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Nocturnal Behaviour of Three Zoo Elephants (*Loxodonta Africana*)

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Abstract
Few studies have investigated the behaviour of zoo elephants and how their personality is expressed when exposed to different stimuli e.g. a higher number of visitors. Observing the nocturnal behaviour is especially important, because it reveals information about the welfare of the elephants when they are not normally observed. The nocturnal behaviour of three female African elephants (*Loxodonta africana*) in Aalborg Zoo, Denmark, was studied to create activity budgets and to evaluate if 1) a period with a 4.8 times increase in visitors affected the nocturnal behaviour; and 2) the three elephants exhibited differences in personality. Behavioural data were collected for six nights between 20:00-06:00, and all-occurrence sampling was used to record all types of behaviour. The average of the three elephants showed that the most common behaviours observed during the night was feeding (43±6%) followed by lying (28±5%) and inactive behaviour (16±5%). The elephants laid down an average of 2.4-3.1 hours per night starting at 20:00, and they never laid down before 22:00. No clear pattern of behavioural changes of the elephants was found when there was an increased number of visitors in the zoo. When comparing the intervals of time, the individuals spent on a certain behaviour, and thereby comparing the individuals, several significant differences were found between the medians and interquartile range (IQR). Significant differences were also found in the slopes of the medians, IQR, skewness, and kurtosis for the distribution of the time intervals of the behaviours between the period with lower number of visitors and the period with a higher number of visitors. In an overall perspective, the results indicated that the elephants displayed distinct personalities.
Keywords: African elephants; Nocturnal; Behaviour; Personality; Activity budget; Captivity; *Loxodonta Africana*; Zoo

Introduction

The observation of nocturnal behaviour of captive elephants can help improve the understanding of their behaviour during the night, e.g. how much time they spend feeding, sleeping, or performing stereotypical behaviour. This information is very useful because the nocturnal behaviour when the elephants are not observed, may differ from the behaviour during the day. It is beneficial since it enables a potential improvement of the care and management of the animals, for instance, regarding social conditions, more enrichment, or changes in the design of the exhibit (Holdgate et al., 2016; Horback et al., 2014; Schiffmann et al., 2018). Studies examining the behaviour of elephants in different zoos found that the presence and softness of the substrate in the exhibit affected how much the elephants laid down, which is an example of behavioural studies suggesting improvements of the welfare of zoo elephants (Boyle et al., 2015; Holdgate et al., 2016).

Zoological institutions enable visitors to watch the animals at a relatively close range, which is unnatural, and it is essential to know whether the visitors affect the animals in a way that is displayed in the behaviour of the animals. Observing how the elephants respond to periods with a higher number of visitors i.e. during vacations in the zoo opposed to periods with a lower number of visitors (off season) can help document if they are affected by the presence of the public, and if there is to be taken measures to ensure a less stressful environment for the elephants. One of the ways animals react when affected by stressful

and un-stimulating environments is by displaying stereotypical behaviour, which can be an indicator of compromised animal welfare (Greco et al., 2016). These abnormal behaviours can be defined as repeated movement patterns that have no apparent function or goal, e.g. bobbing, swaying and pacing, which are some of the stereotypical behaviours displayed by elephants in captivity (Greco et al., 2016; Rees, 2009).

Differences between the individual animals can be seen when observing animal behaviour, and therefore it is relevant to investigate the personalities of the animals. This means that individual animals could have a different response and reaction to a certain stimulus compared to another individual. Animal personality is commonly described as systematic and continuous differences between the behaviour of individuals in such a way that it is consistent across time, and that the behaviour in one situation correlates to the same behaviour in a different situation (Briffa & Weiss, 2010; Dingemanse et al., 2010; Wolf & Weissing, 2012).

Animal personalities have been found in a range of different species across taxa including mammals, reptiles, fish and birds. In populations where different personalities are evident, these are often divided into personality traits, for example, exploration tendency and fearfulness (Wolf & Weissing, 2012). To accurately determine whether two individuals differ in their behaviour, it is relevant to look at both plasticity and personality of the individuals (Dingemanse et al., 2010). Plasticity focuses on the individual responsiveness of the animals to variations in the environment, i.e. behavioural stability, whereas animal personality is concerned with the difference in the average level of displayed behaviour of the individual animals across time and contexts. In other words, plasticity looks at the change in behaviour from one context to another, while animal personality centres around the differences between individuals across contexts (Dingemanse et al., 2010).

The present study seeks to outline the nocturnal activity budgets of the three elephants to (1) test if an increase in the number of visitors during the day has an impact on the individual elephant's nocturnal behaviour; and (2) test if the elephants exhibit different personalities.

Materials and Methods

Subjects

The subjects of this study were three adult female African elephants (*Loxodonta africana*) named Tanja (E1), Maj (E2) and Bibi (E3). At the time of the present study, the keepers considered E1 the matriarch, E2 the second in the hierarchy, and E3 the most subordinate, based on years of subjective observations of the elephants. The elephants were exhibited in Aalborg Zoo, Denmark. They were born in South Africa in the wild around 1982 and relocated to Aalborg Zoo in 1985. At the time of the observations for this study, the three elephants were about 37 years old.

Management and Housing

The keepers showed up no earlier than 07:30 and left the premises at 16:00. If the zookeepers that were affiliated with the elephants were the ones closing the zoo, they left no later than 17:00. Because of changes in matriarchy and past aggression between E1 and E2, E1 was separated from E2 and E3 from approx. 16:00-08:00 in an adjoining stable. At this time of day, E1's enclosure consisted of a 40 m^2 indoor stable and an outdoor exhibit (288 m^2), while E2 and E3's enclosure consisted of two indoor stables (each about 40 m^2) and a 1232 m^2 outdoor exhibit (Appendix 1). Access to the outdoor exhibit was determined by the keepers based on the weather conditions. In this study, the period with a normal number of visitors during the day was affected by unfavourable weather conditions which entailed limited access to the outdoor exhibit.

There were also corridors between the stables and the outdoor exhibit. E1 had access to a corridor measuring 16 m^2, while E2 and E3 had access to one measuring 36m^2.

Each indoor stable contained a hay net suspended from the ceiling as a form of enrichment and a water

supply. The stables had concrete floors, metal wires towards the visitors and several wooden panels along the sides of the stables. There were metal bars between E1's stable and the other elephants' stable, which allowed the elephants to have physical contact with their trunks during the night. The outdoor exhibits consisted of trees anchored to the ground with hay nets attached to them, sand piles and several logs lying on the ground. Furthermore, the larger outdoor exhibit contained a shallow pool, a small pond, large rocks and a suspended log for self-maintenance.

