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Effects of nocturnal outdoor enclosure access on space use and sleep-related behaviour in captive giraffes

Miho Saito[1,2,3], Masayuki Matsunaga[2], Hiroki Fukuizumi[2] and Masayuki Nakamichi[3]

[1]*Graduate School of Asian and African Area Studies, Kyoto University, Japan*
[2]*Kyoto City Zoo, Japan*
[3]*Graduate School of Human Sciences, Osaka University, Japan*

Corresponding author: Miho Saito, email; saito.miho.2w@kyoto-u.ac.jp

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Abstract

Traditional management of large captive animals in zoos involves keeping them outside enclosures during the day and indoors before dark until the next morning. However, the indoor conditions may be uncomfortable for animals especially during summer because of small space, high temperature and humidity. The present study evaluated the nocturnal space utilization and sleep characteristics of giraffe housed in outdoor enclosures (partially covered with sand or grass) compared to those maintained in indoor enclosures a 5–7 mm^2 small stone surface. Specifically, we examined two key aspects: 1) space usage between daytime and night-time for three giraffes, and 2) characteristics of sleep-related behaviour (recumbent posture) in indoor and outdoor enclosures during night-time for four giraffes. The study was conducted at Kyoto City Zoo, Japan over a period of 18 nights in 2020, as well as during daytime hours and an additional 13 nights in 2021. Daytime space usage was assessed through direct observation, whereas night-time observations were made using camera traps and night-vision remote cameras. A modified Spread of Participation Index (mSPI) was employed to analyse space usage. Results indicated that mSPI values did not significantly differ between daytime and night-time for all individuals. Regarding sleep-related behaviour, the older female predominately chose to lie on grass in the outdoor enclosure and remained in the lying position for longer periods compared with the indoor enclosure. We concluded that careful consideration should also be given to individual-level impacts, while housing giraffes outdoors during summer night-time did not negatively affect their behaviours.

Introduction

Improving animal welfare in captivity requires a holistic approach that takes into account resource availability, environmental factors and importantly, the amount of space provided. Reduced space has been linked to increased aggression in dama gazelles *Gazella dama mhorr* (Cassinello and Pieters 2000) and the emergence of stereotypic behaviour in giraffes *Giraffa camelopardalis* (Bashaw et al. 2001; Breton and Barrot 2014).

Traditionally, large animals in Japanese zoos are kept in outdoor enclosures during the day and moved to indoor enclosures before nightfall and until the next morning for their safety and to avoid harsh conditions. However, indoor enclosures can be uncomfortable for animals especially during hot seasons, as they are typically smaller and have higher temperature and humidity levels than outdoor enclosures. For example, in good summer weather cattle exhibit a preference for accessing outside pastures at night (Legrand et al. 2009) and Asian elephants *Elephas maximus* sleep for longer durations when provided with access to outdoor spaces in warmer weather (Evison et al. 2020). It remains unknown whether night-time husbandry changes positively impact animal welfare or potentially induce stress as animals may be accustomed to their established routine of staying indoors at night. Consequently, evaluating the effects of keeping animals in outdoor enclosures during night-time is essential to determine its effectiveness in enhancing captive animal welfare.

One welfare indicator, the modified Spread of Participation Index (mSPI) (Plowman 2003), assesses enclosure complexity. Previous studies on captive animals have linked lower mSPI values to enrichment interventions or absence of visitors (de Vere 2018; Goswami et al. 2021; Rose and Robert 2013). Asiatic lions *Panthera leo persica* have been shown to exhibit a positive mSPI–stereotypy relationship, involving stereotypies such as pacing (Goswami et al. 2020). Stereotypies may indicate stress levels (Mason 1991), with pacing observed in giraffes (Bashaw et al. 2001; Breton and Barrot 2014; Gottlieb et al. 2013). Therefore, evaluating mSPI differences between daytime and night-time is vital to gauge husbandry change effectiveness on welfare. Individual characteristics also influence mSPI, as shy individuals display higher mSPI values than bolder counterparts (Goswami et al. 2020).

Captive giraffes are typically housed indoors at night where they engage in active behaviours such as feeding and inactive behaviours such as recumbency, which are also exhibited by wild giraffes (Burger et al. 2020a, 2021; Takagi et al. 2019). The European Association of Zoos and Aquaria (EAZA) Giraffe Ex-situ Programmes (EAZA Giraffe EEPs 2006) emphasise the provision of ample space in enclosures to ensure the highest standards of care for animals in zoos. In captivity, particularly in zoo settings, outdoor enclosures offer significantly more space than indoor enclosures, making them more favourable for animals in terms of increased space availability.

Sleep is essential for the physical and mental wellbeing of mammals (Owczarczak-Garstecka and Burman 2016). Transportation to an unfamiliar facility has been shown to cause temporary sleep disruption in giraffes (Sicks 2012). Therefore, measuring night-time sleep or sleep-related behaviour serves as a valuable indicator to assess the positive or negative impact of housing management differences on giraffe behaviour.

