms	45
Burlap with lemon oil	48
Hamster ball with 1 rose-beetle larvae and mealworms	56
Burlap with curry powder	69
Burlap with lemon oil	70
Bowl of water with splash of mouthwash (mint) and mint twigs	93

stereotyped behaviour of the male. The decreasing influence of the enrichment on the stereotyped behaviour is not present when the time-sampling method (Method 2) is used. In the 50% and 90% level of the cumulative distribution this difference was not significant; the confidence intervals of both distributions showed overlap (results not shown). Recording with the time-sampling method, the data on the favoured behaviour (grooming and grubbing), as displayed by the male, were indicated to be positively influenced by enrichment (Figure 2). At the 50% and 90% level this difference is even significant. Three enrichment types (browse of Carolina allspice, burlap with heather, hamster ball with rose-beetle larvae and mealworms) fall within the upper 5% tail of the control distribution and thus are indicated to have significantly and positively influenced the favoured behaviour.

Figure 2. Cumulative distribution of the control and enrichment data for the favoured behaviours of the male coati recorded with the time sampling method, expressed in fraction of the total observations.



Discussion

This preliminary study was done to assess the short-term effect of several enrichment items on the behaviour of the male coati. It was found that browse of Carolina allspice, burlap with heather and branch with valerian extract were associated with the lowest amount of stereotyped behaviour, whereas Carolina allspice, burlap with heather and the hamster ball with rose-beetle larvae and mealworms positively influenced the favoured behaviours, self-grooming and grubbing. It is known that coatis in the wild and in captivity self-groom with aromatic substances (Trager and Germaton, 1997; Gompper and Hoylman, 1993; Smith, 1980; Reiger, 1979; Kaufmann, 1962). In the wild, coatis groom their fur with aromatic sap from caraño (*Trattinnickia aspera*) (Gompper and Hoylman, 1993). Reiger (1979) showed that coatis in captivity self-groom with aromatic substances as well. In the study by Trager and Germanton (1997),

captive coatis groomed with strong-smelling cleaning compounds when keepers cleaned the enclosure daily.

By giving the animals an olfactory stimulus, one of the species-specific behaviours could be displayed, in this case self-grooming, and enrichment could thus fulfil the animal's behavioural need (Shepherdson, 1989; Powell, 1995). By using olfactory enrichment the natural self-grooming behaviour of the animals is elicited and maintained. Moreover there is no risk of overfeeding the animals, it is quick to prepare and put into the enclosure and it has a (semi-) natural appearance.

The decreasing effect of the enrichment on the stereotyped head toss of the male coati only showed when the stereotyped behaviour was recorded continuously. The time sampling method did not show this effect, however it did show that enrichment had a positive effect on the favoured behaviours. The reason why the effect on the stereotyped behaviour did not show with the interval observations could be that, although the behaviour was very frequent, the performance of the stereotyped behaviour only takes a few seconds. Recording behaviour with a time sampling method enlarges the probability of missing the specific behaviour. To prevent this, shorter intervals should be taken and focal animal sampling could be used, although for a behaviour of short duration, it seems best to observe the behaviour as it happens (Altmann, 1974).

Both the favoured behaviours, self-grooming and grubbing, are more durable, and thus the effect could be shown with the time sampling method. Time sampling seems the only way to analyze the effect of enrichment on these behaviours. They are hard to count as they occur, because there is no defined boundary or specific behavioural pattern to distinguish. For this pilot study, however, the combination of both methods proved to work, because the impact of the enrichment items on the three behavioural categories of the male coati were clearly shown in one study.

Conclusions

1. The presence of some types of behavioural enrichment diminishes the head tossing of the male coati.
2. The presence of some types of behavioural enrichment increases such natural favoured behaviours as self-grooming and grubbing.
3. The browse of Carolina allspice had the most positive effect on the stereotyped behaviour and favoured behaviours.
4. A combination of observation methods (continuous sampling for one behaviour and time sampling) seems to be the best method to observe the impact of enrichment items on the behaviour of the male coati.

Acknowledgements

We would like to thank the animal keepers of the coatis (Mr Joop Jansen, Ms Monique Versloot-Golstein and others) for their assistance and Ms Ceciel Lamers, assistant animal manager, for her ideas and help with the organization of the project.

Products mentioned in the text

Curry powder, Albert Hein, the Netherlands.
Hamster ball, Pets International Ltd, the Netherlands.

Lemon oil (Citronella olie), Kruidvat, the Netherlands.
Peppermint mouthwash, Colgate, the Netherlands.
Valerian extract, the Essential Oil Company, the Netherlands.

References

Aldenberg, T., and Slob, W. (1993): Confidence limits for hazardous concentrations based on logistically distributed NOEC toxicity data. *Ecotoxicology and Environmental Safety* 25: 48–63.

Altmann, J. (1974): Observational study of behaviour: sampling methods. *Behaviour* 49: 227–267.

Carlstead, K. (1996): Effects of captivity on the behavior of wild mammals. In *Wild Mammals in Captivity: Principles and Techniques* (eds. D.G. Kleiman, M.E. Allen, K.V. Thompson and S. Lumpkin), pp. 317–333. University of Chicago Press, Chicago and London.

Gompper, M.E., and Hoylman, A.M. (1993): Grooming with *Trattinnickia* resin: possible pharmaceutical plant use by coatis in Panama. *Journal of Tropical Ecology* 9: 533–540.

Hutchins, M., Hancocks, D., and Crockett, C. (1984): Naturalistic solutions to the behavioral problems of captive animals. *Der Zoologische Garten* 54: 28–42.

Kaufmann, J.H. (1962): Ecology and social behavior of the coati, *Nasua narica*, on Barro Colorado Island, Panama. *University of California Publications in Zoology* 60: 95–222.

Mellen, J.D., Stevens, V.J., and Markowitz, H. (1981): Environmental enrichment for servals, Indian elephants, and Canadian otters at Washington Park Zoo, Portland. *International Zoo Yearbook* 21: 196–201.

Powell, D.M. (1995): Preliminary evaluation of environmental enrichment techniques for African lions (*Panthera leo*). *Animal Welfare* 4: 361–370.

Reade, L.S., and Waran N.K. (1996): The modern zoo: how do people perceive zoo animals? *Applied Animal Behaviour Science* 47: 109–118.

Reiger, I. (1979): Scent rubbing in carnivores. *Carnivore* 2: 17–25.

Shepherdson, D. (1989): Stereotypic behaviour: what is it and how can it be eliminated or prevented? *Ratel* 16 (4): 100–105.

Smith, H.J. (1980): Behaviour of the coati (*Nasua narica*) in captivity. *Carnivore* 3 (1): 88–136.

Sokal, R.R., and Rohlf, F.J. (1981): *Biometry*. W.H. Freeman and Co., New York.

Trager, G.C., and Germanton, H. (1997):. Coatimundis enrich their own lives in nature by putting on the perfume, so why not let them do it in captivity? In *Proceedings of the Third International Conference on Environmental Enrichment*, pp. 150–154. Sea World, Orlando, Florida.

M.D. Willemsen [1], P.J. van den Brink [2] and J.H. van Weerd [3,4].
[1] temporary address: Artis Zoo, P.O. Box 20164, 1000 HD Amsterdam, The Netherlands.
[2] Alterra Green World Research, P.O. Box 47, 6700 AA Wageningen, The Netherlands.
[3] Artis Zoo, P.O. Box 20164, 1000 HD Amsterdam, The Netherlands (e-mail **h.vanweerd@artis.nl**).
[4] corresponding author.