



Wildlife Research

Comparison of 2 behavioral sampling methods to establish a time budget in a captive female cheetah (*Acinonyx jubatus*)

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ABSTRACT

Behavioral studies of wild animals kept in captivity provide useful information for conservation programs and animal welfare. These studies can also be time and resource consuming. For this reason, the aim of this study was to develop an ethogram for a semi-imprinted cheetah, during lactation and kept in captivity, and to compare 2 behavioral sampling methods to construct a time budget. During the first 34 days of the study, *ad libitum* sampling was used for describing observed behaviors, which allowed development of an ethogram. During the following 30 days, focal sampling with continuous recording and focal sampling with time sampling (instantaneous sampling) every 60 seconds, aided by 3 cameras, was applied to determine the behavioral time budget. An ethogram composed of 8 categories and 22 behaviors was developed. The cheetah allocated most of her time to resting while lying down with her cubs, the most frequent behavioral category assessed by both methods. Pearson's correlation was significant ($P < 0.05$) for 11 of the 22 behaviors, but only 2 presented a moderate correlation according to the r value (pacing and eating chicken). Allocophagia and pacing with cubs were behaviors described for the first time in cheetahs. These behaviors could be indicative of the inability to perform basic, normal behaviors and may represent a welfare concern. For future studies, the use of cameras located in previously detected areas of use with continuous recording could provide the best method for behavioral studies in captive felids.

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Introduction

Behavioral time budgets can provide important information about the welfare of wild animals kept in captivity when compared with time budgets under natural conditions. Such comparisons allow implementation of environmental enrichment programs, provide understanding about which behaviors should be promoted, and alert caregivers to the development of abnormal behaviors such as stereotypies.

The use of an ethogram is necessary for the evaluation of any animal's time budget (McDonnell, 2003). The behavioral sampling method to be used will depend if we are observing one individual, a group of animals, or a specific behavior. Furthermore, behaviors can

be recorded continuously or at intervals (Martin and Bateson, 2007). Video cameras can also aid behavioral studies, since they allow researchers to review images over time and detect short event behaviors. Choosing a behavioral sampling method for the construction of a time budget can be time consuming and costly, but is crucial when designing behavioral studies.

Cheetahs (*Acinonyx jubatus*) have behavioral, energetic, and intraspecific characteristics that contribute to their low population density (Gros, 2002). The current free-ranging population is probably less than 10,000 mature individuals, being classified as vulnerable in the red list of the International Union for Conservation of Nature (Durant et al., 2015). The poor reproductive performance of cheetahs in captivity has been associated with the behavior and management of the species (Wielebnowski et al., 2002). Researchers working with reproduction of endangered species, such as cheetahs, are usually hampered by limited resources, practical difficulties, and challenging environments (Wildt et al., 2003). Such programs could benefit from behavioral studies to improve the conditions in which cheetahs are kept, which results

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in improved fitness and welfare of these animals (see Chadwick et al., 2013; Quirke and O’Riordan, 2011; Quirke et al., 2012; Wielebnowski et al., 2002). To use assets efficiently, methodology must match goals. For this reason, the aim of this study was to develop an ethogram for a semi-imprinted captive cheetah, and then compare 2 behavioral sampling methods, to determine their practical advantages.

Material and methods

The study was conducted at Cheetah Experience, located in Bloemfontein, Republic of South Africa. The subject of study was a female cheetah of 7 years of age, semi-imprinted, and nursing 2 cubs. The female cheetah was kept in an enclosure of 2,273 m², which included a smaller 25 m² area with a 4 m² kennel (Figure). She was provided *ad libitum* water and chicken meat delivered by park personnel 4 times per day. All food and water was provided in the smaller enclosure. Cleaning of the smallest area in the enclosure was performed daily, during which the cheetah was moved into the biggest area.

