

EVALUATING THE LONG-TERM BEHAVIORAL IMPACT OF CARCASS FEEDING IN A FEMALE ASIATIC LION (*PANTHERA LEO PERSICA*)

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Abstract

Replicating species-specific feeding behaviors in captive carnivores presents a challenge for zoological collections and many studies have highlighted the benefits of a naturalistic feeding program, such as feeding whole prey/carcasses, on their health and psychological well-being (e.g., Bond & Lindburg, 1990; McPhee, 2002; Altman *et al.*, 2010; Whitehouse-Tedd *et al.*, 2015). However, most behavioral studies lack information about the long-term behavioral effects of implementing a more naturalistic and species-appropriate diet.

This study evaluated the long-term effect of changing to carcass feeding in a case study of a female Asiatic lion (*Panthera leo persica*) at Chester Zoo. The female observed was 10 years old at the beginning of the study and housed with her sister and an unrelated male. Behavioral data was collected before and shortly after a change in diet from mainly beef joints to a whole calf carcass (Table 1). To assess the long-term behavioral impact of this management intervention, data were collected 12 months after carcass feeds were introduced as well. Each observation event consisted of 60 minutes instantaneous focal sampling with 30 second intervals. Observation events were randomized throughout the day (9AM to 5PM) over the 11 days that each observation period consisted of, so that each one-hour interval of the day was equally represented in the records. A total of 77 hours of behavioral data were collated in the period from March 2016 to May 2017. The ethogram described in Table 2 was used to define and record behaviors. Length of each feeding bout (defined as a period of eating with >1 minute of another behavior before and after the feeding event) was used as a proxy for time spent feeding. Standard inter-observer reliability test confirmed >90% consistency. No changes were made to the enclosure, the group composition or husbandry practices (apart from the diet change) during the study period. Statistical analyses were conducted with SPSS (version 24, IBM Statistics). Data were normally distributed (Kolmogorov-Smirnov test; $P=0.20$) so one-way ANOVAs were used. Tukey's Post-hoc test was used to test for differences between groups. All values are reported as means \pm standard error.

Immediately following the diet change there was a significant ($p\leq 0.0001$) increase in the time spent per feeding bout, from 6.2 ± 1.1 minutes before carcass feeding was introduced to 20.5 ± 3.7 minutes. This increased feeding time was still observed a year after the diet change (20.6 ± 4.0 minutes). An increase in resting behavior and a decrease in pacing behavior was observed in both observation periods after the diet change, though only significantly in the latter observation period compared to before the diet change (Figure 1). The average time spent resting increased from a baseline of $42.8\pm 7.3\%$ to $65.2\pm 6.5\%$ of the observation time at 12 months post-carcass feeding ($P=0.029$). Pacing behavior decreased massively from $21\pm 5.2\%$ to $0.1\pm 0.07\%$ of the observation time ($P=0.001$).

A natural feeding pattern of gorging followed by fasting has previously been shown to encourage increased resting on gorge days in lions (Clark, 1987; Stander, 1992), and reduce vigilance

behavior in spotted hyenas (*Crocuta crocuta*), another social carnivore (Pangle & Holekamp, 2010). Similar to the finding in this study, levels of pacing have been shown to be reduced following introduction of a more species-appropriate diet in large felids (McPhee, 2002; Bashaw *et al.*, 2003; Altman *et al.*, 2010). The lack of immediate (significant) changes in time spent resting and pacing in the weeks following the diet change is likely because physiological and psychological adaptation to a gorge and fast feeding routine requires time. Albeit a case study on one individual, this study highlights the value of using longitudinal behavioral data as tool to evaluate the effectiveness of diet changes and demonstrate how this information can facilitate the implementation of evidence-based management decisions.

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Table 1. Daily diet fed to one adult Asiatic lion (*Panthera leo persica*) at Chester Zoo before and after replacing beef joints (Original diet) for whole or partial calf carcasses (Carcass diet).

