THE EFFECT OF A MOVING BAIT ON THE BEHAVIOUR OF CAPTIVE CHEETAHS (*ACINONYX JUBATUS*)

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Abstract *Animal Welfare 1996, 5:* 271-281

*Members of the cat family are highly motivated to hunt, but in captivity are unable to do so for a variety of reasons. This inability to hunt may reduce their welfare. In this study we used a moving bait to stimulate and release hunting motivation in two captive cheetahs (*Acinonyx jubatus*). Essentially our enrichment device consisted of a dead rabbit, hung from a pulley, just above the ground, moving down a 34 metre length of wire by the force of gravity. We observed the cheetahs for 140 minutes per day over three sequential food presentation periods: Baseline (10 consecutive days), Device (10 consecutive days) and Post-device (5 consecutive days). The moving bait significantly increased the frequency of sprinting (hunting) and time spent performing observations. It significantly decreased time spent in affiliation and feeding. These effects were also observed at times other than when the moving bait was presented. Thus, a moving bait allows captive cheetahs to perform 'natural-looking' hunting in captivity.*

Keywords: *animal welfare, cheetahs, environmental enrichment, exercise, hunting*

Introduction

Captive-housed members of the cat family (Felidae) present a special challenge to their caretakers, namely providing them with the opportunity to hunt. It has been suggested that cats are highly motivated to hunt (eg Leyhausen 1979; Beaver 1980; Shepherdson *et al* 1993; Shepherdson 1994), and that if an animal does not have an outlet for a strong motivation then its welfare may be reduced (Hughes & Duncan 1988). In captivity the lack of opportunity to hunt may result in lethargy, boredom, stereotypies and poor physical condition (Lindburg 1988). Few zoos offer live prey because it is considered inhumane, would be offensive to members of the public, or because offering disoriented prey to a carnivore would only result in a quick kill (Snyder 1977); and in the United Kingdom (*Protection of Animals Act 1911; 1912* Scotland) it is illegal.

The declining status of cheetahs (*Acinonyx jubatus*) in the wild and the poor breeding record in captivity has focused attention on their physiology, disease pathology, genetics, nutrition, reproductive and maternal behaviour (see Zoo Biology 1993: 12 (1), a special edition devoted to cheetahs). However, we know of no formal studies on the behavioural benefits of hunting for captive cheetah.

Cheetahs unlike most other members of the cat family, depend upon speed and not stealth to capture their prey (Amman & Amman 1985) and show many anatomical and physiological adaptations for high speed running (O'Brien *et al* 1985). The hunting of free-living members of the cat family can be divided into four stages: location of prey, pursuit, the kill and behaviour after the kill (Lindburg 1988).

Cheetahs depend on sight to locate their prey and have a horizontal visual streak on the retina of the eye to enable them to locate prey moving on the horizon (Hughes 1977). Once located, the prey is often approached using available cover. The distances at which prey are pursued is dependent upon its vulnerability (Bertram 1979; Caro 1986); chases are relatively short (a few hundred metres) and fast. Runnning at full speed is used to draw close to the prey, which is then followed at a slower speed (Schaller 1972). Cheetahs usually only capture prey whilst it is running, and usually strike the prey with a fore-leg or trip it up (Eaton 1972; Lindburg 1988). Once felled the prey is usually killed by strangulation (Schaller 1972; Lindburg 1988). Cheetahs are normally exhausted after the chase and often rest for up to thirty minutes in the shade before feeding, a behaviour which also reduces detection by other large carnivores which might steal the carcase (Lee 1992).

Providing captive cats with appropriate stimulation to elicit and perform hunting may result in a more natural time budget, and increase the diversity of behaviours expressed. This in turn might help to prevent the development of stereotypic behaviours (see Lawrence & Terlouw 1993) and stimulate activity. It has been suggested that allowing captive cheetahs to hunt improves breeding success (Eaton & Craig 1973). It has also been suggested that lack of exercise in a species whose liver is adapted for sudden mobilization of energy may be a contributing factor to liver disease (Eaton 1974), one of the major causes of mortality in captive cheetahs (Lee 1992). In this study we report the behavioural consequences of a moving bait that allowed captive cheetahs to perform most aspects of species-specific hunting.

