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TECHNICAL REPORT

Nocturnal Behavior in Captive Giraffe (*Giraffa camelopardalis*)—A Pilot Study

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Captive giraffes (*Giraffa camelopardalis*) are known to perform oral and locomotor stereotypies. However, many studies do not consider the behavioral repertoire of these animals during the time when animals are confined to night quarters. At two zoological institutions, a total of six captive giraffes were observed via camera trap technology throughout six diurnal and nocturnal periods to record feeding, ruminating, and stereotypic behaviors. The effect of browse enrichment was assessed on alternate nights to determine how behaviors may be altered in the presence of natural forage. Results need to be interpreted with caution due to a high proportion of time when animals were out of camera range. For the observed time, stereotypical licking behavior was significantly higher at night compared to daytime at both facilities, while tongue play increased at the same time, but not significantly. The provision of browse enrichment during the night decreased the rate of tongue playing, but not significantly; however, browse did significantly reduce pacing behavior. Across treatments and institutions, observed oral stereotypies tended to correlate negatively with increased feeding behavior. Apart from a short-term effect of enrichment, this study indicates relevant differences in the frequencies of behaviors observed during the day and night, suggesting that assessing nocturnal behavior specifically may be important in many species. Zoo Biol. 35:14–18, 2016.

Keywords: stereotypic behavior; nocturnal; giraffe; feeding; environmental enrichment

STATEMENT OF THE PROBLEM

Historically, maintaining giraffes (*Giraffa camelopardalis*) in captivity has proven somewhat difficult, particularly when considering their nutritional requirements [Junge and Bradley, 1993; Hatt et al., 2005; Potter and Clauss, 2005]. Most zoological collections are capable of maintaining adequate giraffe nutrition through the combined use of alfalfa hay and concentrated feeds (Lintzenich and Ward, 1997; Hummel and Clauss, 2006; Valdes and Schlegel, 2012]. While potentially nutritionally adequate, concentrated feeds do not promote natural foraging activities or the complex tongue manipulation exercised by free ranging giraffes, which often results in abnormal repetitive behaviors, or stereotypies [Sato and Takagaki, 1991; Schaub et al., 2004; Hummel et al., 2006].

Bashaw et al. [2001] determined that 80% of giraffes in captivity perform at least one type of stereotypic behavior, with over 2,000 giraffids estimated to be affected worldwide [Mason et al., 2007]. The most commonly observed are oral stereotypies [Bashaw et al., 2001]; non-food object licking or apparently functionless tongue movements, interpreted as a result of reduced feeding duration and inadequate tongue and chewing stimulation [Kolter, 1995]. Free ranging giraffes have been reported as performing tongue playing stereotypies (0.8% of observed time), but they occur at much greater frequencies in captivity (up to 16.2% of observed time), suggesting that the actual behavior is not abnormal, but occurs at abnormal rates [Veasey et al., 1996]. Pacing, a locomotor stereotypy, is the second most commonly observed abnormal behavior in giraffes [Bashaw et al., 2001].

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Free-ranging giraffe browse throughout the night [Dagg and Foster, 1976], and although captive giraffes are provided with *ad libitum* hay at night, a lack of other physically complex feed may result in higher oral and locomotor stereotypy rates than can be observed during the day [Veasey et al., 1996; Baxter and Plowman, 2001]. Captive browsers are known to maintain foraging activities throughout the night, with peaks occurring outside of supervised hours [Horback et al., 2014], so it is important to consider the behavioral requirements for the entirety of each day, not only during keeper shifts.

Increasing roughage intake has helped in reducing oral stereotypies [Koene and Visser, 1996; Redbo and Norblad, 1997; Baxter and Plowman, 2001; Hatt et al., 2005; Hummel et al., 2006] and zoological collections are encouraged to provide *ad libitum* hay in a way that requires tongue manipulation [Hummel and Clauss, 2006], and supplemental feeding enrichment is encouraged [Burgess, 2004; EAZA, 2006]. Locomotor stereotypies are thought to be associated with limited available space and ranging opportunities in captivity [Dagg and Foster, 1976; Bashaw et al., 2001]; in carnivores, it is the species with larger natural home ranges that pace more in captivity [Clubb and Mason, 2003], suggesting that pacing reflects a propensity to perform natural ranging behavior, though locomotion may be linked to feeding to a higher degree in carnivores than in ungulates [Bashaw et al., 2001]. Indoor enclosures for hoofstock tend to contain fewer types of stimulation, and of less variety, than outdoor areas, and may contribute to higher stereotypy levels [Baxter and Plowman, 2001], particularly at night, when keeper care and its potentially enriching effect is not provided.

This study aimed to i) assess nocturnal stereotypic behavior frequencies of captive giraffe; ii) compare nocturnal behaviors to daytime levels; and iii) investigate the effect of feeding enrichment in the reduction of nocturnal stereotypic behaviors.