The present study aimed to investigate the effects of night-time outdoor enclosure access on giraffe behaviour, focusing on the following aspects: individual-level space usage differences between daytime and night-time in outdoor enclosures and lying behaviours in indoor and outdoor enclosures at night. The study findings offer valuable insights for future captive management of giraffes during night-time.

Materials and methods

Observations were conducted at Kyoto City Zoo, Japan, during three data collection periods: 1) night-time indoor enclosure observations, 2) daytime outdoor enclosure observations and 3) night-time outdoor enclosure observations. A comprehensive overview of each data collection period is provided in Table 1. Occasionally, daytime observations were halted due to rain or the giraffes being moved to a smaller outdoor enclosure by zookeepers. Consequently, daytime observation data were considered if the total observation time exceeded 4 hours per day. Throughout the observation period, giraffes were exclusively housed within the outdoor enclosures during daytime hours, with no opportunity for independent selection between indoor and outdoor environments. Due to a malfunction of the data storage server associated with the night-vision camera in the indoor enclosure in 2021, a comparative analysis was conducted utilising data collected from the indoor enclosure in 2020 and data obtained from the outdoor enclosures in 2021.

Subjects and housing conditions

During the 2020 study period, three unrelated adult reticulated giraffes *G. c. reticulata* comprised the study group, consisting of one male (M1) and two females (F1 and F2; Tables 1 and 2). On 10 February 2021, F2 gave birth to a male calf (M2).

The giraffes typically entered the outdoor enclosure around 0900 and returned to the indoor enclosure at approximately 1600. Data collection focused solely on the large outdoor giraffe enclosure (1,097 m^2), the ground of which was covered in sand. Certain areas within the enclosure were enhanced with a specific breed of centipede grass. During the daytime, the giraffes shared the large outdoor enclosure with one or two Grevy's zebras *Equus*

Table 1. Details of data collection periods

Data collection	Period 1	Period 2	Period 3
Description	Indoor enclosure observations	Outdoor enclosure observations	Outdoor enclosure observations
Data collection time	Night	Day	Night
Participating giraffes	F1, F2, M1*	F1, F2, M2	F1, F2, M2
Study period	August to September 2020	September to October 2021	August to October 2021
Observation hours	1900 and 0700	0900 and 1600	1900 and 0700
Observations days in total	18 nights	12 days	13 nights
Total hours of observation	216	58	156
Data set purpose	Lying bout duration analysis	Space use analysis Lying bout duration analysis	Space use analysis Lying bout duration analysis

*M1 was housed in a separate indoor enclosure to the females

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grevyi. The females consistently occupied the same outdoor enclosure, although there were three daytime housing conditions: 1) F1, F2 and M1 together; 2) F1, F2 and M2 together and 3) F1 and F2 together without any males. During the night-time in the outdoor enclosure, the females were always with M2 but not with M1.

The indoor enclosure used by the two females during the night-time measured 100 m^2 and had a floor covered with broken stones (5–7 mm^2). The stones were replenished every three to four months from the outdoor enclosures. Throughout the night-time period, M1 was always separated from the females, whereas M2 joined the females in 2021. Both indoor and outdoor enclosures provided the giraffes with hay cubes, dry lucerne hay and branches ad libitum. Water was made available as needed in both enclosures.

Data collection

In this study, the focus was solely on lying posture as a sleep-related behaviour (Takagi et al. 2019). Lying posture was defined as lying on the trunk and abdomen or flank with the legs folded under and slightly displaced to the sides without any movement, which was defined by Tobler and Schwierin (1996) as a sleep behaviour. Due to limitations in video camera resolution, it was not possible to reliably record short spontaneous movements of the eyes or ears, which are typical indicators of rapid eye movement (REM) sleep. Therefore, the term 'sleep-related behaviour' was used instead of 'sleep behaviour' or 'recumbent sleep' to avoid confusion, as described previously by Takagi et al. (2019). A single bout of lying behaviour was defined as starting when the trunk touched the ground and ending when the giraffe returned to a standing position. The time when the individual began to lie down and stand up were recorded. This study primarily aimed to investigate the influence of enclosure type on sleep-related behaviours in giraffes. Therefore, cases where the start or end of a lying bout were not observed or when the lying individual was awakened by another individual were excluded from the analysis of lying duration.

The large outdoor enclosure was divided into 11 zones (Table 3), with certain areas containing resources such as feeding locations. Scan sampling (Martin and Bateson 1986) was used to record the zone ID of each animal at 10-minute intervals. The occurrence of stereotype behaviours (pacing and licking non-food objects) was also monitored at 10-minute intervals. These behaviours were chosen as they represent the most prevalent stereotypies observed in giraffes (Bashaw et al. 2001). The zones were designated and mapped using a satellite picture of the enclosure obtained from Google Earth™ Pro, and the areas (m^2) of each section were calculated.