Methods

Subjects and housing

The subjects were a six-year-old male and a three-year-old female cheetah (*Acinonyx jubatus*). Both were captive-born and housed together outdoors at the Scottish National Zoological Park (Edinburgh, UK). The enclosure measured 14x34m and was sited on a grassy slope of approximately 20 degrees (see Figure 1). Furnishing consisted of two kennels (measuring 1.4x2.0m and 1.5x2.0m), a water bowl filled daily, and shrubs and dead tree trunks arranged as a 'viewing platform' (tt). The view from the enclosure included: hoofstock (blackbuck, *Antilope cervicapra*), the public and a valley below. During the whole of the experimental period both cheetahs were each fed one whole dead rabbit (*Oryctolagus cuniculus*) per day whilst the enclosure was cleaned, between 0915h and 0935h. During the experiment there was: an average of 5.4 hours ± 0.3 (SD) of sunshine per day; an average rainfall of 2.3mm ± 0.3 (SD) per day; maximum average daily temperature was 17.3°C ± 0.2 (SD); and minimum average daily temperature was 9.0°C ± 0.2 (SD). These cheetahs had not been subjects of a hunting enrichment study before.

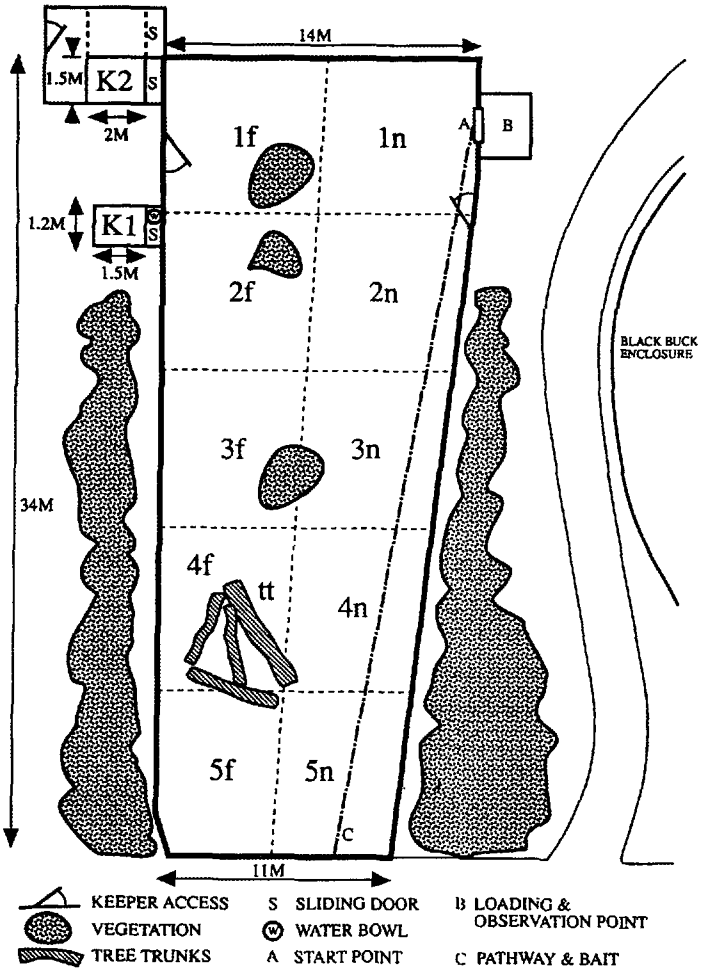

Figure 1 **Diagram of the cheetahs' enclosure.**

The enrichment device

The device consisted of two steel pulley carriages with 58mm pitch nylon pulleys, running on approximately 34m of 3mm diameter galvanized steel wire with a stop clamp to prevent the pulleys running to the end (see Figure 2; designed by John Carruthers, Robert J Young and Beverley G Williams; constructed by the Scottish Centre for Agricultural Engineering, Bush Estate, Penicuik, Midlothian, EH26 0PH, UK). The wire was connected to the perimeter fence at the top and the bottom of the slope by a 6mm standard turnbuckle (allowing wire tension adjustment) and a 6mm standard bolt hook. The bottom-most pulley carriage contained two cup roller clutch bearings to prevent it running back when it had travelled to the bottom of the wire. Suspended beneath the bottom-most pulley was a 4.725kg steel counter weight and beneath the top pulley carriage was a lightweight of 650g. The top pulley carriage was connected to the top fence by 30m of 3mm diameter nylon cord, which tied off at different lengths varied the length that the pulleys could travel down the wire. The two pulleys were loosely joined by a steel wire. The bait was suspended from a crocodile clip just above the ground and centrally between the two pulleys by a loop of nylon cord connected to each pulley. The device was activated by dropping the bait over the fence, and letting the pulleys and bait run