DESCRIPTION OF THE PROCESS

Behavioral data were collected at two British zoological institutions with a total sample size of six giraffes. "Zoo 1" housed two female Reticulated Giraffes (*G. c. reticulata*) and one female Rothschild Giraffe (*G. c. rothschildi*), while "Zoo 2" kept three Reticulated Giraffes; one male and two females. Animal care at these institutions equated to approximately 10 hr each day while keeper staff was on site, leaving about 14 hr of unsupervised time during the night.

Observations were conducted between May and July, 2013, with three KeepGuard^{TM} 8MP Infrared Outdoor Digital camera traps with infrared video capabilities (Model KG-680V, Keepway Industrial Co. Ltd., Shenzhen, China). Three cameras were mounted at each zoo, in locations that would maximize the visible area, including approximately 80% of the indoor enclosure at Zoo 1, and capturing approximately 64% of the indoor enclosure, and 50% of an outdoor hard-stand at Zoo 2. Camera views included sleeping quarters, feeding pens and water troughs.

Camera traps were set to record 24 hr of diurnal and nocturnal activity at each facility. A total of 6 days and 6 nights of video recordings were obtained for each. Video recording was motion-triggered, with 30 sec video segments recorded with each camera activation. The nocturnal period was defined as between 18:00 hr and 9:00 hr. Video segments were viewed by a single observer (GD) and behavior logged according to focal sampling for each individual that was visible [Martin and Bateson, 2007]. Behavioral data points were logged based on a behavioral ethogram, adapted from previous giraffe behavioral studies [Sato et al., 1994; Fernandez et al., 2008; Garry, 2012; Grittinger, 2012].

At each institution, enrichment was provided on alternate observation nights ("enrichment nights"). Whole natural browse was selected as the enrichment item as it promotes tongue manipulation and natural foraging behavior [Myers 2004; Schaub et al., 2004], has been shown to reduce stereotypies [Koene and Visser, 1996; Hummel et al., 2006], and could be replicated at each institution.

Focal animal sampling data were logged into compiled datasets for both collections using binary categorical input (i.e., "1" or "0") to indicate presence or absence of behavior. Behavioral observation counts were taken from the first 15 min of every hour of footage and organized into three 5 min intervals (0–5 min, 5–10 min, 10–15 min). This was done for each giraffe, for each hour, providing three 5 min 'time categories' per giraffe for each hour. Results were expressed in percentage of time devoted to behavior, within observed time. Data were aggregated for individual giraffes, procuring mean levels of behaviors throughout each day and night period. Generalized linear model (generalized estimating equations) statistical functions were performed in SPSS Statistics Processor 20 (IBM Corporation, Armonk, NY), with variables for individual giraffes (a random effect), zoos, enrichment treatment as well as day/night and each behavior as the binary or normally distributed response. Additionally, a correlation was tested (after confirming normal data distribution) by Pearson's R. The significance level was set at 0.05, with *P*-values between 0.05 and 0.10 considered as trends.

DEMONSTRATION OF EFFICACY

Giraffes at both zoos spent a total 1,110 min/77% (18.5 hr) active, with at least one stereotyping for 90.83 min/6.25% (1.5 hr) during the day, and 327.5 min/22.7% (5.45 hr) at night. The camera trap method resulted in a percentage of time in which the giraffes were not visible in the video segments. Zoo 1 showed 25% visibility during the day and 57% visibility across all nights. At Zoo 2, 23% visibility occurred during the day, with 52% visibility across all nights. Visibility during enriched nights however, was high for both institutions (95%). The real values of time spent stereotyping

are likely higher than reported here, due to "inactive" periods when behavior occurred out of site of the cameras. This method of observation was used in order to obtain behavioral data from throughout the night, without the presence of observers. Previous studies had attempted nocturnal observations with observers, but animals were nervous of observer presence [Veasey et al., 1996; Fernandez et al., 2008]. Baxter and Plowman (2001) had some success with infra-red cameras. This method can be perfected to allow for unconfounded nocturnal observations.

Feeding behavior showed crepuscular tendencies, with peaks in the morning (6:00–9:00 hr) and late evenings (18:00–21:00 hr). Ruminating followed feeding patterns throughout the day, with an additional large peak at 13:00 hr (Fig. 1) for giraffes at both facilities. Oral stereotypies also showed peaks in frequency at relatively parallel times as feeding, or slightly afterwards. The majority of these peaks (except midday peaks) occurred during the nocturnal period. At Zoo 1, tongue playing maintained a relatively persistent rate of occurrence throughout the day (Fig. 1a), while this appeared more varied at Zoo 2 (Fig. 1b).