Diet ingredients	Qty	M	T	W	T	F	S	S
“No-carcass diet”								
Beef joint	~3 kg	x	x	x	x		x	x
Chicken, whole	1.5-2 kg					x		
“Carcass diet”								
Calf carcass, whole	20-25 kg			x				
Calf carcass, partial	5-10 kg	x					x	x
Chicken, whole	1.5-2 kg					x		

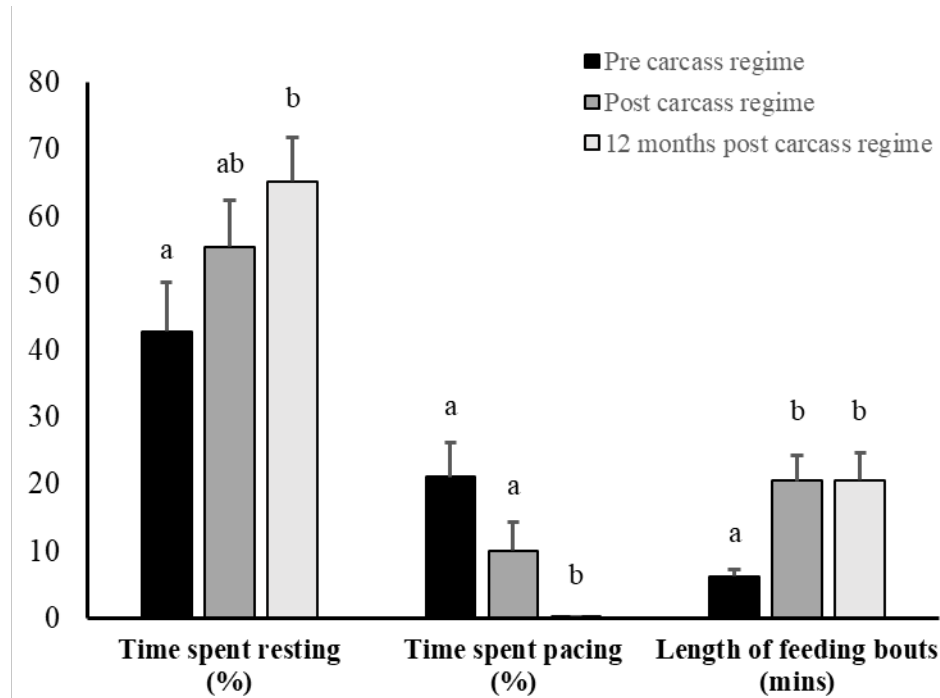


Figure 1. The effect of carcass feeding on resting and pacing behavior, as well as the length of feeding bouts in a female Asiatic lion (*Panthera leo persica*) observed for an 11-day period before, immediately after and 12 months after included whole calf carcass in the diet. Different superscripts within each category denotes a significant difference between observation periods.

Table 2. Ethogram used to record the behaviour of an Asiatic lion (*Panthera leo persica*)

Behaviour	Description
<i>Alert</i>	Highly responsive to stimuli. Looking around or focused in a specific direction
<i>Digging</i>	Using paws to displace substrate
<i>Feeding</i>	Ingestion of food item or liquid
<i>Excretion</i>	Elimination of urine and faeces from body
<i>Grooming</i>	Self-maintenance which includes rolling, stretching, licking, scratching, and biting of own body
<i>Locomotion</i>	Walking or running from one place to another. Does not include pacing
<i>Object Interaction</i>	Licking, scratching, rubbing, or scent marking an object within the enclosure
<i>Out of Sight</i>	The subject is not visible to the observer
<i>Pacing</i>	Continuous walking back and forth in a repetitive way for at least three times
<i>Resting</i>	Lying down, body motionless, note if eyes open or closed
<i>Sniffing</i>	Brief inhalation of object, ground, or air during olfactory investigation
<i>Social interaction</i>	Any form of interaction with a conspecific. Includes; aggression, rubbing heads, courtship, grooming, etc.
<i>Vocalisation</i>	Opening mouth and producing sound. May occur while solitary, at a conspecific, or at human(s)
<i>Yawning</i>	Opening mouth in a yawn