A night-time monitoring video camera was installed in the indoor enclosure, running continuously for a 24-hour period. The video data were automatically stored on the server once per day. The recorded video data were used to measure the duration of each individual's lying bouts.

To monitor night-time behaviour in the outdoor enclosure, eight Bushnell 16MP Trophycam HD E3 night-vision cameras were positioned at strategic locations. The cameras were programmed to be active from around 1700 to 0800 the following day. Videos recordings were motion-activated, capturing a 1-minute image sequence after each trigger. The memory card and battery of each camera were replaced every morning. During each 10-minute interval, the zone ID of each giraffe present in the enclosure was recorded throughout the night. For the analysis of lying duration, it was assumed that the giraffes maintained their recumbent posture and location throughout periods where camera data were unavailable between the observed initiation and termination of lying bout. The analysis focused on the duration of individual lying bouts rather than the total lying duration per night. A total of 32 of the 145 bouts were excluded from the analysis owing to incomplete observation of bout end times or interruptions caused by other individuals.

Data analysis

Enclosure usage was evaluated using the mSPI, which accounts for unequal zone sizes (Brereton 2020; Plowman 2003; Rose et al. 2018; Rose and Robert 2013). Lower mSPI values (toward zero) indicate wider zone usage, whereas higher mSPI values (toward one) indicate narrower zone usage. The mSPI is an advancement of the SPI (Plowman 2003), which divides the enclosure into equal-sized zones. SPI encounters several issues as animals use the enclosure space based on the location of desired resources and/

Table 2. Demographic information of study giraffes

ID	M1	M2	F1	F2
Sex	Male	Male	Female	Female
Name	Ibuki	Mikuni	Mirai	Mei
Birth date	6 Apr 2017	10 Feb 2021	24 Mar 2001	18 May 2013
Transferred date to Kyoto City Zoo	28 Jun 2018	N/A	24 Oct 2005	10 Nov 2014

or features they aim to avoid. Frequently, resources that animals use effectively are relatively small compared with the zone in which they are located. Consequently, these zones are recorded as being frequently used, despite only a small portion of the zone being visited. Conversely, if animals strongly avoid certain features that are relatively small compared with the zone size, this can lead to an underestimation of enclosure usage. To address these challenges, mSPI allows for the use of unequal zones, where zones of varying sizes can be assigned based on enclosure resources that hold significance for the animals. Natural features are used to mentally map these resources within the enclosure and delimit the boundaries of each zone.

The mSPI difference between daytime and night-time was compared using a generalised linear model (GLM) with a gamma distribution and a log link function implemented using the lme4 R package (Bates et al. 2015). The GLM models included the mSPI as the response variable, and the time (day or night), highest temperature for daytime (21.1–31.3°C) and lowest temperature for night-time (16.8–26.4°C) as explanatory variables. Temperature data for Kyoto City on each observation day was obtained from the Japan Meteorological Agency. Stepwise selection based on the Akaike information criterion (AIC) was performed using the StepAIC tool from the MASS R package (Ripley et al. 2013) to select the best-fit model with the smallest AIC value. Models with AIC values of ≤2 were considered competitive.

The Kruskal–Wallis test was used to compare individual differences in mSPI values and lying bout duration (min) across the three individuals between indoor and outdoor conditions. When statistically significant differences were found, the Mann–Whitney U test was used for multiple comparisons with the Bonferroni correction. The Wilcoxon rank sum test was used to compare differences in lying bout duration (min) between indoor and outdoor conditions for each female. Furthermore, Fisher's exact test was used to assess whether there was a difference in the pattern of which females initiated lying first between the indoor and outdoor conditions. This analysis focused on the first bout of lying behaviour for each observational day for the two adult females, as one giraffe started her second lying bout while the other was still in her first lying bout. The time duration between when F1 ended the lying bout and when F2 stood up in indoor and outdoor conditions was also tested using the Wilcoxon rank sum test.

Table 3. Areas of designated zones in the giraffe outdoor enclosure

Zone	Name	Area (m^2)
1	Browsing and drinking areas	36
2	Corners	22
3	Housing	309
4	Short grass area	188
5	Next to wood deck	110
6	Landscape tree 1	10
7	Landscape tree 2 with wooden table	24
8	Landscape tree 3	10
9	Landscape tree 4	10
10	Landscape tree 5	10
11	Others	368

All statistical analyses were performed using R version 4.0.3 (R Core Team 2018). The significance level was set at P<0.05 (two-tailed). Mean±standard error values are reported.

Results

Comparison of daytime and night-time space usage

The mSPI values of individual giraffes did not differ significantly between daytime and night-time (Table 4), although F1 and F2 appeared to favour zone 4, the 'short grass' area, during night-time more than daytime (Figure 1). Zones 1, 3 and 11 had the greatest overall use both in daytime and night-time. Temperature had a significant effect on F1's mSPI value; F1 exhibited a bias toward certain areas of the enclosure as the temperature became hotter.

