

INACTIVITY AT NIGHT: A CASE STUDY OF THE NOCTURNAL BEHAVIORS OF TWO CAPTIVE *Panthera onca* (FELIDAE) SPECIMENS

Inactividad en la noche: un estudio de caso de los comportamientos nocturnos de dos especímenes de *Panthera onca* (felidae) cautivos

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ABSTRACT

Inactivity is a common daytime behavior expressed by wild cats in zoos. It is not clear whether this inactivity is due to the constraints of the captive environment or is a result of a more natural behavior by these animals. Therefore, this work evaluated the behavior of two *Panthera onca* captive specimens, including their inactivity, during the evening/night period. The jaguars were filmed individually in different days, starting at 5:30 pm and finishing between 7:00 pm and 1:30 am, including non-feeding and feeding days. Regardless of whether they were fed or not, both jaguars expressed a significant rate of inactivity. In addition, when fed, one of the jaguars increased its movements and active behaviors, although its inactivity remained high, while the other jaguar further reduced the expression of such behaviors. Therefore, this work concludes that these jaguars were just as inactive during the evening/night period as they were during daytime. Excessive inactivity might be regarded as a negative behavior; with its highest expression being an effect of the captive environment, which might compromise the welfare of the assessed jaguars and possibly of other wild cats. In addition, since the behavioral expression varied between the studied jaguars, depending on the feeding or non-feeding status, we recommend that futures studies should taking into account the individual variations, especially when there are differences in age, health, and management conditions between the specimens.

Keywords: caged mammals, felid behavior, jaguars, zoo animals.

RESUMEN

La inactividad es un comportamiento común expresado por gatos salvajes en los zoológicos durante el día. No está claro si esta inactividad es un efecto de las restricciones del ambiente de cautiverio o si puede representar un comportamiento más natural en estos animales. Por lo tanto, el comportamiento de dos *Panthera onca* cautivos, incluida la inactividad, se evaluó durante los períodos de tarde / noche. Los jaguares fueron filmados individualmente en diferentes días a partir de las 5:30 pm y terminando entre las 7:00 pm y la 1:30 am, incluidos los días en que fueron alimentados y los días en que no lo fueron. Independientemente de que se alimentaran o no, ambos jaguares expresaron una frecuencia significativa de inactividad. Además, cuando se alimentó, uno de los jaguares incrementó el movimiento y las conductas activas de pie, aunque su inactividad siguió siendo alta, mientras que el otro redujo aún más la expresión de tales conductas. Se concluye que estos jaguares son tan inactivos durante los períodos de tarde / noche, como lo son durante el día. La excesiva inactividad puede considerarse un comportamiento negativo y su alta expresión parece ser un efecto de las condiciones de cautiverio, las cuales podrían perjudicar el estado de bienestar de los jaguares evaluados y posiblemente de otros gatos salvajes. Además, como las expresiones de comportamiento variaron entre los jaguares, dependiendo de la alimentación o no, se recomienda que se considere la variabilidad individual de la respuesta en estudios futuros, especialmente cuando existen diferencias de edad, salud y condiciones de manejo.

Palabras clave: animales de zoológico, comportamiento felino, jaguares, mamíferos enjaulados.

INTRODUCTION

Despite the role of zoos in the conservation of several wild species of mammals, it is common for these captive animals to face a lack of sufficient stimulation in this environment, which usually represents an unnatural condition for them. Although some zoological institutions have properly addressed this issue, there are still many things to improve in several zoos around the world. In this scenario, behavioral problems expressed by wild animals may emerge in the captive environment such as, for example, stereotyped behavior and increased inactivity (Carlstead, 1996; Morato *et al.*, 2001). In fact, when expressed in the presence of public visitors, inactivity is regarded as stressful for the animals in zoos (Davey, 2007). However, despite this, while stereotypies are easily accepted as a negative behavior exhibited when the animals are found under poor conditions, increased inactivity is not usually seen as a problematic or negative behavior. For example, although jaguars (*Panthera onca* Linnaeus 1758) were inactive for most of the day, and this was considered as a negative behavior by the authors, visitors at the zoo still viewed the animals in a positive way, in a similar way they regarded the animals when they were active (Godinez *et al.*, 2013). This fact reveals that most people usually neglect inactive behavior, although it might be, in fact, an expression of negative behavior. In this scenario, zoos should be concerned about animals engaged in excessive inactive behavior, trying to improve the life quality of these captive animals.