Data Collection

The elephants were observed during the night for 10 hours from 20:00 to 06:00 (DST) for six days in ultimo September and primo October 2019. They were observed during three consecutive days where the number of visitors in the zoo were low during the day (LA), which function as control and during three consecutive days where the number of visitors in the zoo were 4.8 times higher during the day (HA). The two observation periods were two weeks apart, and the three elephants were observed for the same amount of time. Three cameras (ABUS, 25 FPS) were set up beforehand by the zoo, and each was recording one of the three indoor stables. The footage was saved on a server which made subsequent watching possible. The behaviour of the elephants was only observed in the indoor stables due to a scarcity of light in the outdoor exhibit, meaning the movements of the elephants were not visible at night. The recordings were as far as possible made without keeper activity, but this was not possible during LA due to the weather conditions meaning the keepers had to close the doors to the outdoor exhibit during the recordings. The observed behaviours could be divided into several categories (Table 1). Start time and end time were noted every time a behaviour was observed to obtain intervals for how long the elephants performed a certain behaviour.

The two observers recorded start and end time of the intervals for the different behaviours, and these were compared using Spearman's rank correlation to estimate the degree of agreement (Zar, 1999). After observing 10 hours of footage, the index of concordance ranged from 91-100%.

Data Analysis

Data were processed in two different ways, as described in the following. A threshold of at least five data recordings were determined to ensure representative results of the statistical tests. If there were less than five individual data recordings in a behavioural category, statistical tests were not executed. When comparing individuals, the data consisted of pooled data from LA and HA, respectively.

Firstly, the nocturnal activity time budgets for LA and HA were each created by dividing the sum of seconds of each behaviour by the total amount of time the elephants were recorded (10 hr×3 = 108000 s). To test the two hypotheses and thereby test for differences in activity time budgets, χ^2 test were used (Zar, 1999). Secondly, to test the hypotheses, descriptive statistics such as median, interquartile range (IQR), skewness, and kurtosis for the intervals spent on a certain behaviour were found. Since the data were non-normally distributed, a non-parametric approach was applied. To analyse potential significant differences between the medians of the intervals spent on each behaviour, Mann-Whitney U test (pairwise) was used (Zar, 1999). Levene's test for medians was used to find significant differences in the IQR of the intervals (Zar, 1999). Confidence intervals (constructed by bootstrapping) were used to determine whether the skewness and kurtosis of the distribution of the intervals were significantly different. If the confidence intervals were non-overlapping, they were considered significantly different.

Slopes of the medians, IQR, skewness and kurtosis for the distribution of the time intervals of the

Table 1. Ethogram of recorded behaviours.

Behaviour	Description
Feed from ground	Search for food and manipulation of food from the ground or through bars. This included intake of food pellets, hay, and branches from the outdoor exhibit. There was no contact with the hay net.
Feed from hay net	Intake of food from hay net suspended from the ceiling and also fallen hay if the behaviour is in connection with the trunk reaching for the hay net.
Drink	Intake of water.
Inactive	Upright and stationary. This also applied when the elephant was standing still, and no other behaviour was clearly visible. This included both the complete rest and inactive behaviour for a short period of time.
Walk	Movement forward or backwards more than an elephant's body length.
Lie	Recumbent rest. Lying down on the ground.
Sway	Standing, moving from side to side at least three consecutive times. Often in combination with swinging of leg and also movement of food from side to side.
Stereotypy	Any repeating behaviour and behaviour with no obvious purpose lasting for more than three seconds. Included the trunk touching metal wire, touching teats, swinging it back and forth or putting it on the top of the head.
Other	Any behaviour not listed on the ethogram. Included defecation, urination, throwing dust or hay on the body, scratching body with trunk or against a surface, contact of the trunk to another elephant, and activity involving contact with the bars (food was not involved in this).

behaviours were calculated and converted into per cent. This was done to compare the individuals and their change in behaviour from LA to HA. To test for differences between the slopes, χ^2 test were used.

For all statistical tests, $p<0.05$ was considered statistically significant.

Results

The activity budgets, made from an average of the three elephants, were largely similar in LA and HA with the majority of the night being spent on feeding (43±6%), lying (28±5%) and inactive behaviour (16±5%) (Appendix 2).

The progress of the six nights for each elephant relating to the different behaviours can be seen in the cumulative graphs in Appendix 3. Feeding, whether it was from the ground or from hay net, occurred more or less continuously throughout the night. E1 and E2 never laid down until 00:00, and no lying was seen until 22:00 for E3. In general, they laid down between 2.4-3.1 hours per night and woke up between 04:00-06:00. A long duration of inactive behaviour was not distinct until 22:00 for all three elephants. Swaying and other stereotypical behaviour were mostly performed by E1 and E2, whereas E3 only swayed one of the nights for a total of 13 minutes. The elephant that swayed the most during the six days was E1 with a total of 1.2 hours, while E2 performed other stereotypical behaviours the most with a total of 1.1 hours.

Comparing LA and HA Relative to each Individual

In general, there were no statistical differences between the average summarized percentages of the behaviours when comparing the two periods relative to each elephant. The only significant difference found was that E1 spent more time feeding from hay net in LA (27.4%) compared to HA (11.8%) (χ^2=5.2, df=1, p=0.02).

No clear tendencies were found in the interval lengths of each behaviour, but the Mann-Whitney test showed a significantly higher median for walking in LA compared to HA, which was applicable for all three elephants (Table 2). Levene's test for medians showed no clear tendency for either of the elephants concerning the IQR, though in some cases two of the elephants showed similar tendencies.

Table 2. Results of Mann-Whitney U test (pairwise), Levene's test for medians, and a 95% confidence interval of skewness and kurtosis for the time the elephants spent on a certain behaviour in a period with a low number of visitors during the day (LA) and in a period with a higher number of visitors during the day (HA).