Table 4. Results of generalized linear models assessing factors influencing modified Spread of Participation Index values in three giraffes (significance level: P<0.05)

ID	Factor	Estimate	Std. Error	t	P
F1	AIC=−29.58: mSPI~Temperature				
	(Intercept)	−1.377	0.218	−6.311	<0.01
	Temperature	0.036	0.009	4.144	<0.01
	AIC=−28.56: mSPI~Time+Temperature				
	(Intercept)	−1.057	0.388	−2.726	0.013
	Time_Night	−0.119	0.118	−1.005	0.327
	Temperature	0.026	0.014	1.895	0.072
F2	AIC=−76.29: mSPI~1			-14.15	
	(Intercept)	−0.784	0.055	0	<0.01
M2	AIC=−27.37: mSPI~1			-13.14	
	(Intercept)	−0.600	0.046	0	<0.01

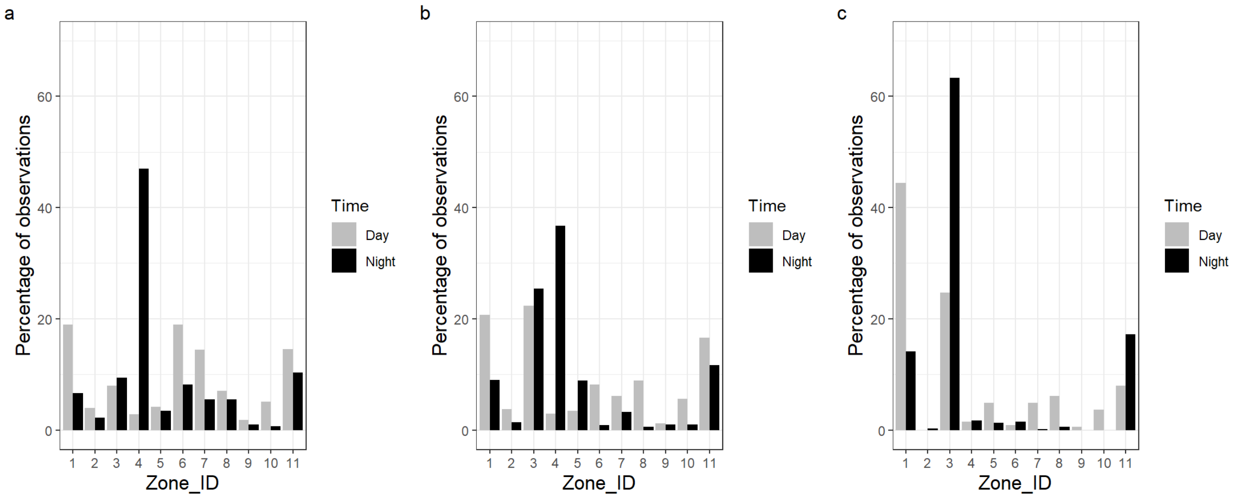

Figure 1. Distribution of observed locations for each giraffe (a. F1, b. F2, c. M2) across zones within the outdoor enclosure during daytime and night-time

Significant differences in the mSPI among the giraffes were observed during both daytime (F1 versus F2: P<0.001; F1 versus M2: P=0.017; F2 versus M2: P=0.051; Figure 2a) and night-time (F1 versus F2: P=0.042; F1 versus M2: P=0.920; F2 versus M2: P=0.226; Figure 2b). F2 exhibited the lowest mSPI value for both daytime and night-time.

Comparison of indoor and outdoor sleep-related behaviour during night-time

In the indoor enclosure, 47 lying bouts (139±54 min) were recorded for F1, 73 (96±73 min) for F2 and 87 (92±31 min) for M1. In the outdoor enclosure, 22 lying bouts (158±59 min) were observed for F1, 38 (82±47 min) for F2 and 53 (53±32 min) for M2. F1 exhibited significantly longer lying bout durations compared