Tongue playing differed significantly between zoos, with Zoo 1 giraffes displaying higher levels both day and night ($X^2_1 = 15.964$, $P < 0.0001$) (Fig. 2). Licking increased both at Zoo 1 ($X^2_1 = 27.363$, $P < .0001$) and Zoo 2 ($X^2_1 = 12.175$, $P < 0.0001$) during the night period as compared to daylight hours. Pacing increased at Zoo 1 ($X^2_1 = 11.087$, $P = 0.001$) during the night, but decreased at Zoo 2 ($X^2_1 = 11.866$, $P = 0.001$). Tongue playing appeared to decrease somewhat with the enrichment treatment, but not significantly ($X^2_1 = 2.539$, $P = 0.111$). For both facilities, enrichment significantly reduced the prevalence of pacing behavior ($X^2_1 = 4.106$, $P = 0.043$) (Fig. 2). Using averages for individual giraffes from both collections, there tended to be a moderate correlation between increased total feeding behavior and decreased oral stereotypy levels ($R = -0.47$, $P = 0.052$; Fig. 3).

This study's trends support previous findings that the provision of browse enrichment can reduce oral stereotypies [Koene and Visser 1996; Bashaw et al., 2001; Baxter and Plowman 2001; Schaub et al., 2004; Hatt et al., 2005] but suggests that pacing behavior can also be reduced with browse provision. The use of camera traps resulted in unexpectedly low rates of visibility. Less video was recorded when giraffes were in the outdoor enclosures during the daytime, and the field of view of each camera may have excluded in particular non-feeding behaviors. Greater visibility would likely have resulted in a more significant result.

Feeding and ruminating behavior (Fig. 1) had a crepuscular pattern at both zoos, with peaks in feeding activity between 6:00–9:00 hr and 18:00–21:00 hr for each collection, with ruminating increasing simultaneously with, or immediately after, feeding. There was an additional rumination peak after midday (13:00 hr). Dagg and Foster [1976] and Pellew [1984] describe wild giraffes as having peaks in feeding at dawn and dusk, while ruminating the most just after midday, when feeding is at its lowest, agreeing with this study's findings (Fig. 1). As the giraffes had access to lucerne hay *ad libitum*, these natural feeding behaviors appear to be retained in captive giraffes, but keeper feedings times must also be considered.

Oral stereotypies appeared to follow feeding or rumination in sequence (peaks at 6:00–7:00 hr and 19:00–24:00 hr), suggesting a relationship between feeding, rumination, and oral stereotypies [Koene and Visser, 1996; Carlstead, 1998; Bashaw et al., 2001]. Veasey et al. [1996] made similar observations, with oral stereotypies following bouts of feeding and drinking, suggesting a functional role. An increase in licking behavior at both institutions at night corroborates research in which captive giraffes stereotype at greater levels at night versus during the day, when placed in their indoor enclosures [Veasey et al., 1996; Baxter and Plowman, 2001].

Pacing at both zoos occurred during the morning, when awaiting feeding, or when denied access to the paddock. Feeding or ranging motivation may explain the anticipatory pacing observed, particularly as it occurred in the early morning, the natural feeding peak for giraffe [Dagg and Foster, 1976]; also, increased feeding opportunity decreased pacing during the night (Fig. 2), which suggests nocturnal pacing is linked to foraging motivation.

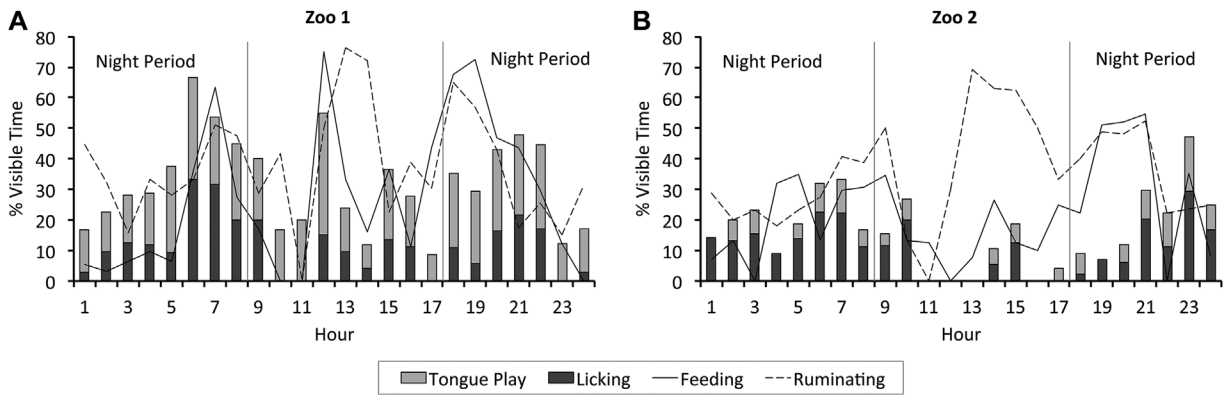

Fig. 1. Percentage of visible time giraffes were engaged in behavior over time, averaged for all six 24 hr-cycles and all three giraffe at Zoos 1 and 2.