	Behaviour	**No. of tests**	**Mann-Whitney**	**Levene's**	**Skewness**	**Kurtosis**
E1	Feed from ground	15	**(LA<HA)** 33%	**(LA<HA)** 20% (LA>HA) 7%	ns	ns
	Feed from hay net	10	ns	ns	ns	ns
	Drink	1	ns	ns	ns	ns
	Inactive	15	(LA>HA) 7%	(LA>HA) 7%	ns	ns
	Walk	15	**(LA<HA)** 13%	**(LA<HA)** 7%	ns	ns
	Lie	0	-	-	-	-
	Other	15	**(LA<HA)** 27%	**(LA<HA)** 7%	**(LA<HA)** 7% (LA>HA) 7%	**(LA<HA)** 13% (LA>HA) 13%
	Sway	10	**(LA<HA)** 20%	ns	**(LA<HA)** 10%	**(LA<HA)** 10%
	Stereotypy	0	-	-	-	-
E2	Feed from ground	15	**(LA<HA)** 13%	**(LA<HA)** 7%	**(LA<HA)** 7% (LA>HA) 7%	**(LA<HA)**7% (LA>HA) 13%
	Feed from hay net	15	**(LA<HA)** 7% (LA>HA) 27%	**(LA<HA)** 7% (LA>HA) 13%	ns	ns
	Drink	1	ns	ns	ns	ns
	Inactive	15	ns	ns	**(LA<HA)** 7%	**(LA<HA)** 20%
	Walk	15	**(LA<HA)** 7%	ns	ns	ns
	Lie	0	-	-	-	-
	Other	10	ns	ns	**(LA<HA)** 20%	**(LA<HA)** 20%
	Sway	1	ns	(LA>HA) 100%	ns	ns
	Stereotypy	15	(LA>HA) 7%	(LA>HA) 7%	ns	ns
E3	Feed from ground	15	ns	ns	ns	(LA>HA) 7%
	Feed from hay net	10	ns	**(LA<HA)** 20%	ns	ns
	Drink	6	ns	ns	ns	(LA>HA) 17%
	Inactive	15	ns	(LA>HA) 7%	ns	**(LA<HA)** 7%
	Walk	15	**(LA<HA)** 13%	ns	**(LA<HA)** 13% (LA>HA) 7%	**(LA<HA)**13% (LA>HA) 7%
	Lie	0	-	-	-	-
	Other	10	ns	**(LA<HA)** 20%	**(LA<HA)** 10%	**(LA<HA)** 10%
	Sway	0	-	-	-	-

The table is based on data from each of the six studied days separately. The number of tests is noted, and the proportion of significant difference is shown in per cent. No significance is marked with *ns* and a hyphen means no tests were made.

For example, inactive behaviour of E1 and E3 had a significantly smaller IQR in HA compared to LA, but this difference was not evident for E2 (Table 2). Regarding skewness, there was an overall trend of right skewness. In the few instances where this was not the case, the significant differences were the outcome of varying degrees of right-skewness - and not left-skewness (Table 2). Concerning kurtosis, there was a minor tendency of higher values which indicated a wide distribution of the data, but overall there were no results that indicated a clear trend regarding the differences between LA and HA (Table 2).

Comparing the Personalities of the Individuals

Comparing the individuals in relation to the activity time budgets in LA and HA separately resulted in several differences between the elephants, but only a few were significant (Appendix 2). A significant difference was found in the average percentage time spent on feeding in LA, where E3 spent more time feeding from the ground than E2 (χ^2=4.3, df=1, p=0.04). Another significant difference was found in HA where E1 spent more time being inactive than E3 (χ^2=4.7, df=1, p=0.03).
The results of Mann-Whitney and Levene's test showed several significant differences between the median time the individuals spent on a certain behaviour when focusing on LA and HA separately. For the IQR, this was also the case (Table 3). For both LA, HA and all elephants, there was a tendency of a right-skewed distribution. For both skewness and kurtosis, there were only a few significant differences when comparing the individuals (Table 3).
The changes in the median, IQR, skewness and kurtosis for the time spent on a specific behaviour from LA to HA can be seen in Fig. 1. Comparing the individuals concerning median time resulted in several significant differences, for instance, in swaying where none of the elephants showed the same slope from LA to HA.

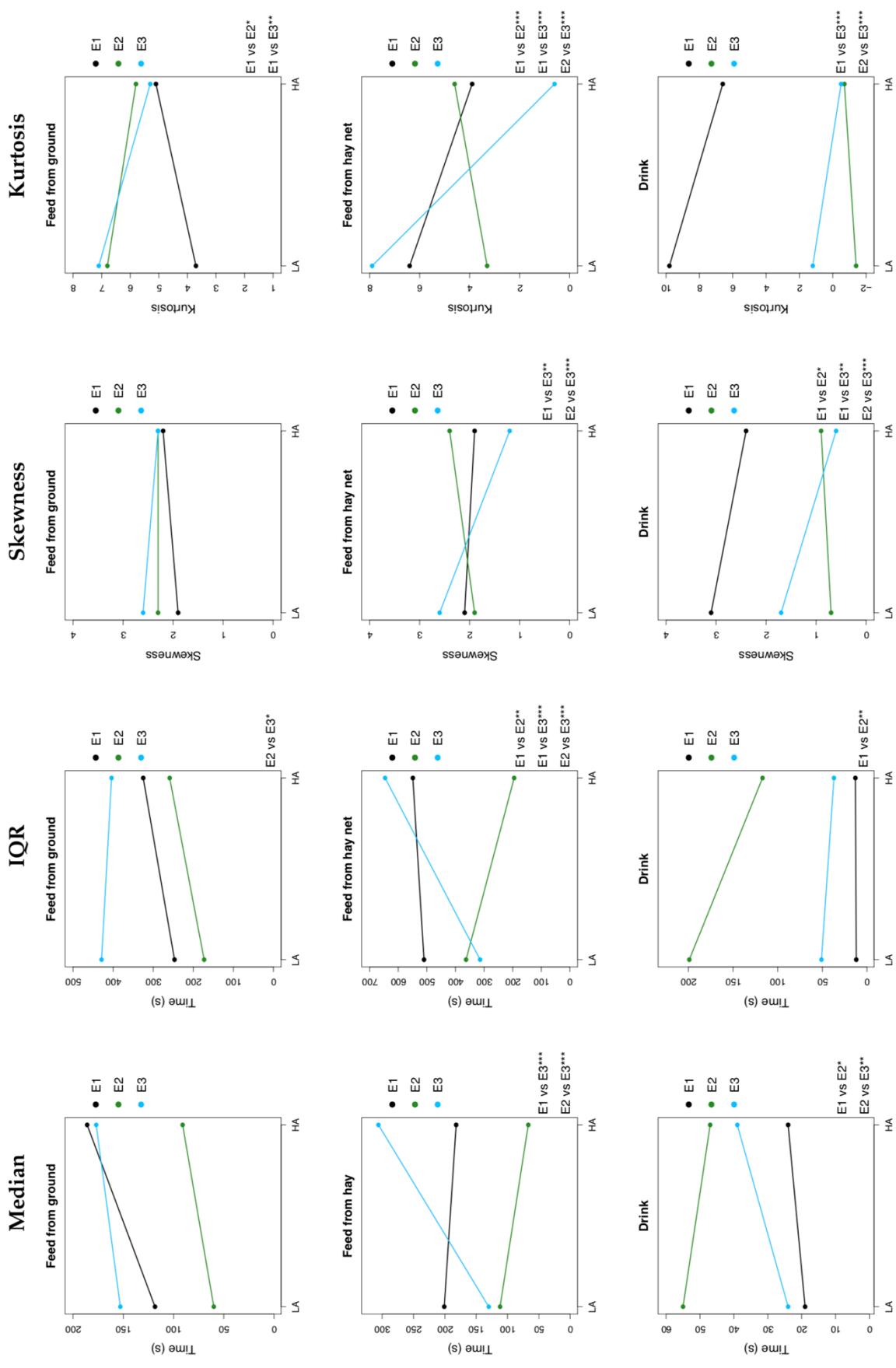
Regarding the slope for the median time spent on lying, no significant differences were found between the elephants (Fig. 1). This is also supported by the result of the Mann-Whitney test, which showed no significant differences between the elephants regarding the median time spent on lying in both LA and HA (Table 3). This means that the three elephants spent the same median time on lying in LA and HA.