down the wire from the top of the enclosure to the bottom; under the force of gravity. The pulleys and bait ran down the wire together until the top-most pulley was stopped by the nylon cord. Then the wire connecting the two pulleys straightened, releasing the bottom-most pulley, which continued to run down the wire until stopped by the nylon loop connecting both pulleys. This resulted in the bait being lifted out of reach of the cheetahs, if it had not been caught.

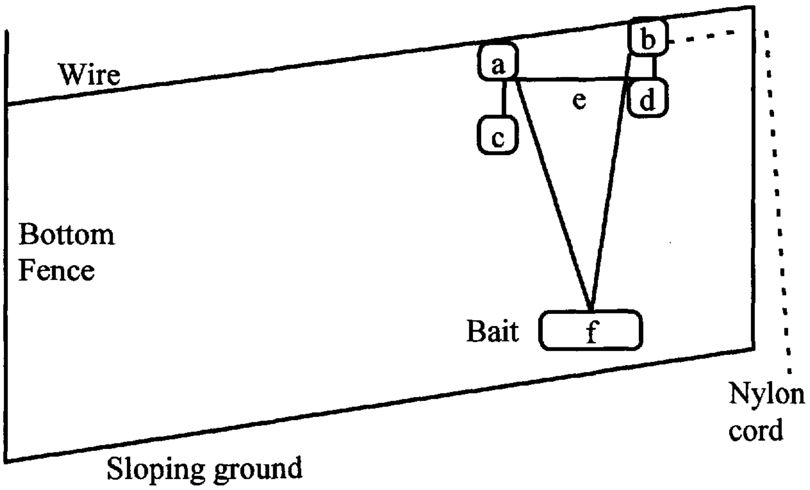

Figure 2 **Schematic diagram of the enrichment device within the enclosure: a = bottom pulley, b = top pulley, c = steel counter weight, d = lightweight, e = steel wire, f = dead rabbit.**

Data collection

The enclosure was divided into 13 sections for recording purposes (the 10 areas labelled 1 to 5, f and n, the tree trunk tt and the two kennels – see Figure 1), and the behaviour and enclosure use of the cheetahs were observed sequentially under three regimes of food presentation over a two-month period:

1 Baseline: on ten consecutive days, the cheetahs were fed according to the normal procedure (see above). This period was immediately followed by a two-week period when both cheetahs were trained to take their food from the device (see Table 1).

2 Device: on ten consecutive days, the cheetahs were each fed one whole rabbit from the device.

3 Post-device: the device period was immediately followed by a two-week return to baseline conditions, during which five consecutive days of observations were made (post-device). On all these days, feeding was again according to normal procedures.

Table 1 **Training regime.**

Days	Procedure followed
1–2	Runners fixed together to prevent bait rising at the end of the run. Bait lowered down the enclosure slowly by hand, moved back and forth at the bottom until a cheetah showed signs of taking it.
3–6	Runners fixed, bait run under weights, but slowed by friction from a gloved hand.
7–8	Runners fixed, bait at full speed.
9–13	Runners unfixed to allow bait to rise out of reach at the end of the run, bait at full speed.

During all three feeding regimes behavioural observations were made from one hour before feeding, for the 20 minutes during cleaning and feeding and for one hour after cleaning had finished. The recorded behaviours are described in Table 2. The behaviours were recorded using instantaneous point sampling (Martin & Bateson 1986) at 30 second intervals, except for sprinting whose absolute frequency was also recorded. During the device feeding sessions it was noted whether there was a chase, and the method of capturing the bait.