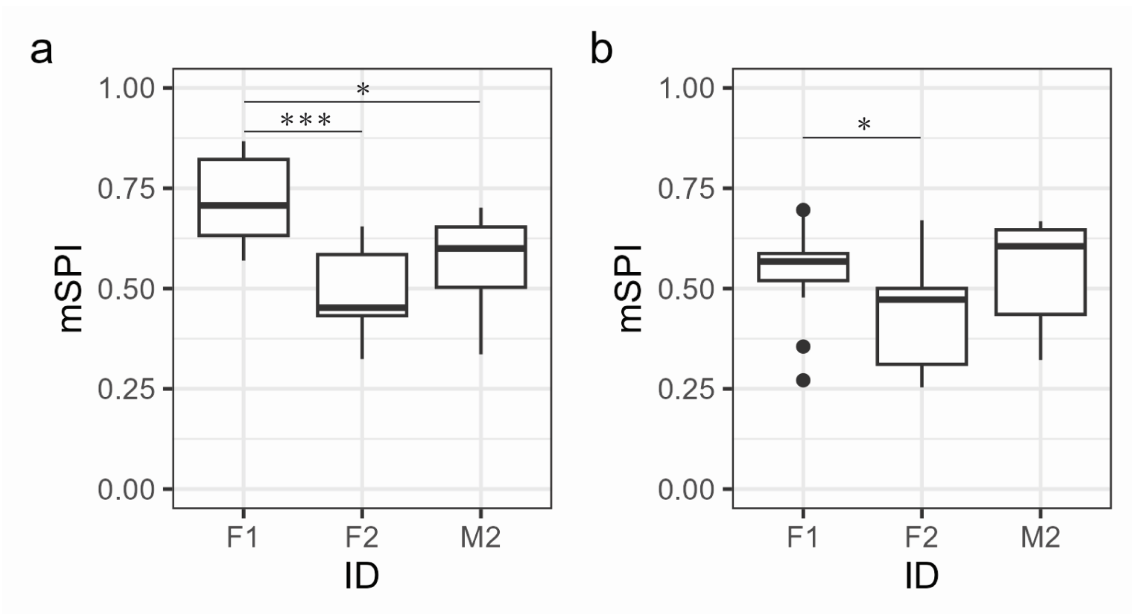

Figure 2. Modified Spread of Participation Index values for study individuals (F1, F2, M2) during (a) daytime and (b) night-time. Significance levels: * P<0.05, ** P<0.01, *** P< 0.001.

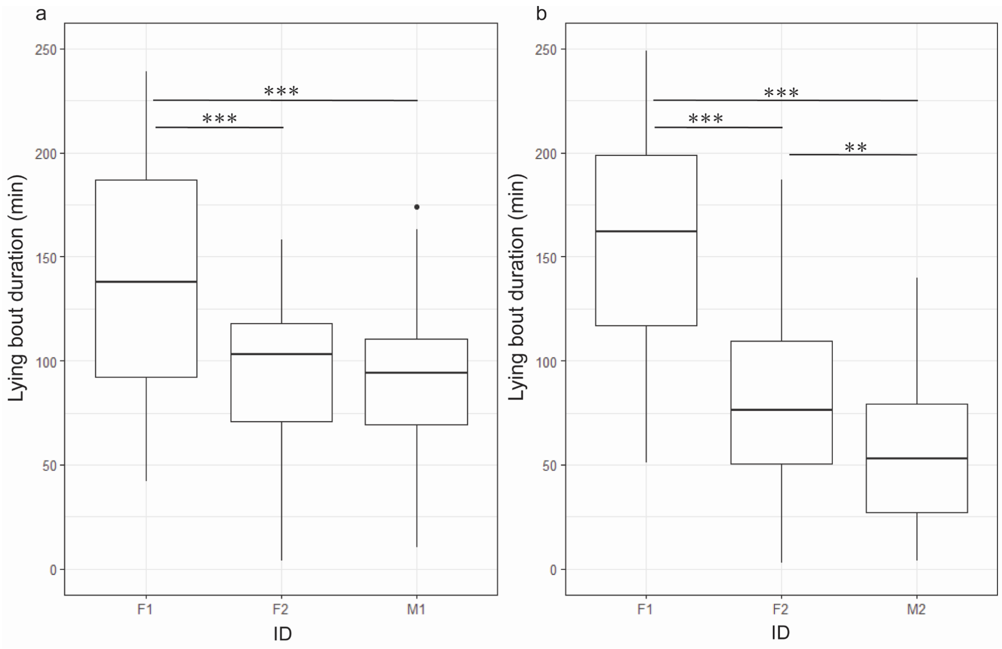

Figure 3. Lying duration (min) of giraffes in the (a) indoor enclosure (F1, F2, M1) and (b) outdoor enclosure (F1, F2, M2). Significance levels: * P<0.05, ** P<0.01, *** P<0.001

with F2 and M1 in the indoor enclosure (F1 versus F2: P<0.001; F1 versus M1: P<0.010; F2 versus M1: P=0.232; Figure 3a). Similarly, in the outdoor enclosure, F1 had significantly longer lying bout durations compared with F2 and M2 (F1 versus F2: P<0.001; F1 versus M2: P<0.001; F2 versus M2: P=0.004; Figure 3b). M2, the youngest individual, showed the shortest lying duration compared with the adult females.

F1 had a significantly longer lying duration in the outdoor enclosure compared with the indoor enclosure (W=4,761, P<0.001; Figure 4a) whereas F2 exhibited the opposite pattern, with a shorter lying duration in the outdoor enclosure (W=12,321, P<0.001; Figure 4b).