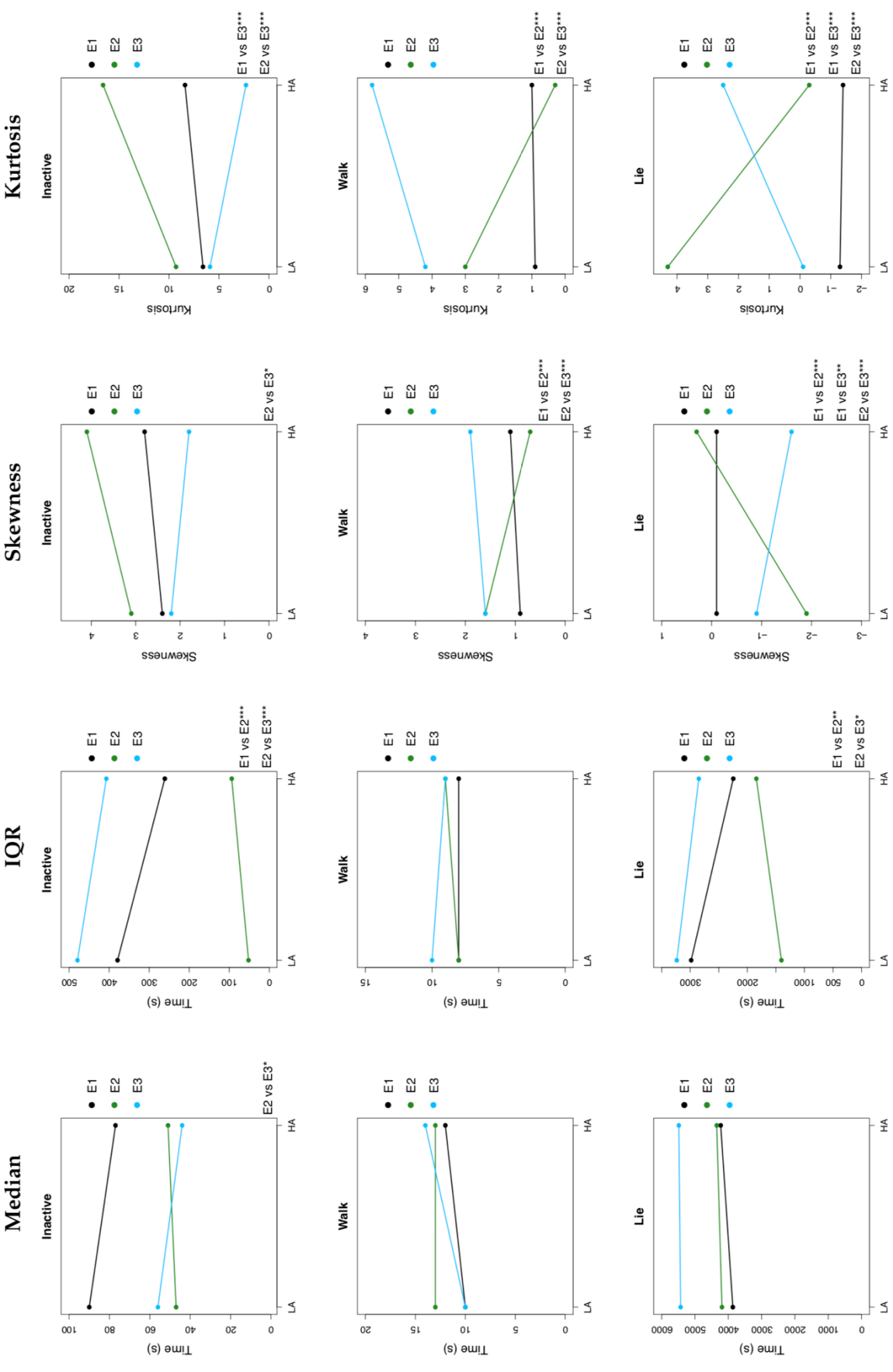
When looking at the change in the IQR several significant differences were found, for instance, in feed from hay net where the three elephants showed different slopes from LA to HA (Fig. 1). In contrast to this, no significant differences in the change in IQR were found in regards to walking, meaning none of the elephants walked significantly more or less than another.

Concerning the change in skewness significant differences were found in all behaviours except for feeding from the ground. Differences in the slopes between the elephants were predominantly found between E2 and E3, meaning that these two elephants differed the most concerning changes in the skewness (Fig. 1). In regard to the change in kurtosis, significant differences were found in all behaviours with no clear tendency of either increasing or decreasing slopes (Fig. 1).

Table 3. Results of Mann-Whitney U test (pairwise), Levene's test for medians, and a 95% confidence interval of skewness and kurtosis for the time spent on a certain behaviour when comparing the individuals in a period with a low number of visitors (LA) and in a period with a higher number of visitors (HA).

	Behaviour	No. of tests	Mann-Whitney	Levene's	Skewness	Kurtosis
LA	Feed from ground	3	(E1>E2) 33% (E1<E3) 33% (E2<E3) 33%	(E1>E2) 33% (E1<E3) 33% (E2<E3) 33%	ns	ns
	Feed from hay net	3	(E1>E2) 33%	Ns	ns	ns
	Drink	3	(E1<E2) 33% (E2>E3) 33%	(E1<E2) 33%	ns	(E1>E2) 33%
	Inactive	3	(E1>E2) 33%	ns	ns	ns
	Walk	3	(E1<E2) 33%	ns	ns	ns
	Lie	3	Ns	ns	ns	(E1<E2) 33%
	Other	3	Ns	ns	(E1>E2) 33%	(E1>E2) 33%
	Sway	1	(E1<E2) 100%	(E1<E2) 100%	ns	ns
	Stereotypy	0	-	-	-	-
HA	Feed from ground	3	(E1>E2) 33% (E2<E3) 33%	(E1>E2) 33% (E2<E3) 33%	ns	ns
	Feed from hay net	3	(E2<E3) 33%	ns	ns	ns
	Drink	3	(E1<E2) 33%	(E1<E2) 33%	(E1>E3) 33%	(E1>E2) 33% (E1>E3) 33%
	Inactive	3	(E1>E2) 33%	ns	ns	ns
	Walk	3	ns	ns	ns	ns
	Lie	3	ns	ns	ns	ns
	Other	3	(E1>E2) 33%	(E2<E3) 33%	ns	ns
	Sway	1	ns	ns	ns	ns
	Stereotypy	1	(E1<E2) 100%	(E1<E2) 100%	ns	ns