Table 2 **Ethogram.**

Behaviour	Description
Sleeping	Lateral lying with head down and eyes closed
Resting	Ventral or lateral lying with head raised and eyes open
Resting alert	Crouching, leaning on elbows from a laterally recumbent position or sitting
Standing	Self explanatory
Walking	Self explanatory
Sprinting	Running or trotting
Playing	Directing 'non-serious' behaviour at objects, self or mate
Feeding	All behaviours concerned with the consumption of food
Grooming	Licking or biting at fur or paws (auto- or allo-grooming)
Affiliation	Resting or sleeping within three feet of mate, or interacting in an amicable way
Sniffing	Olfactory investigation of the enclosure or mate
Observation	Interrupting current behaviour to stare at stimulus
Other	All other behaviours including out-of-sight

Statistical analysis

Behaviour and enclosure use recorded under each regime of food presentation were expressed as daily percentages. Differences between feeding regimes were determined by a Kruskal-Wallis one-way non-parametric analysis of variance test using MINITAB version 7.2 (see Ryan *et al* 1985). Significant differences between feeding regimes were then further explored in a pairwise manner using Mann-Whitney Tests (see Ryan *et al* 1985).

To compare the diversity of behaviour under each feeding regime, a Shannon diversity index (Shannon & Weaver 1949) was calculated each day. This index is commonly used as an ecological measure of species diversity, however, it has been used to assess behavioural diversity (Shepherdson 1994). It is calculated by the formula:

$$H = \Sigma p_i \log (1/p_i)$$

where p_i is the proportion of time engaged in the ith behaviour. The value of the index depends partly on the number of behaviours in the sample, and partly on the equality of the distribution of time between behaviours. Larger values of H indicate greater diversity. Kruskal-Wallis and Mann-Whitney tests were then used to detect any effect of feeding regime.

Space utilization was assessed using the spread of participation index (Dickens 1955; Traylor-Holzer & Fritz 1985) which is calculated by the formula:

$$S = \frac{M(n_b - n_a) + (F_a - F_b)}{2(N-M)}$$

where N = total number of observations made on the subject; M = mean frequency of observations in all enclosure sections: N divided by number of sections; n_b = number of sections with a frequency less than M; n_a = number of sections with a frequency greater than M; F_a = total number of observations in sections with frequency greater than M; F_b = total number of observations in sections with frequency less than M. An S value of 1 indicates minimum space utilization, with the cheetahs spending all their time in one section, a value of 0 indicates maximum space utilization with all sections used equally. S was calculated for each treatment in order to give a measure of overall enclosure use under each condition. A value (S_D) was also calculated daily, and Kruskal-Wallis and Mann-Whitney tests were used to detect any effect of feeding regime.

Results

The cheetahs required two weeks of training before they would chase and capture the moving bait from the behavioural enrichment device. Once trained, both cheetahs, upon sighting the keeper, would crouch about 5m from the point where the bait entered the pen and would typically wait until the bait had travelled 10m before sprinting after it. The cheetahs usually drew level with the bait after it had travelled 25 to 30m and then captured it by striking it off the device using a fore-limb. Once captured the bait was first held down with the fore-limb and then transferred to the mouth. The bait was then carried several metres away from the device and consumed immediately. Once trained the cheetahs chased the bait on all occasions and swiped it off with a forepaw before the end of the run.

Behaviour

The time budgets for behaviour in the three feeding regimes are given in Figure 3. The significant effects of the feeding regimes on behaviour are given in Table 3. Frequency of sprinting was significantly higher (three times) during the Device feeding regime. Subsequent post-hoc pairwise testing revealed that the significant difference in sprinting resulted only from a significant difference between baseline and device (Table 3).