There is a significant difference in the individual that initiated lying behaviour first during the initial lying bout of each night in the indoor and outdoor enclosures (P<0.01). F1 predominantly initiated lying in the outdoor enclosure whereas F2 was the primary initiator in the indoor enclosure (outdoor: 10 times versus 2 times; indoor: 4 times versus 13 times). The duration between when F1 stood up and when F2 stood up next was significantly shorter in the outdoor enclosure compared with the indoor enclosure (W=676, P<0.01; 6±46 min versus 14±28 min). Interestingly, when F2 initiated lying after another individual had already started lying in the outdoor enclosure, she tended to select a lying place within two body lengths of F1 or M2 in 28 out of 40 lying bouts (70%).

Discussion

Comparison of daytime and night-time space usage

The mSPI value is known to have a positive relationship with the occurrence of abnormal repetitive behaviours, which are an indicator of stress levels (Goswami et al. 2021; Shepherdson et al. 2013). There were no differences in mSPI values between daytime and night-time observations for individual giraffes. The three giraffes were mainly spotted in zones 1, 3 and 11 during both daytime and night-time. These zones correspond to browse/water, housing and 'other' (walking area), suggesting that regardless of time of day, the giraffes preferred areas with important resources. The enclosures were constructed in 2013 and the two adult females have been in the zoo since 2005 and 2014 respectively. The practice of keeping giraffes outside during summer nights began in 2020. Therefore, it is possible that the giraffes have become accustomed to their enclosure and the changes in husbandry. Additionally, M2, who experienced being in an outside enclosure during night-time for the first time, did not show any significant difference in space usage between daytime and night-time. Based on these findings, housing giraffes in an outside enclosure during night-time does not have a negative impact on their space usage.

Significant differences in mSPI values among giraffes were observed both during daytime and night-time. F2 consistently exhibited lower mSPI values compared with the other individuals

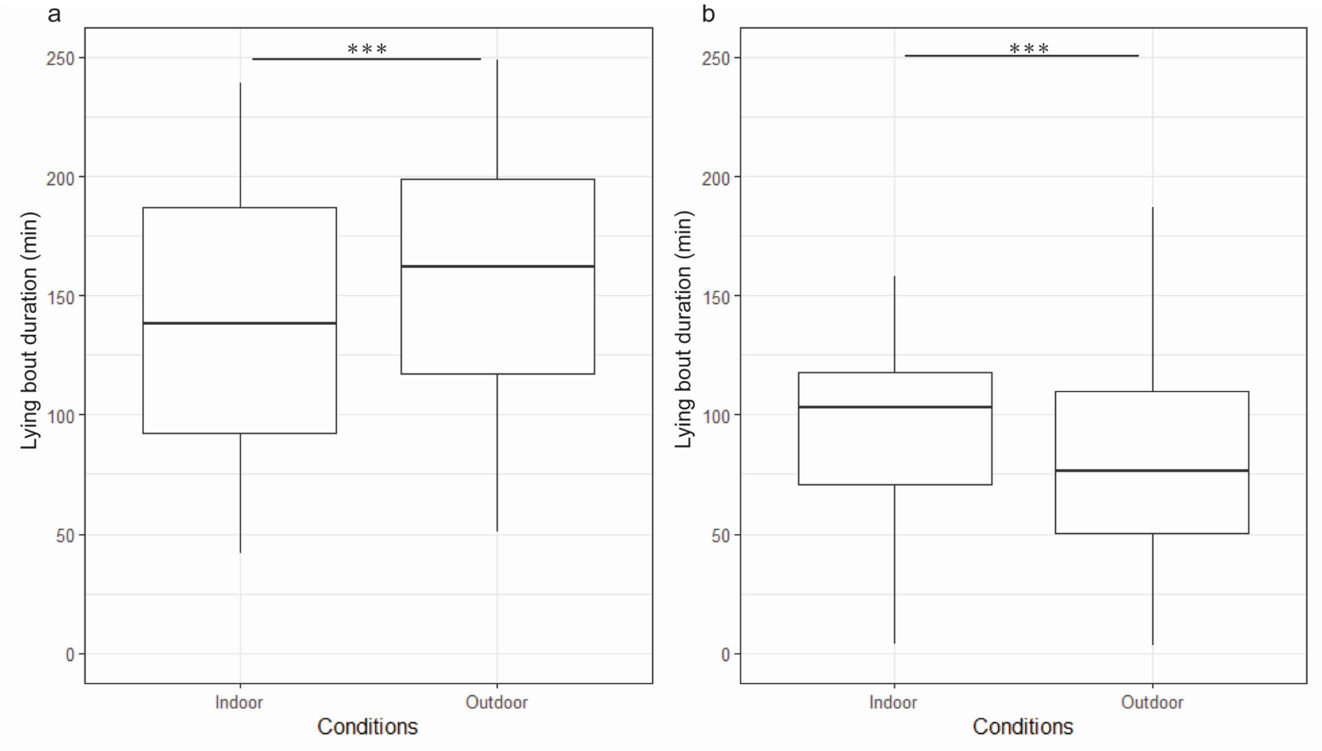

Figure 4. Lying duration (min) of (a) F1 and (b) F2 in indoor and outdoor enclosures. Significance levels: * P<0.05, ** P<0.01, *** P<0.001