Median
IQR
Skewness
Kurtosis
Feed from ground
Feed from hay net
Feed from hay
Drink
Time (s)
Skewness
Kurtosis
E1
E2
E3
E1 vs E2*
E1 vs E3**
E2 vs E3*
E1 vs E2**
E1 vs E3***
E2 vs E3***
LA
HA


Median
IQR
Skewness
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Inactive
Walk
Lie
E1
E2
E3
E2 vs E3*
E1 vs E2**
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E2 vs E3***
LA
HA
Time (s)
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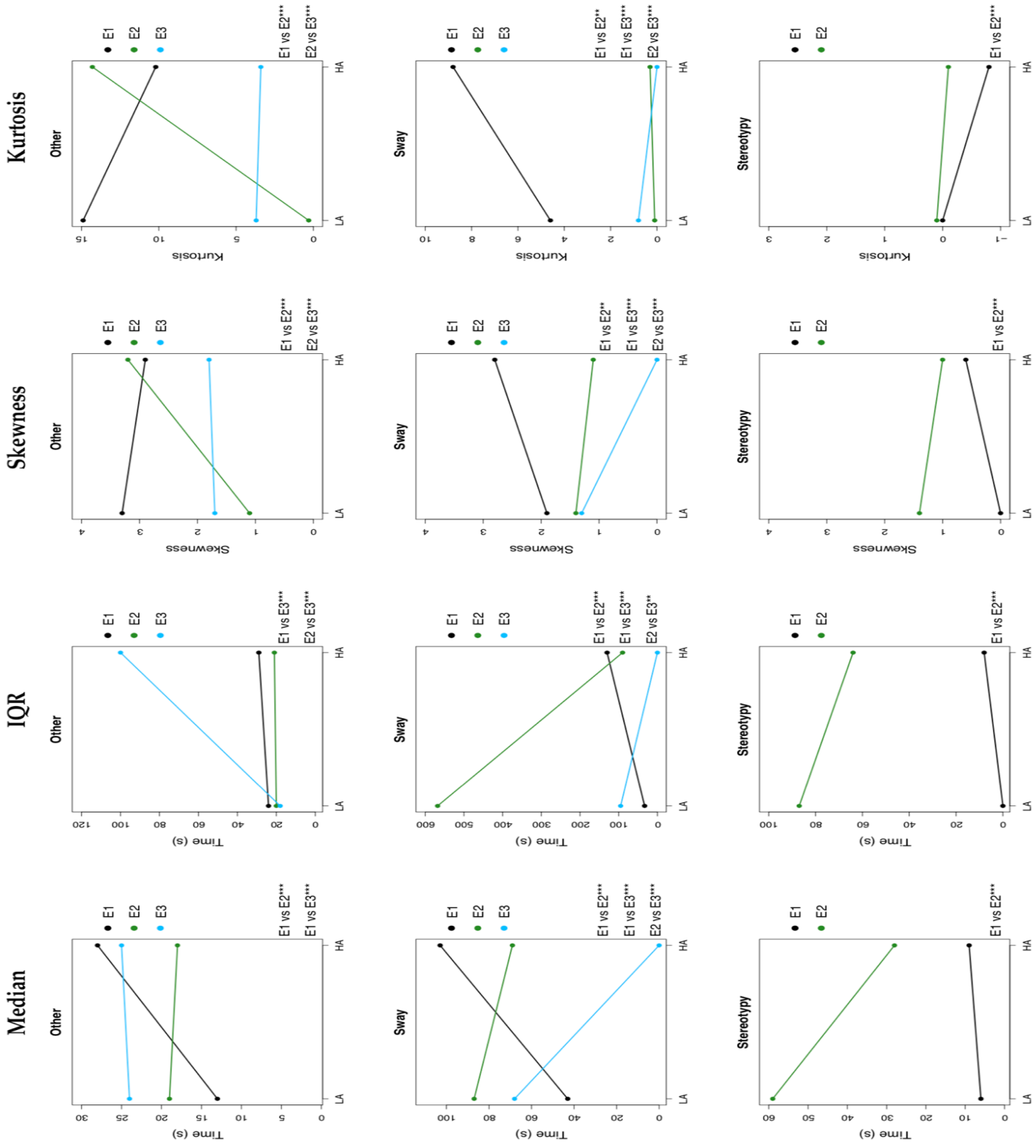

Figure 1. Comparison of the median, IQR, skewness and kurtosis of the time spent on nocturnal behaviour for the three elephants, between 20:00-06:00, during three days with a normal visitor number during the day (LA) and three days with a higher visitor number during the day (HA). Asterisks mark significant differences found with χ^2 test (df=1) between two elephants (* significant at $p<0.05$; ** significant at $p<0.01$; *** significant at $p<0.001$). Missing lines reflect lack of

data

Discussion

Summary of Activity Budgets

In this study, feeding was the most common nocturnal behaviour observed when taking an average of the three elephants (43±6%). This corresponds well with other studies observing this behaviour as the most common one among African elephants in captivity, ranging from approx. 35-90% of the night (Brockett et al., 1999; Greco et al., 2016; Horback et al., 2014; Wilson et al., 2006).

According to other behavioural studies, African elephants in captivity were recorded lying down from 2.1 and up to 5.0 hours per night on average depending on the study (Boyle et al., 2015; Holdgate et al., 2016; Horback et al., 2014). In this study, the elephants were lying down 28% of the night on average, which is equivalent to an average duration of approx. 2.8 hours per night. This corresponds to the results from other studies though the spread is relatively great. Additionally, the time of awakening found in this study (between 04:00-06:00) seems to be similar to results of other studies (Boyle et al., 2015; Holdgate et al., 2016; Schiffmann et al., 2018). In the wild, African elephants were only observed lying down every third to fourth night, which can attribute to the fact that they experience predation and must travel great distances to have an adequate amount of food and water (Gravett et al., 2017). Since this is not the case with elephants in captivity, it is reasonable to assume that the patterns of captive elephants do not reflect the patterns of wild elephants.

Comparing LA and HA Relative to each Individual

The total amount of time E1 spent on feeding from the hay net in HA was significantly lower than in LA, and this result is heavily affected by the fact that she only fed from the hay net four times with short duration during one of the nights in HA. Apart from this, a higher number of visitors does not seem to affect the total amount of time spent on each behaviour.

When looking at both the median and the IQR of the interval lengths of behaviours in LA compared to HA, there were no clear signs indicating that the elephants' behaviour changed in response to a higher number of visitors in the zoo during the day. Notably, there was a longer duration of walking for all three elephants in HA compared to LA. It is noteworthy that this change in behaviour was seen in all the elephants, and it is possible that this behavioural change appeared because of the higher number of visitors during the day, which caused an increase in the duration of walking. A review found that a higher number of visitors can cause behavioural changes in different species of zoo animals, for instance, an increase in pacing. However, a higher number of visitors did not necessarily have a negative effect on the animals (Davey, 2007). In this study, it is also possible that the behavioural change was a consequence of other events or stress factors during the day or night.