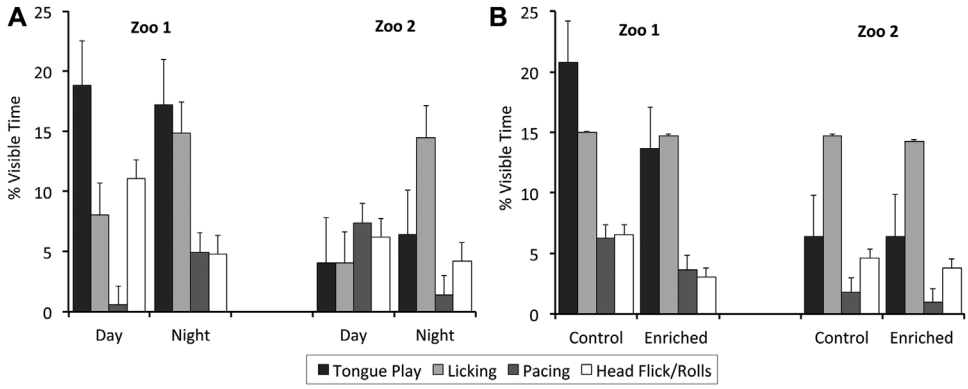

Fig. 2. Stereotypy activity levels (grand means of individual giraffes and observation days with standard deviation) during day and night, and during enriched and control nights.

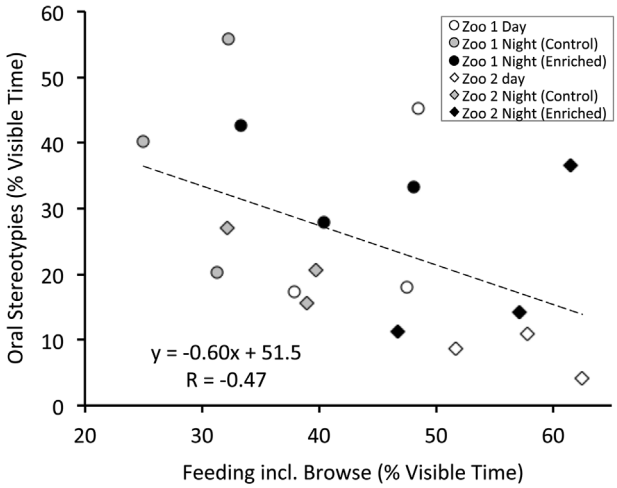

Fig. 3. Negative correlation of combined feeding (including browse) and oral stereotypies.

While *ad libitum* hay feeding remained constant across treatments, browse feeding increased when additional browse was made available at night, extending the overall feeding time on enriched nights. Browse may act as a stimulus or mediator for optimal food intake [Hatt et al., 2005] and the greater total feeding time on enrichment nights may support this theory. An increase in overall feeding behavior tended to correlate with a reduction of oral stereotypies (Fig. 3). Schaub et al. [2004] describe the importance of physically complex forage and, if presented in a complex manner as whole branches, as in this study, browse probably has the ability to reduce oral stereotypies. In addition to browse supplementation, many zoological collections provide artificial enrichment devices for their giraffes [Burgess, 2004; EAZA, 2006]. These efforts may prove effective during the day when such enrichments are offered; ideally, such devices should be provided and their efficacy assessed during the night period also.

As oral stereotypies may be a derivative of natural behavior [Veasey et al., 1996], the benefit of their performance, if any, is not fully understood, but satiety, calming effects and anxiety relief [Mason 1991; Bergeron et al., 2006], or rumen pH buffering [Hummel et al., 2006] may sometimes result from these behaviors. Pacing behavior may not be fully linked to feeding but may be based on a motivation for movement on its own [Bashaw et al., 2001]. Other, as yet unidentified factors may lead to higher rates of stereotypies in captivity than in the wild [Veasey et al., 1996], but our results further substantiate the link between feeding, inadequate oral stimulation, and the performance of nocturnal stereotypic behavior.

1. This investigation confirms that captive giraffe stereotype at higher levels during the night compared to the daytime, as was briefly proposed by previous studies, and that the use of browse can aid in decreasing these stereotypies.
2. Pacing behavior was significantly reduced during the night with the provision of browse feeding enrichment, suggesting captive giraffes maintain a strong motivation to forage during the night.
3. Behavioral time budgets in these captive giraffes appear to correlate with free ranging patterns in the wild, while stereotypies show large variation between facilities and individuals.

4. Most importantly, this study promotes the thought that the welfare of captive animals in our care is a 24 hr undertaking, and not confined to the working hours of humans.

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