Behavioral observation

The first 34 days of the study were used to habituate the cheetah to the presence of the observer and to select the locations where cameras would be installed. During this period *ad libitum* behavior sampling was done to develop an ethogram (Table 1).

Focal sampling with 2 recording methods and 2 media were used in parallel:

- (1) Continuous recording: direct observation by one observer (the same that constructed the ethogram) was used. Exact times and duration of behaviors were registered in a notebook. Over a

period of 30 days, 3 daily observations were conducted, according to natural light availability; morning period (07:00–09:00 hours), midday period (11:00–12:00 hours), and afternoon period (15:00–17:00 hours), completing a total registration time of 7,900 minutes. Any time the cheetah was “out of sight” was also recorded.

- (2) Time sampling (instantaneous sampling): instantaneous sampling every 60 seconds was used following Wielebnowski et al. (2002) and Chadwick et al. (2013), who also observed cheetahs in captivity. The 1-minute interval allowed registering the briefest states of interest according to the observations performed during the first 34-day period. For this, 2 Pentax Optio WG-2 cameras (Pentax Corporation, Tokyo, Japan) were installed in the small area of the enclosure, and 1 security camera was installed inside the kennel. The video information was captured and stored using a digital video recorder (DVR, Provision-isr, Israel). A total of 5,636 sampling points (images), corresponding to the same sampling periods used for the continuous method, were obtained. Behaviors were registered as total frequencies of occurrence. The amount of time the cheetah was “out of sight” was also recorded.

Statistical analysis

Behavioral data, obtained using both methods during the 30-day period, was tabulated in an excel spread sheet. For the time budget, the average percentage of time allocated to each behavior and behavioral category, within the 30-day period, was calculated for each recording method.

For the comparison of the 2 recording methods, a Pearson’s correlation was applied to determine how reliable the methods were in detection and quantification of the behaviors. For these analyses, statistical software InfoStat (FCA-UNC, Argentina) was