E2 only swayed between 20:00-22:00 in LA, whereas the behaviour did not start until approx. 01:00 in HA, which could imply that a higher visitor number possibly affects this behaviour. Swaying is a stereotypical behaviour and is thought to be due to unfulfilled physical and psychological needs of the elephant (Greco et al., 2016). It is not remarkable that zoo elephants experience lack of stimulation since wild African elephants spend between 60-80% of their waking hours feeding or searching for food (Clubb & Mason, 2002).

Comparing the Personalities of the Individuals

According to the activity budgets, the total amount of time spent on a specific behaviour did not vary significantly between the three elephants, but this does not imply that the durations are similar, e.g. when E1 fed from the ground, the duration of the behaviour would last longer than E2's would on average. Exhibiting the same total amount of the behaviours could be owing to elephants being gregarious animals that seem to follow relatively similar schedules for feeding, lying etc. (Clubb & Mason, 2002).

The results showed that the elephants differed from each other in several behaviours when looking at the

duration of the performed behaviour, e.g. the median duration spent on feeding from the ground was significantly different for all three elephants in LA. However, no clear patterns, indicating that one elephant in general performed behaviours for a longer or shorter amount of time than the others in either LA or HA, were found. Nevertheless, several significant differences were found between the elephants when looking at the change in median duration spent on a certain behaviour from LA to HA. Results showed that the median duration of feeding from hay net of E3 increased, and therefore it had a significantly distinct slope compared to E1 and E2, whom both had a slight decrease in the duration spent performing this behaviour. This indicates that E3's reaction to a higher number of visitors is different from the other two elephants. Moreover, several differences between slopes were found when looking at IQR, skewness and kurtosis, which means that a higher number of visitors seems to influence the elephants differently (Fig. 1).

The results of this study show that the elephants have different personalities because of several significant differences in the slopes of medians across two different contexts (LA and HA). It is, however, necessary to further measure the consistency of these differences across, e.g. another treatment or situation. This is relevant because the elephants are possibly habituated to a more or less constant flow of visitors, which makes them less sensitive to the larger number of visitors (Sherwen & Hemsworth, 2019). For this reason, it would be relevant to introduce the elephants to a novel situation or influence and investigate their potential behavioural changes.

Overall, it is essential to preserve a wide range of personalities or behavioural traits in a population since this can enhance the carrying capacity (maximum population size that the environment can sustain) (Frankham et al., 2002; Wolf & Weissing, 2012). Diverse populations, consisting of individuals with different behavioural traits, are more likely to include traits that can cope with new conditions and, thereby, these populations are expected to be less vulnerable to environmental changes (Wolf & Weissing, 2012). Reintroduction of animals from captivity into the wild benefits from conservation of different personalities and behavioural traits, since this could enhance a population's chance to adapt and succeed in its novel habitat (Frankham et al., 2002).

Discussion of Methods

A new and practical method to identify individual differences between elephants in captivity was used by a study of elephants, where they found correlations between specific personality characteristics and cortisol levels in their blood and saliva (Grand et al., 2012). This made it possible to couple a certain content of cortisol to a behavioural trait, which could subsequently help with the management and care of the elephants. In most field studies of animal behaviour, the sampling method is limited by a lack of opportunity to observe and record every behaviour of all the studied animals, and it is often necessary to choose between which individuals and which behaviours to observe. This has also been the case in several other studies concerning elephants (Brockett et al., 1999; Greco et al., 2016; Powell & Vitale, 2016; Rees, 2009; Wilson et al., 2006). Instantaneous and scan sampling are often used, and both are defined by sampling at predetermined points of time. Some behaviours may only occur for a short duration of time and sometimes only a few times during the studied period, and the probability of observing that type of behaviour is therefore very low (Lehner, 1987). Few observations make it easy to misrepresent the amount and pattern of a behaviour that is, in fact, present. This is clear when looking at the cumulative graphs where some of the behaviours do not constantly occur throughout the night, e.g. lying, drinking and swaying behaviour. On account of this, instantaneous and scan sampling does not give the full picture of what the studied animals are doing, and it also does not include the behaviours that have longer durations.

In this study, all-occurrences sampling was used, and all behaviours were recorded through a 10-hour period, which made it possible to note all the different behaviours and the entire length of them. It also makes it possible to make cumulative graphs that clearly and correctly shows the proportion of each behaviour and what time of the night the elephants are most likely to perform a specific behaviour. The instantaneous and

scan sampling is, however, less time consuming than watching everything, and is probably more applicable when having a larger sample or in the wild where it is not possible to continuously observe the elephants.

The fact that it is possible to look at skewness of the time spent on a specific behaviour is an advantage since a right-skewed distribution, for instance, implies that there are several short intervals but also a few longer ones, which drags the skewness to the right. This means that all the longer intervals that would not be possible to capture with scan sampling are more visible in this study. Concurrently, it is possible to examine the elephants' predictability and variability by looking at the kurtosis and IQR of the time spent on a certain behaviour where high predictability is indicated by high kurtosis or low variance (IQR). By looking at IQR, skewness and kurtosis for the duration of time spent on a specific behaviour, it is also possible to observe potential patterns in the change of each of these parameters when the studied animals are being exposed to stimuli or a change in their environment. However, this study did not observe a clear pattern for either the IQR, skewness or kurtosis.

Conclusions

The elephants spent the majority of the night (20:00-06:00) feeding, lying and being inactive. On average, the elephants laid down 2.4-3.1 hours per night and never laid down before 22:00. The results revealed no clear trend of significant differences in the behaviour of the elephants when there was a higher number of visitors in the zoo, although a significant difference was found regarding the elephants' walking, where a higher number of visitors resulted in an increased duration of this behaviour. Furthermore, results showed that the elephants performed the recorded behaviours for a different duration of time. Additionally, it forms evidence of the elephants having personalities since these results show signs of different nocturnal behavioural responses to change in the number of visitors during the day. Further research could include a larger sample size, including studying the behaviour of the elephants across several months or exposing them to another novel situation. Additionally, this could involve elephants in other zoological institutions.