This is even more relevant when considering jaguars and other large wild cats, who usually need large territorial areas for living and moving, and yet are very restricted under the captive conditions, which favor the occurrence of inactive behavior. Despite this, we should take into account the fact that jaguar and other feline species are usually more active during the nocturnal period, especially at dawn and dusk, when they usually hunt (Nowak, 1999; Cheida *et al.*, 2006; Santos *et al.*, 2009). Thus, these animals may naturally express more inactivity during the daytime hours. Considering that most studies evaluating the behavioral expression of jaguars in zoos were usually conducted during daytime (Godinez *et al.*, 2013; Boccacino *et al.*, 2018), it is not clear whether the high inactivity usually expressed is an abnormal behavioral expression due to the restricted conditions of captivity or is just a more common behavior during the daytime hours.

Panthera onca is considered a threatened species, with a high risk of mid-term extinction (Morato *et al.*, 2013). Thus, it is relevant to investigate this high rate of inactive behavior in order to improve the captive conditions of this species in zoos, playing a role in providing better care and meeting conservation purposes. In this context, this study aimed to assess whether the inactivity level of two captive jaguar specimens (Gabi and Negona) was high during the evening/night period, and to check if this behavior was present when the animals were not fed, and thus, were stimulated to engage in such active behavior in order “to hunt”.

MATERIALS AND METHODS

SPECIMENS AND ENCLOSURES

We have observed two *P. onca* females (‘Negona’, a melanic variant, and ‘Gabi’) housed at the Rio de Janeiro Zoo Foundation (RIOZOO), located in a wooded area of 138 000 m² at Quinta da Boa Vista Park, Rio de Janeiro (RJ), Brazil. Negona was 13 years old and Gabi, her daughter, was six years old at the time of the study. Negona was originally captured in the field when she was four years old and frequently limped with her front leg, while Gabi was born in the RIOZOO. Both jaguars had access to two different enclosures: an outdoor and an indoor area. The outdoor enclosure was 85 m², being surrounded by concrete walls and fences, with a dirt floor. This enclosure also presented a concrete stair, wooden platforms, a waterfall, and overlapping tree trunks. In contrast, the indoor area was small (5.0 m x 3.0 m), located at the bottom of the outdoor enclosure, and included separate chambers, where the animals were maintained isolated overnight or for routine-management purposes during daytime. It is important to mention that the employees of the zoo always kept the jaguars restricted to the indoor areas during the evening/night period, as this is a safety standard of the zoo. Thus, all records of their nocturnal behaviors were conducted in this area. Detailed information about the specimens used in this study, their enclosures, and their breeding in captivity is available in a previously published study (Boccacino *et al.*, 2018).

DAILY MANAGEMENT

Every morning the staff of the zoo cleaned the enclosure before the female jaguars (and a male jaguar that was also at the RIOZOO at the time of this study) were released from the indoor enclosure around 08:00 am. Negona was released every day in the outdoor enclosure, while Gabi was released on alternating days with the male jaguar. When Gabi was not released, she was kept in the indoor enclosure during the entire day. The jaguars were returned to their individual chambers in the indoor enclosure everyday around 05:00 - 05:30 pm. The two female jaguars were fed on alternate days with 2.0 kg of meat (chicken or bovine heart/muscle) which was always provided during the day inside the chambers in the indoor enclosure.

PROCEDURES

First, the specimens were freely observed in the outdoor enclosure for over 20 hours, during the diurnal period, in order to train the researchers in observing the jaguars and to organize an ethogram (Table 1). This term has previously proved to be sufficient for these purposes (Boccacino *et al.*, 2018). After that, the two female jaguars were filmed only during the evening/night period, when they were in the indoor enclosures. Aiming to record their behavior without

Table 1. Ethogram of the observed behaviors of the two female jaguars (*Panthera onca*) at RIOZOO, Rio de Janeiro, Brazil.