under both conditions. M2, the calf of F2, received artificial nursing due to neglect from F2 and M2 was never observed attempting to suckle from F2 during the study period. It can be concluded that M2 had no impact on F2's behaviour, such as walking around to avoid M2's attempts to suckle. In animals that show abnormal repetitive behaviour such as pacing, the mSPI value indicates high enclosure-use bias i.e. the mSPI value is close to one (Goswami et al. 2020). Interestingly F2 displayed pacing behaviour more frequently than F1 and M2 (F1 and M2 were never observed pacing but F2 paced almost every afternoon). The lower mSPI values of F2 can be explained by her pacing behaviour, which involved walking in large circles inside the enclosure and covering multiple zones. It is important to consider not only the mSPI value but also the pattern of the pacing route to further understand the differences in mSPI data.

Temperature was identified as a factor that affected mSPI values, specifically influencing F1, who exhibited higher enclosure-zone biases when the temperature was high. In the wild, giraffes tend to rest in standing or lying down postures more frequently when the temperature is higher (Saito and Idani 2020). Similarly the giraffes in this study selected shaded areas during midday for resting and stayed in these areas continuously for a few hours. F1, the oldest individual in this study (19 years old in 2020), may have been more susceptible to heat stress. Notably the average female giraffe's life expectancy in the wild is 17.9 years (Bercovitch and Berry 2017). Therefore, the higher enclosure-zone biases observed in F1 under hotter temperature conditions, compared with those of the younger giraffes, can be attributed to age-related differences and increased susceptibility to heat stress (Renaudeau et al. 2012).

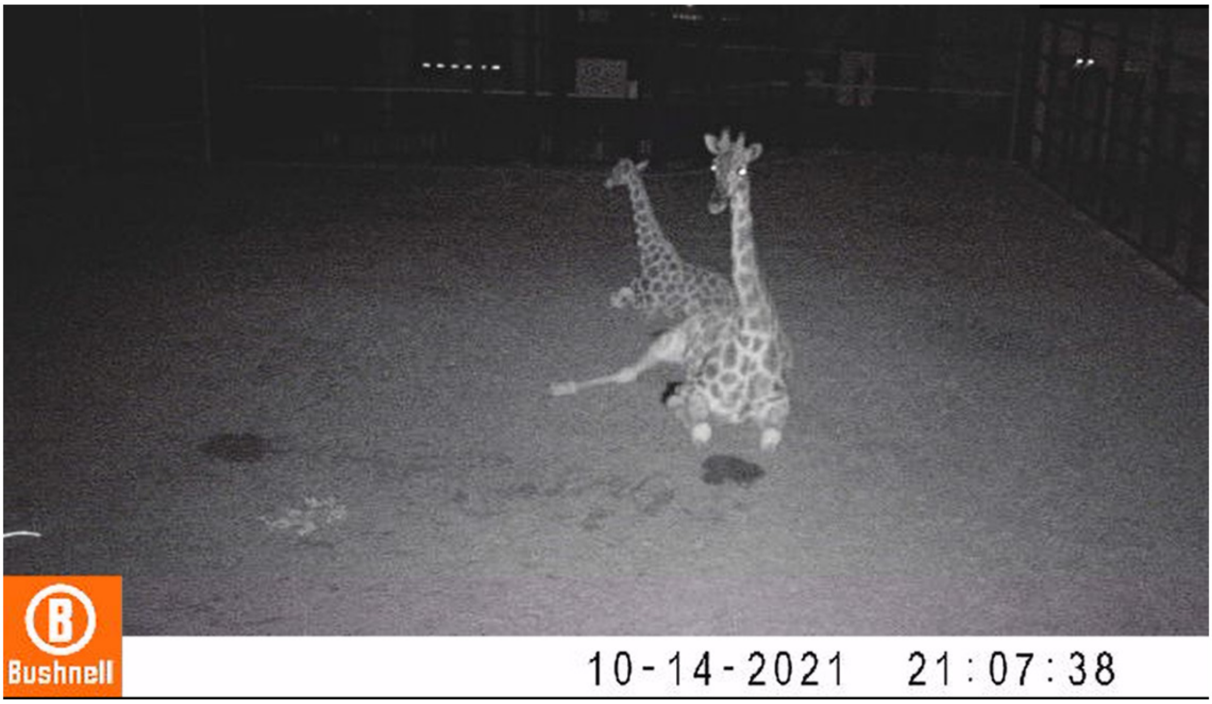

Figure 5. F2 lying (in the front) beside M2 (in the back) after F1 initiated lying down.