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Appendix 1: Floor plan of elephant enclosure

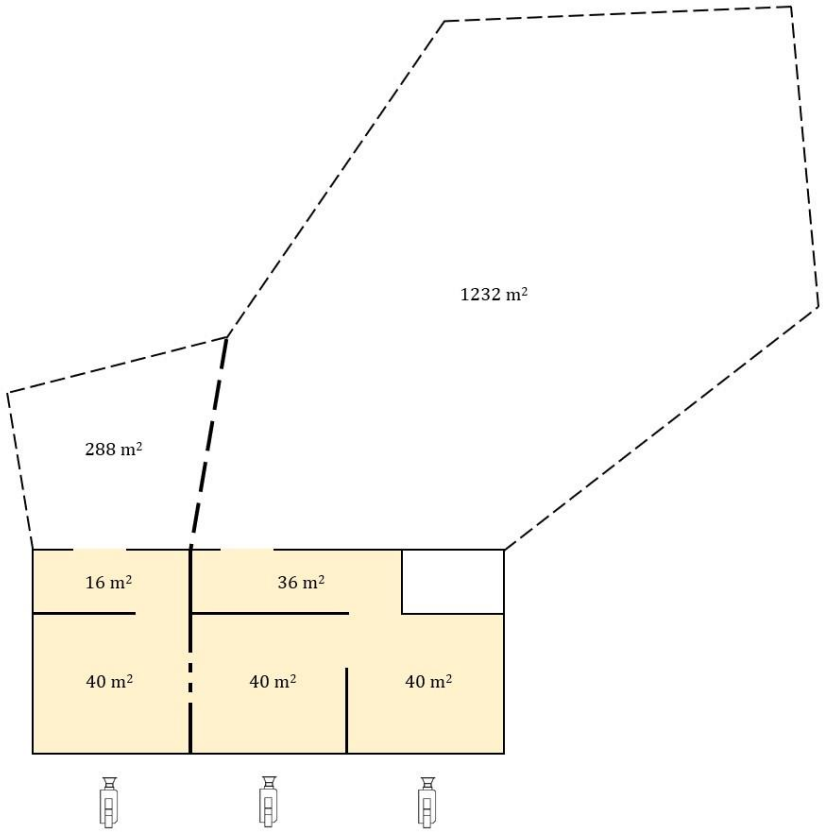


Figure 2. Illustration of the elephant enclosure with listed dimensions, the position of the cameras, the indoor stables and corridors coloured yellow, dashed line marking the fence in the outdoor exhibit and also the bars in the indoor stable where the elephants had the opportunity to have physical contact through. The thick lines indicate the separation between E1 and the two other elephants at night.

Appendix 2: Comparing elephants' nocturnal activity time budgets

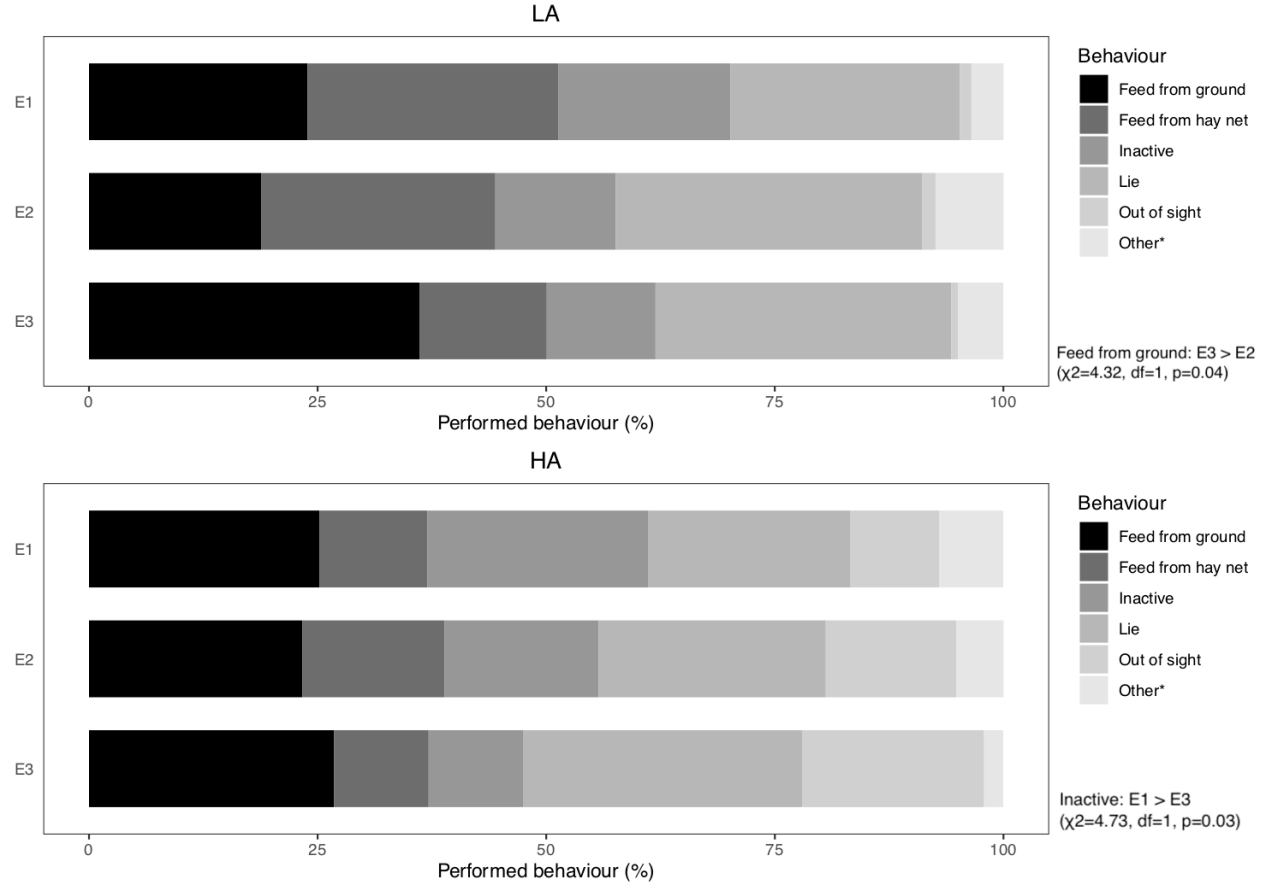
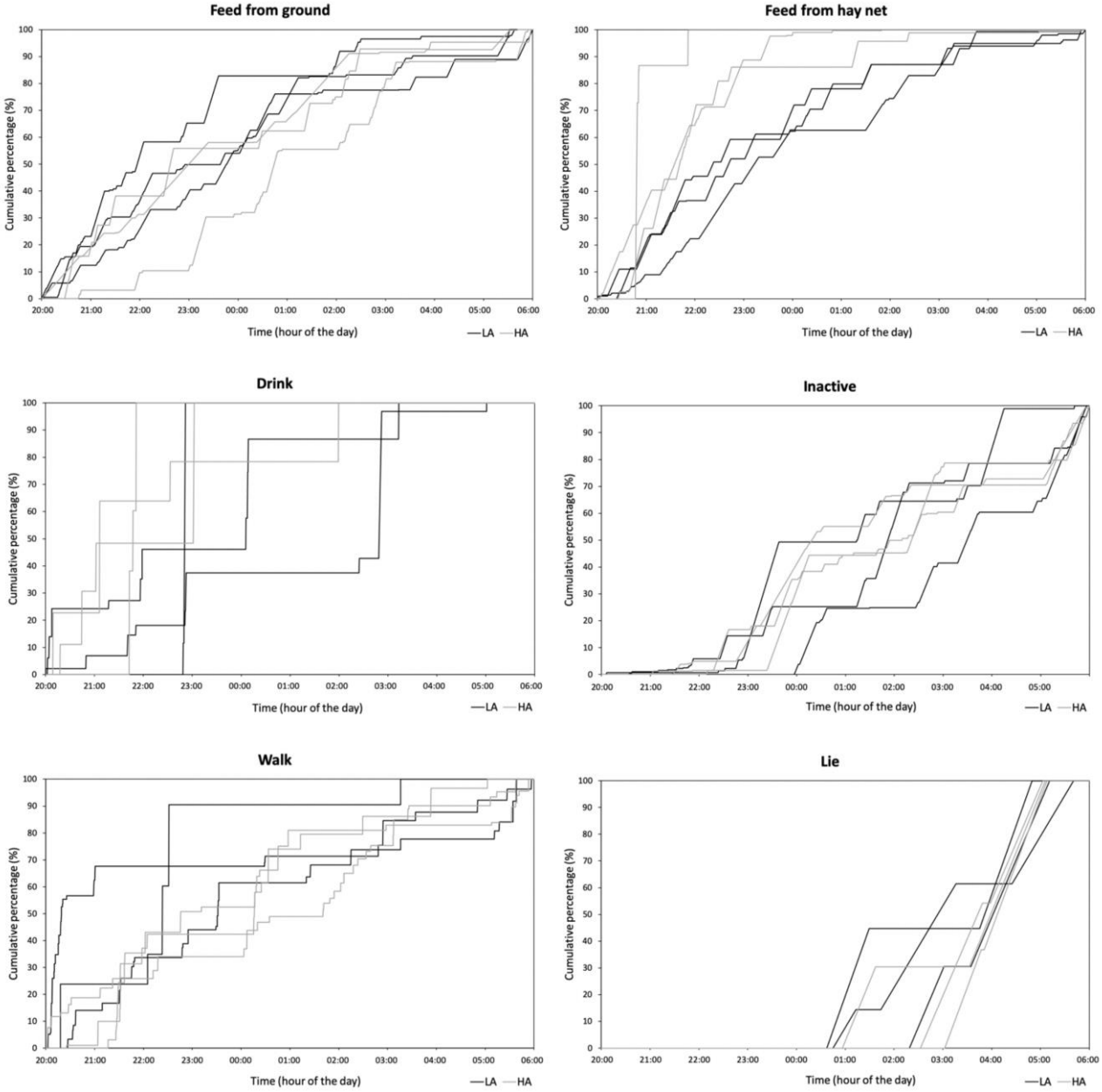