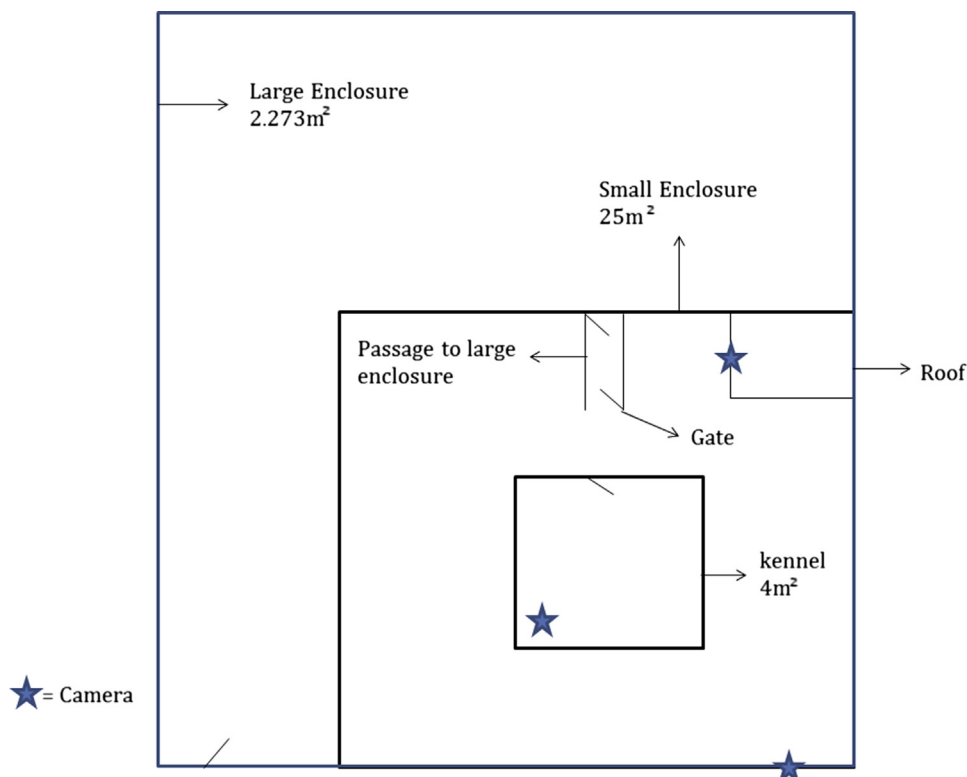


Figure. Reference layout for the cheetah’s enclosure and its dimensions at The Cheetah Experience, located in Bloemfontein, Republic of South Africa (not to scale).

Table 1

Ethogram produced by the observation and registered behaviors in a semi-imprinted female cheetah in captivity, over a 30-day period

Category	Behavior	Definition
Self-directed	Autogrooming	Elongates, licks, or scratches itself. The behavior may occur while lying down, sitting, or standing.
	Allogrooming	The cheetah is groomed and licked by the cubs.
Resting	Standing	On 4 limbs, inactive with no other part of the body in contact with the ground.
	Sitting	Hind limbs in flexion with forelegs vertically supporting the body (Chadwick et al 2013).
	Lying down	On sternal or lateral recumbence, head can or cannot be in contact with the ground. Eyes can be open or closed.
	Lying down with cubs	Lying down with part of the body in contact with the cubs, which may be standing or lying down.
Locomotion	Walk	Cheetah moves from a point A to B alternating the 4 limbs, always leaving 1 in contact with the floor.
	Walk with cubs	Walk occurs while carrying a cub in the mouth moving it from a point A to B.
	Pacing	Repetitive locomotory movement along a given route (up/down fence line; Quirke et al., 2012).
	Pacing with cubs	Pacing is performed while carrying a cub in the mouth.
Feeding	Drinking	Ingestion of water or milk.
	Eating	Ingestion of chicken meat.
Elimination	Urinate and defecate	Any projection of bodily fluids (except scent marking; Chadwick et al., 2013).
Social interactions	Positive with cubs	Alert about the location of cubs, can pursue them, play with them, make contact with paws, groom them, feed them, or stimulate them to urinate or defecate.
	Agonistic with cubs	Moves cubs away from itself or changes position when cubs approach for suckling.
	Agonistic to conspecific	Aggressive attitude toward other cheetahs including stalking, jumping, and ears pointing backward.
	Positive toward humans	Interacts with humans that enter the premises or approach it from the outside. Allows to be pet, to retire ticks from the body and follows humans.
	Agonistic toward humans	Aggressive behavior toward humans approaching the fence. Includes jumping, ears pointing back, and ambush.
Exploration	Vigilance	Eyes focused on animal/visitor/location/object, head rigid, and ears back (Quirke and O’Riordan, 2011).
	Sniffing	Exploration of any surfaces by olfaction.
	Licking blanket	Exploring its blanket inside the kennel using its tongue.
Other behaviors	Allocoprophagia	Ingestion of the cubs’ feces.

used. Correlation between both methods was classified according to the *r* value (high: 0.75 to 1 or -0.75 to -1 ; moderate: 0.5 to 0.75 or -0.5 to -0.75 ; weak: 0.25 to 0.5 or -0.25 to -0.5 ; very weak: 0 to 0.25 or 0 to -0.25).

Results and discussion

Behavioral studies in captive animals usually aim to improve welfare and fitness of individuals. Ethograms and time budgets are useful tools for these purposes. Although Stanton et al. (2015) developed a universal ethogram for the Felidae family, some behaviors may differ when animals are kept in captivity. The

ethogram developed in this study is presented in Table 1. A total of 8 categories and 22 behaviors were described for this study including 2 new behaviors not described in Stanton et al. (2015): “pacing with cubs” and “allocoprophagia”. In addition, there were some differences in the classification of behaviors.