Behavioral Classes	Detailed description of behaviors
Inactivity	Animal not expressing any movement around the enclosure, nor directed gaze to the environment; jaguar could be sleeping or lying down
Active Standing	Animal not expressing any movement around the enclosure, but expressing a directed gaze to the environment; jaguar could be sitting or standing
Maintenance	Animal was urinating, defecating, licking, scratching, sharpening the claws or ingesting vegetation in the environment; these behaviors were never related to stereotyped actions
Drinking	Animal was drinking water from the small fountains
Movement	Animal was moving around the enclosure
Human Interaction*	Animal interacted with, or expressed directed gaze to zookeepers
Out of sight	Animal was in specific points of the enclosure that partially or completely prevented appropriate visualization by researchers

*Although we have recorded the nocturnal behavior of the jaguars, human interaction was included in our analyses because the animals could interact with the zookeepers around 17:00-17:30 pm when they returned to their individual chambers in the indoor enclosure every day. In addition, we wanted to evaluate whether there was a difference in this behavior if the jaguars have been previously or not fed during the day by the zookeepers.

any human interference, a camera capable of recording at low light (even 0.05 lux) was employed. The camera was placed at the gate of one of the chambers in the indoor enclosure (depending on the jaguar being filmed) and filmed the animal through a small hole made at the gate. A red lamp (60 W) was added in the external area of the indoor enclosure to improve the quality of the footage. This technique for filming and recording animal behavior at night was previously validated (Santori *et al.*, 2014).

The female jaguars were individually filmed in alternate nights, one in which they had been fed and the other when they had not. The recording always started at 05:30 pm and finished between 07:00 pm and 01:30 am, depending on the availability of the shooting location. Gabi was filmed for four nights whereas Negona was filmed for six. Thus, the total number of filmed hours varied between the two jaguars (32 h for Gabi -16 h when fed; and 24 h 46 min for Negona - 11 h 46 min when fed). The data were compared by a proportion test (see Statistical analyses) and were proportionally corrected in the analyses.

We registered the behavior of each jaguar at 30 s intervals, thus totaling 120 observations per hour per jaguar (focal scan sampling; based on Del-Claro, 2002). Our sample effort enabled us to get 1920 and 1554 behavioral records for Gabi and Negona, respectively, from nights when they were not fed; and 1820 and 1412 behavioral records for Gabi and Negona, respectively, from nights when they were fed. Since two different researchers analyzed the behavioral data from the registered footage, comparative sections were carried out highlighting the same behavior recorded by both researchers at the same time. The researchers repeated this procedure until at least 90% of the records between them were equal (based on Del-Claro, 2002).

ETHICAL NOTE

All the procedures applied in this study took into account the importance of preventing, or at least minimizing, any kind of animal discomfort or suffering. Moreover, this work was authorized by the Ethics Committee of RIOZOO.

DATA ANALYSES

We compared the frequencies of data points of each recorded behavior described in Table 1 for each jaguar. First, we compared all the behavioral frequencies among themselves on days in which the jaguars were fed or on days when they had fasted, independently, in order to evaluate which was the most and least common behavior on such days. These comparisons were performed using the Goodman proportion test for multinomial comparisons (Goodman, 1965). Moreover, we also compared each behavioral rate independently and for each jaguar between days when they were fed and not fed, to detect any significant difference more specifically related to fasting, regarding each behavior and each jaguar. That is, the researchers tried to assess if these behaviors were influenced by the feeding status of the animals. Such comparisons were made using the Goodman proportion test for multinomial comparisons (Goodman, 1964). Since the Goodman test directly compares frequencies, not means or medians, the normality and homogeneity distribution of the frequency data did not need to be checked. For all these analyses, we settled $p = 0.05$.

RESULTS

For both jaguars, Inactivity was the most frequently behavior expressed, followed by Active Standing and Movement behaviors, regardless of the feeding status of

the individuals (Fig. 1; Goodman proportion test – within multinomials; $p < 0.05$). On the other hand, Out of Sight, Drinking, and Human Interaction behaviors were the least frequent behaviors for both Gabi and Negona, also regardless of whether the jaguars had been fed or not (Fig. 1; Goodman proportion test – within multinomials; $p < 0.05$). However, considering other behavioral classes expressed by the jaguars, Gabi and Negona responded differently according to the feeding status. When they were fed, Inactivity was higher for Gabi and lower for Negona, whereas Active Standing and Movement behaviors were lower for Gabi and higher for Negona compared to the days when both jaguars were fasting (Fig. 1; Goodman proportion test – among multinomials; $p < 0.05$). Negona also expressed a higher frequency of Maintenance behaviors in the days when she was fed (Fig. 1 – Negona; Goodman proportion test – among multinomials; $p < 0.05$), a response not observed in Gabi (Fig. 1 – Gabi; Goodman proportion test – among multinomials; $p > 0.05$).