Comparison of lying behaviour during night-time

Individual variations in sleep-related behaviours were observed. F1 exhibited longer lying durations than the other three individuals, regardless of the indoor or outdoor conditions, whereas the calf M2 had shorter lying durations than the adult females. This pattern aligns with the behaviour of giraffe calves in the wild, who lie down for shorter periods but do so more frequently during the daytime (Saito and Idani 2020). Burger et al. (2020b) documented a trend where younger individuals slept for longer total durations at night compared to older individuals. It is plausible that younger giraffes like M2 might find it easier to stand up and resume lying down due to their smaller body size. This could potentially explain the observed significant differences in sleep behaviour between M2 and the adult females in this study. Although the oldest individual F2 exhibited a potentially contrasting pattern with longer lying durations, this might be attributable to factors beyond age. Leg-related limitations associated with the act of lying down and rising could potentially explain this observation. However, further investigation is necessary to confirm this hypothesis.

Resting behaviours can serve as useful indicators for measuring stress levels, as they show a negative relationship with stress (Abou-Ismail et al. 2007; Evison et al. 2020; Wells 2005). The present results reveal that F1 exhibited longer lying bout durations when she was in an outdoor enclosure. In a previous study, Takagi et al. (2019) recorded F1's sleep-related behaviour during night-time in an indoor enclosure for 199 days, reporting an average lying bout duration of 136±86.7 min when she was not in the pre- or post-parturition period. This duration was not markedly different from the indoor enclosure data obtained in the current study (139±54 min), although the duration in the outdoor enclosure was longer (158±59 min). The outdoor enclosure may provide a more comfortable environment for F1 to lie down in. This is similar to captive African elephants *Loxodonta africana*, which engage in recumbent behaviour only when the environment is comfortable (Koyama et al. 2012). One factor contributing to this comfort is the difference in ground substrate. In the outdoor enclosure, specific areas were covered with grass as part of a project and F1 chose those areas for the majority of her lying bouts (74.36% of 39 bouts). Ground substrate differences have been found to impact sleep-related behaviour in elephants (Holdgate et al.

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2016), horses *Equus caballus* (Pedersen et al. 2004) and cows *Bos taurus* (Mandel et al. 2016). Elephants in all-soft substrate conditions (grass, sand or rubber) spend 1.1 hours longer engaged in recumbency than those who spend no time on such substrates (Holdgate et al. 2016). Cows spend more time lying on straw compared with sand (Mandel et al. 2016). Therefore, the comfort provided by the ground substrate may have triggered longer lying bout durations for F1 in the outdoor enclosure. Conversely, F2 exhibited the opposite pattern, lying for shorter durations in the outdoor enclosure compared with the indoor enclosure. Notably, F2 predominantly initiated lying bouts in the indoor enclosure (76.47%) but not in the outdoor enclosure. Furthermore, she chose lying places close to F1 or M2 (Figure 5), with occasional body contact between F2 and F1 in the outdoor enclosure.

The zookeepers described F2 as being more nervous in temperament (Matsunaga personal communication). Social relationships are known to influence relaxed behaviour in animals. For example, in Asian elephants, individuals with weaker bonds tend to have longer sleep durations when they move (Evison et al. 2020). Separation from a strongly bonded individual can lead to a decrease in standing, which is one of the resting postures in giraffes (Tarou et al. 2000). Therefore, it is possible that F2 felt more at ease during this change of husbandry when near F1, who has been in the zoo for a longer time and is older than F2. This study highlights the need for long-term, in-depth investigations to determine the time required for nervous individuals to re-establish sleep patterns comparable to those observed within the indoor enclosure. While the current analysis utilised sleep behaviour data within the indoor enclosure from both 2020 and 2021, future studies aiming for a more precise examination of lying behaviour should ideally gather data from the same year. This approach would enable better control of social structures and environmental variables like temperature and sunshine exposure.

In summary, this study examined how giraffes responded to a husbandry change by comparing their space usage and sleep-related behaviour patterns under different enclosure conditions (indoor night-time and outdoor daytime). Overall, the impact of the husbandry change on space usage was positive as the giraffes maintained similar mSPI values. Unfortunately, in 2021 due to management issues the giraffes were not able to use the indoor enclosure when they were in the outdoor enclosure during night-time. Allowing access to both indoor and outdoor enclosures during night-time may provide a more comfortable environment for the giraffes. As suggested in a previous study (Wolfensohn et al. 2018), individual differences in response to this husbandry change were also examined. The findings reveal that changes in sleep-related behaviour varied among individuals with some individuals exhibiting longer or shorter lying durations and differences in the individual who initiated lying bouts. To implement management changes effectively, nervous individuals should be kept with an older or familiar individual to minimise any negative impact. Outdoor enclosures are generally larger than indoor enclosures in many captive settings. Allowing giraffes to access the outdoor enclosure during night-time under favourable weather conditions, as this study has shown, could be an effective solution to address space limitations. However, to fully understand the effectiveness of this husbandry change in enhancing animal welfare, it is important to exercise caution when interpreting individual-based data on relaxed behaviour.

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