When the time budget was calculated (Table 2), the category “resting” and specifically the behavior “lying down with cubs” was the most frequent behavior registered by both methods, once time “out of sight” was removed. For the continuous recording time, “out of sight” was the most common category. Most resting occurred inside the kennel, leaving the cheetah “out of sight” from the observer, a disadvantage with direct observation. The category

Table 2

Description of the behavioral time budget of a captive cheetah represented by the time allocated, in minutes and percentage, to each behavior and behavioral category according to the continuous recording (CR) and interval sampling (IS)

Category	Behavior	Minutes and percentage (%) for CR	Minutes and percentage (%) for CR by category	Minutes and percentage (%) for IS	Minutes and percentage (%) for IS by category
Self-directed	Autogrooming	260.7 (3.3)	260 (3.3)	157.8 (2.8)	507.2 (3)
	Allogrooming	0 (0)		11.3 (0.2)	
Resting	Standing	245 (3.1)	2,678 (33.9)	197.3 (3.5)	3,404 (60.4)
	Sitting	166 (2.1)		73.3 (1.3)	
	Lying down	102.7 (1.3)		163.4 (2.9)	
	Lying down with cubs	2,173 (27.5)		2,965 (52.6)	
Locomotion	Walk	166 (2.1)	411 (5.2)	129.6 (2.3)	270.5 (4.8)
	Walk with cubs	7.9 (0.1)		5.6 (0.1)	
	Pacing	229 (2.9)		129.6 (2.3)	
	Pacing with cubs	7.9 (0.1)		11.3 (0.2)	
Feeding	Drinking	7.9 (0.1)	79 (1)	5.6 (0.1)	39.5 (0.7)
	Eating chicken	71.1 (0.9)		33.8 (0.6)	
Elimination	Urinate and defecate	7.9 (0.1)	7.9 (0.1)	0 (0)	0 (0)
Social interactions	Positive with cubs	671.5 (8.5)	893 (11.3)	817 (14.5)	913 (16.2)
	Agonistic with cubs	3.2 (0.04)		0 (0)	
	Agonistic toward other conspecific	126 (1.4)		0 (0)	
	Positive toward humans	111 (1.2)		90.2 (1.6)	
	Agonistic toward humans	3.2 (0.04)		0 (0)	
Exploration	Gazing	55.3 (0.7)	63.2 (0.8)	343.8 (6.1)	372 (6.6)
	Sniffing	7.9 (0.1)		5.6 (0.1)	
	Licking blanket	0.8 (0.01)		22.5 (0.4)	
Abnormal behavior	Allocoprophagia	3.2 (0.04)	3.2 (0.04)	0 (0)	0 (0)
Out of sight	Out of sight	3,515 (44.5)	3,515 (44.5)	473.4 (8.4)	473.4 (8.4)

“social interactions” was the second most frequent category, where “positive interactions with cubs” was the behavior to which the cheetah allocated most of her time. For the category “locomotion,” it is important to emphasize that more than half of this time was dedicated to the stereotyped behavior “pacing” and “pacing with cubs”, which could be a sign of a present or past welfare problem (Wiepkema and Koolhaas, 1993). Although the percentage of time allocated to “pacing” was lower than the percentages reported by Quirke et al. (2012) for cheetahs (10%–37%) and by Mohapatra et al. (2014) for tigers (6.9%–49%), the presence of this behavior, regardless, may flag a welfare concern. Pacing in cheetahs has been associated with the size of the enclosure, possible stress caused by other female cheetahs nearby or in the same enclosure, and predictability of feeding schedules (Quirke et al., 2012). All these aspects of husbandry practice were observed at the Park, as cheetahs were maintained in adjacent enclosures, a feeding scheme existed and the limitation that free access by the cheetah to the bigger enclosure was not possible.