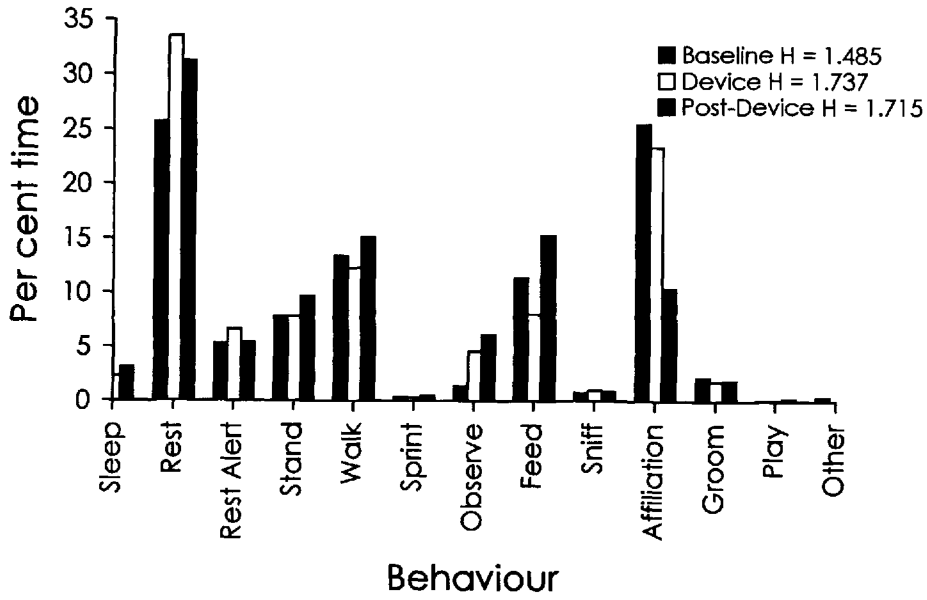

Figure 3 **Time budget of behaviour. H = Shannon diversity index.**

Table 3 **Significant effects of feeding regimes on behaviour.**

Behaviour	Kruskal-Wallis (H value[a])	Mann-Whitney Test Comparisons of Feeding Regimes (W value)		
		Baseline vs Device	Device vs Post-device	Baseline vs Post-device
Observation	21.39***	262***	296	227***
Feeding	10.34**	504*	247**	290
Affiliation	10.98**	460	358*	386***
F. Sprinting	6.43*	328*	266	319
H	9.97**	302**	317	259*

[a] all $df = 2$; $*P < 0.05$; $**P < 0.01$; $***P < 0.001$. H = Shannon diversity index; F.Sprinting = frequency of sprinting.

Observing occurred for significantly longer duration during the device feeding regime. For observing the significant differences were found between baseline and device, and between baseline and post-device, but not between device and post-device feeding regimes (Table 3 and Figure 3). This suggests that the enrichment device caused a general stimulation of hunting and not that hunting was increasing with time. Feeding occurred for significantly less time during the device feeding regime (Table 3 and Figure 3).

Affiliation occurred for a significantly shorter duration during post-device compared to the device and during post-device compared to baseline feeding regime (Table 3 and Figure 3). This suggests either that the withdrawal of the enrichment device caused a decrease in affiliation, or that affiliation was decreasing with time.

There was a significant increase in behavioural diversity between the baseline and device regimes, and between the baseline and post-device regimes, but not between the device and post-device regimes (Table 3 and Figure 3). This suggests that the use of the device produced a general increase in behavioural diversity, rather than an increase with time.

Enclosure use

The time budgets for enclosure use in the three feeding regimes are given in Figure 4. The significant effects of feeding regime are given in Table 4. The use of sections 1n, 1f and k2 (see Figure 1) was significantly reduced in device and post-device regimes compared with the baseline (except k2 baseline versus post-device) regime, while the use of the viewing platform (tt) increased over the three regimes, and was significantly higher in the post-device regime than in the baseline regime (Table 4 and Figure 4). This reflects the increase in the amount of time spent observing, which was usually performed from the viewing point. The S values shown in Figure 4 suggest that space utilization improved with the introduction of the device. However, changes in S_D with regime were not significant.