DISCUSSION

For both evaluated female jaguars, Inactivity was the most frequent behavior expressed during the evening/night

period, a response also detected during the diurnal period for the same animals in another study (Boccacino *et al.*, 2018). Such findings emphasize that despite the small sample size evaluated here, the high frequency of inactive behavior frequently expressed by jaguars in zoos might represent an abnormal behavior. In fact, it should be regarded as a negative behavior, at least for the studied jaguars, following the considerations of other authors (Godinez *et al.*, 2013; Boccacino *et al.*, 2018). Furthermore, the two evaluated jaguars expressed different behavioral responses during the evening/night period, depending on the food availability. Such differences include Inactivity but also Active Standing and Movement behaviors, which could be at least partially explained by differences of age, health, and management conditions between these two jaguars. Together, these findings indicate the relevance of evaluating the behavior of animals in zoos individually, considering the existence of biological and environmental differences between them.

The expression of high Inactivity during the evening/night period by the two evaluated female jaguars is in accordance with the findings obtained from the same animals in another study (Boccacino *et al.*, 2018), from other jaguars (Godinez *et al.*, 2013), or even from other large wild cats such as pumas (Maia *et al.*, 2012). However, as far as we know, this

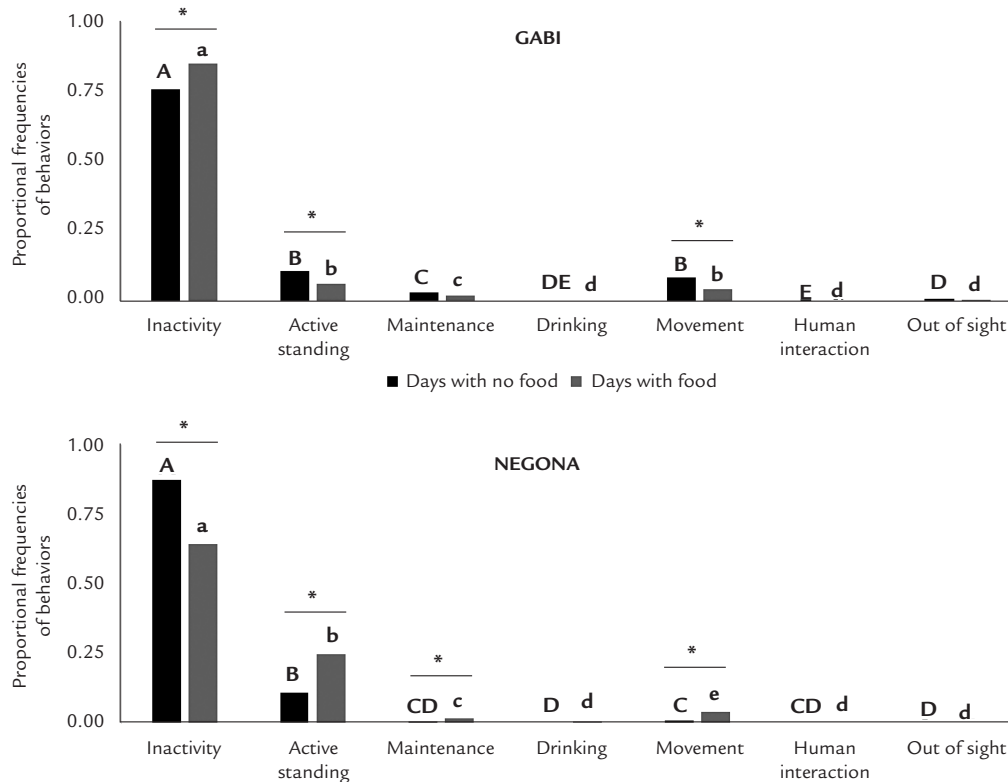


Figure 1. Frequencies of nocturnal behaviors according to the feeding status of the observed jaguars, Gabi and Negona.