The continuous recording method using direct observation did not detect the behavior “allogrooming” which occurred inside the kennel. On the other hand, the interval recording method was not able to detect short duration behaviors such as “elimination behaviors” (urinate and defecate), “agonistic behaviors,” and “allopophagia.” Thus, using interval recording would then be a disadvantage when investigating short duration behaviors or of rare occurrence (Mann, 1999). The continuous recording method was more efficient in detecting these behaviors, with the exception of those that occurred mainly inside the kennel, such as “licking blanket” and “allogrooming.” It is important to consider the recording medium applied. We chose indirect recording by camera to study behaviors that the individual tends to perform in locations of difficult access for direct observation. Preliminary observations of the individual can facilitate decision making in the study design.

The correlation of behaviors by recording method was studied (Table 3). None of the studied behaviors was highly correlated between methods. The behaviors “pacing” and “eating chicken” were moderately correlated across recording methods. Consequently, for the study of these behaviors, both methods could be applied without producing significant differences in time budgets. On the

other hand, “walk with cubs,” “pacing with cubs,” “lying down with cubs,” “autogrooming,” “sitting,” “standing,” and “positive interaction toward humans” presented a weak correlation, although significant. These behaviors are usually classified as behavioral states and are characterized by their longer duration. The use of a short 60-second interval was brief enough to capture the briefest state of interest (Mann, 1999).

One of the main findings of the present study was the description of 2 behaviors not present in the review by Stanton et al. (2015). Although “pacing” is a stereotypic behavior widely described in the Felidae family, and in cheetahs, specifically (Quirke et al., 2012), “pacing with cubs” had not been reported. In many cases, particular stereotypic patterns can be associated with specific motivational states (Würbel et al., 1998). “Pacing with cubs” could be associated to the cheetah’s motivation to move cubs from one burrow to another during the first weeks of life (Laurenson, 1993), a natural behavior that may be curtailed by captivity. In the case of “allopophagia,” eating the newborn feces could function as a way to eliminate cues to potential predators and keep the burrow or kennel clean.

Continuous sampling using indirect recording by cameras placed in areas most used by the individual seems to provide a useful tool when studying the behavior of wild animals kept in captivity. It allows access to areas where the animals perform behaviors that otherwise cannot be captured by direct observation and avoids possible perturbation by the presence of an observer. Finally, the present study provided the opportunity to describe “allopophagia” and “pacing with cubs” as 2 new behaviors for cheetahs in captivity.

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Table 3

Results of Pearson’s correlation (r and P -value) between the 2 behavioral recording methods applied (continuous recording [CR] and interval sampling [IS]), over a 30-day period of observation

Behaviors	r	P -value	% CR	% IS
Pacing	0.62	0.000000	2.9	2.3
Eating chicken	0.59	0.000000	0.9	0.6
Walk with cubs	0.49	0.000000	0.1	0.1
Pacing with cubs	0.45	0.000000	0.1	0.2
Lying down with cubs	0.39	0.000000	27.5	52.6
Autogrooming	0.38	0.000000	3.3	2.8
Sitting	0.31	0.000000	2.1	1.3
Standing	0.30	0.000000	3.1	3.5
Positive interactions toward humans	0.25	0.000000	1.2	1.6
Walk	0.19	0.000000	2.1	2.3
Positive interactions with cubs	0.15	0.000000	8.5	14.5
Lying down	0.11	0.000000	1.3	2.9
Gazing	0.04	0.010000	0.7	6.1
Out of sight	-0.14	0.000000	44.5	8.4
Allogrooming	0	1	0	0.2
Drinking	-0.00061	0.97	0.1	0.1
Urinate and defecate	0	1	0.1	0
Agonistic interactions with cubs	0	1	0.04	0
Agonistic interactions to conspecific	0	1	1.4	0
Agonistic interactions toward humans	0	1	0.04	0
Sniffing	-0.0005	0.97	0.1	0.1
Licking blanket	0	1	0.01	0.4
Allopophagia	0	1	0.04	0

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