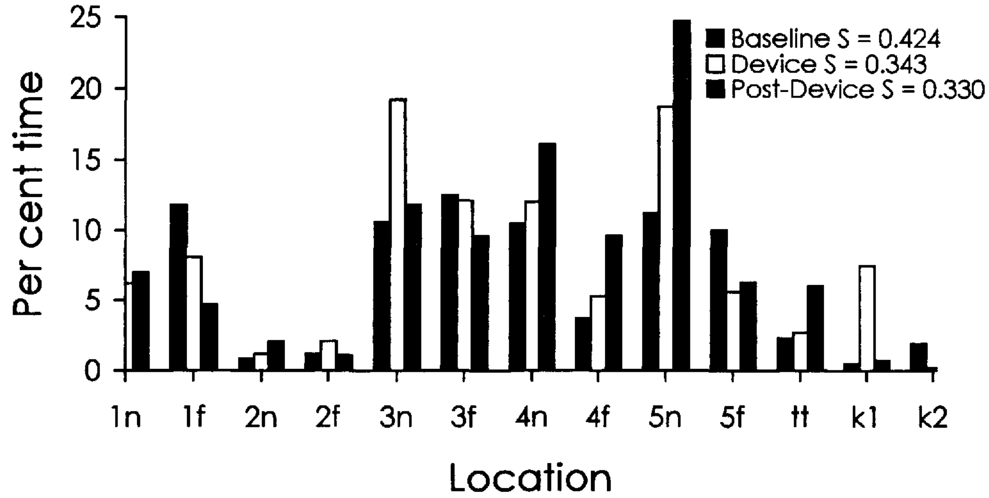

Figure 4 **Time budget of enclosure use. S = spread of participation index.**

Table 4 Significant effects of feeding regimes on enclosure use.

Enclosure section	Kruskal-Wallis (H value[a])	Mann-Whitney Test Comparisons of Feeding Regimes (W value)		
		Baseline vs Device	Device vs Post-device	Baseline vs Post-device
1n	9.66**	510.0**	314.0	366.5*
1f	9.02*	488.0*	344.0	369.5**
tt	6.60*	356.5	266.5	261.0*
k2	6.22*	481.0*	343.0	308.0

[a] all $df = 2$; $*P < 0.05$; $**P < 0.01$

Discussion

There have been few previous attempts to simulate live prey for captive carnivores. Examples include: the 'flying meatball' for servals (*Felis serval*; Mellen *et al* 1981); the 'sqeaking rodent', also for servals (Markowitz & LaForse 1987); and the 'mechanical hare' for a puma (*Felis concolor*; Synder 1976). The latter device was abandoned when the frequency of hunting became quantitatively abnormal (ie the frequency of the behaviour being greater than the range expressed in the wild (Stevenson 1983)), because the puma controlled the appearance of the hare.

The present study differs in that only one successful hunting opportunity was provided for each animal per day. Despite this the effects of the enrichment altered enclosure use and elevated behavioural diversity and hunting activity (frequency of sprinting and time spent observing) throughout the day. These effects also persisted after the enrichment device was no longer being used, demonstrating that some of the effects of hunting enrichment are not transient.

In this study we regarded observation behaviour and the increased use of the viewing point as part of hunting for two reasons. First, cheetahs locate their prey by sight, often from the top of features such as rock outcrops (Hughes 1977). Second, post-introduction of the device, the increase in observation was almost entirely directed at hoofstock in adjacent enclosures.

The significant reduction in time spent feeding during the device feeding regime is surprising since the cheetahs were fed the same amount of food throughout all three feeding regimes. It has been previously reported, that captive felids may release some of their hunting motivation by 'playing' with their food (Stevenson 1983), however, this was never seen in this study. Cheetahs eat quickly in the wild to reduce the chance of their kill being stolen (Lindburg 1988). It is possible that the cheetahs were eating faster because chasing their 'prey' stimulated this behaviour at the kill.

The significant reduction in affiliation from the start to the end of the experiment may have resulted from alterations in the cheetahs' time budget. For example, to spend more time observing, the time allocated to perform other behaviours (eg affiliation) would have to be reduced. It has been suggested that allowing captive cheetahs to hunt improves breeding success (Eaton & Craig 1973). However, it has also been suggested that when maintained in close proximity to males, reproduction in female cheetah is inhibited (Eaton *et al* 1978; Lindburg 1991). Since female cheetahs are normally solitary when not mating, it is therefore possible that these results reflect an ongoing decline in sexual interest temporarily slowed due to the presence of the device.

Animal welfare implications

This study has shown a cheap (approximate cost £150) and practical method of allowing captive cheetahs to hunt. The small sample size of the present study means that we cannot determine whether this device will have beneficial effects, such as improved breeding success or a reduction in liver disease. However, its use made the cheetahs run and, therefore, elicited more intense exercise than expressed before its introduction. The positive effects of exercise are not just physical or physiological, but may also be psychological (Chamove 1986). From our observations it appeared that this device also provided an outlet for the cheetahs hunting motivation and thereby improved their welfare (Hughes & Duncan 1988).

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