* Indicates significant differences in proportions of the same behavioral class between days with feeding and without feeding (Goodman proportion test – among multinomials; $p < 0.05$). For days when jaguars were not fed (black-colored bars), proportions of different behavioral classes with different capital-case letters were significantly different (Goodman proportion test – within multinomials; $p < 0.05$). For days when jaguars were fed (grey-colored bars), proportions of different behavioral classes with different lower-case letters were significantly different (Goodman proportion test – within multinomials; $p < 0.05$).

is the first time that a high rate of inactive behavior of a wild cat is detected during the evening/night period in a zoo, despite our relatively small sampling for each jaguar. This fact indicates that, although jaguars - as well as other felines - are natural nocturnal hunters (Nowak, 1999; Cheida *et al.*, 2006; Santos *et al.*, 2009), they could be very inactive during the night in captive environments. This is also emphasized by the fact that the two jaguars evaluated here expressed such high inactivity even considering that both presented different ages and had different health and handling conditions (see Materials and Methods section). This observation shows that the frequent expression of Inactive behavior in such different specimens might in fact reveal a stressful situation and low welfare conditions, as has been proposed (Davey, 2007) and considered (Maia *et al.*, 2012; Godinez *et al.*, 2013; Boccacino *et al.*, 2018) by other authors, being even worse than previously thought. Future studies, with greater behavioral sampling per specimen might result in a generalization of our findings. Although the sampling was low and the behavior of the jaguars was recorded only during some nights, this does not compromise our conclusion, since the inactivity was significantly very high; however, a larger volume of observations is required to corroborate the relationship between inactivity and feeding periods.

We have also found that, regardless of whether the jaguars had been fed or not, Active Standing and Movement behaviors were more frequently expressed than other behaviors such as Drinking, Human Interaction, and Out of Sight behaviors, which were, on the other hand, the least frequent behaviors for both jaguars (Fig. 1). This was expected, since similar results were found during the diurnal period in a previous study (Boccacino *et al.*, 2018). Moreover, at evening/night it is much less common for humans to be near the enclosures, thus restricting the interaction with humans or zookeepers at the time when the jaguars returned to the indoor enclosures in the late afternoon. This lack of humans near the enclosures at evening/night also had likely minimized the need to seek out of sight hiding areas during the night.

Furthermore, the availability of food evoked different responses in the two female jaguars of this study. During the night period, when the jaguars were fed, Gabi was more inactive and correspondingly expressed less active-related behaviors (Active Standing and Movement behaviors) while the behavior of Negona was the opposite (Fig. 1). Moreover, only Negona expressed a higher frequency of Maintenance behavior at night when fed (Fig. 1). Such findings indicate that the effect of food availability on nocturnal behaviors is variable between these two jaguars, thus emphasizing that the high inactivity recorded at night for both jaguars might in fact represent an abnormal and negative behavior not related just to the natural feeding habits of these animals. Such individual differences of behavioral responses detected in our study agree with the findings of Sellinger and Ha (2005), who noted that two other jaguars expressed

different behavioral responses when exposed to public visitation, as well as with the findings of Vidal *et al.* (2016), who found individual behavioral differences among three jaguars exposed to environmental enrichment. Moreover, it is also important to mention that in the present study, the two jaguars presented different ages and were under different health and handling conditions, which could, at least partially, explain the different behavioral responses of these jaguars at night according to the feeding status. This highlights the need to evaluate behavioral responses of zoo animals individually, always considering the biological, environmental, and management differences among the different animals.

CONCLUSIONS

The two assessed female jaguars were as inactive during the evening/night as they were during daytime, since we have also found significantly greater inactivity of these same specimens during the day period, in another study (Boccacino *et al.*, 2018). Therefore, such inactivity should be regarded as an abnormal behavior of these animals, thus indicating the need to improve their welfare conditions in captivity for the benefit of the animals, as well as for conservation purposes. This is even more important considering that poor welfare conditions might compromise the reproduction of animals in zoos since, as reported by Morato *et al.* (1999), male jaguars express a high level of morphologically abnormal sperm production in zoos, thus reducing the reproductive success of these animals. Furthermore, we recommend that the jaguar behavior should be assessed individually in future studies, since the responses to the restrictions imposed by the captive environment varied significantly between the mother (Negona) and the daughter (Gabi) specimens. Nevertheless, our data proved to be insufficient to provide any conclusion about the relation between the inactivity behavior and the feeding status due to the different responses recorded, which, therefore, requires further investigation.

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DISCLOSURE OF INTEREST

The authors declare that there is no conflict of interest.

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