Figure 3. The activity time budgets during the night, between 20:00-06:00, shown in per cent for each observed elephant during three days with normal visitor number during the day (LA) and three days with a higher visitor number during the day (HA). The figures are based on pooled data for LA and HA. Out of sight accounts for the periods of time where the elephant's behaviour was not clearly visible because it was either behind another elephant or because the elephant was located in the outdoor exhibit or in the corridors. Other* includes behaviours that accounted for under 5% of the total time (Drink, Stereotypy, Sway, Walk and Other). Significant results of χ^2 test is shown in the bottom right corner.

Appendix 3: Cumulative graphs



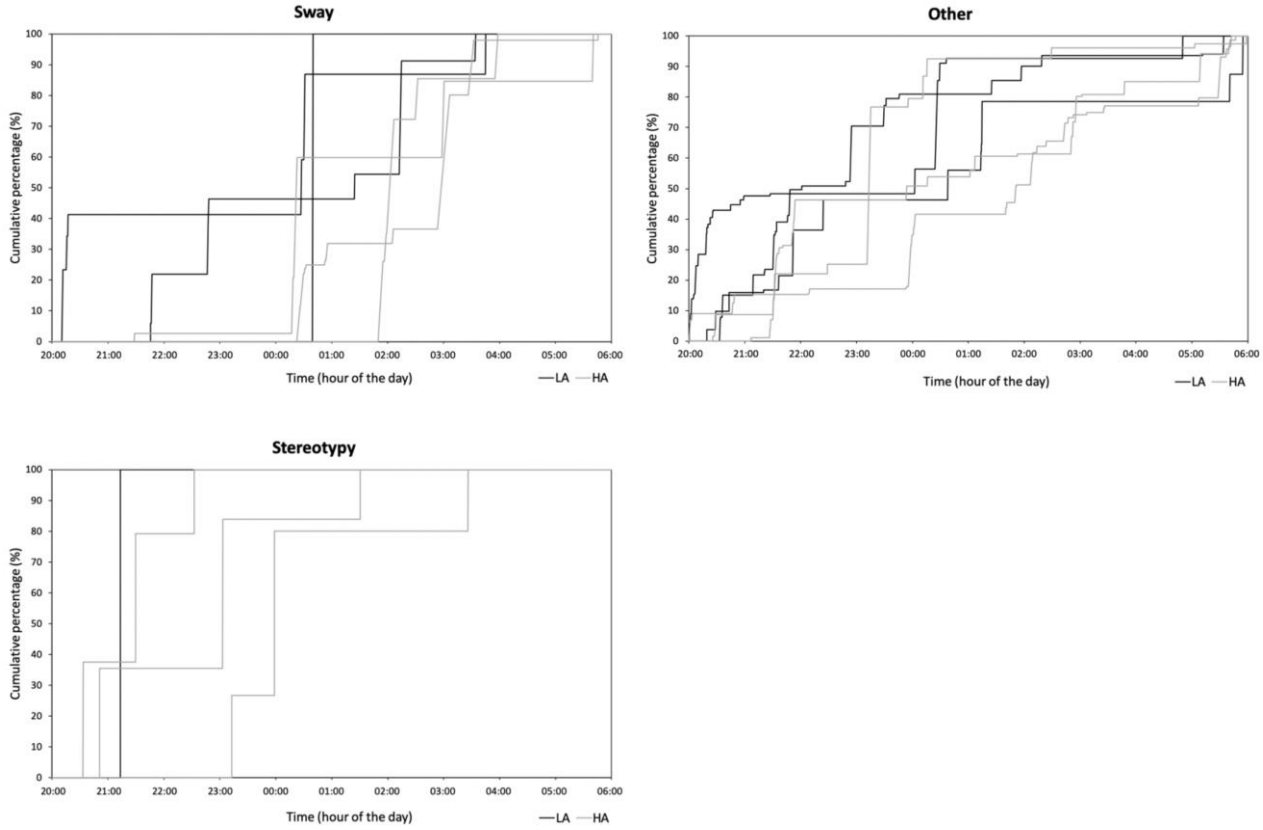
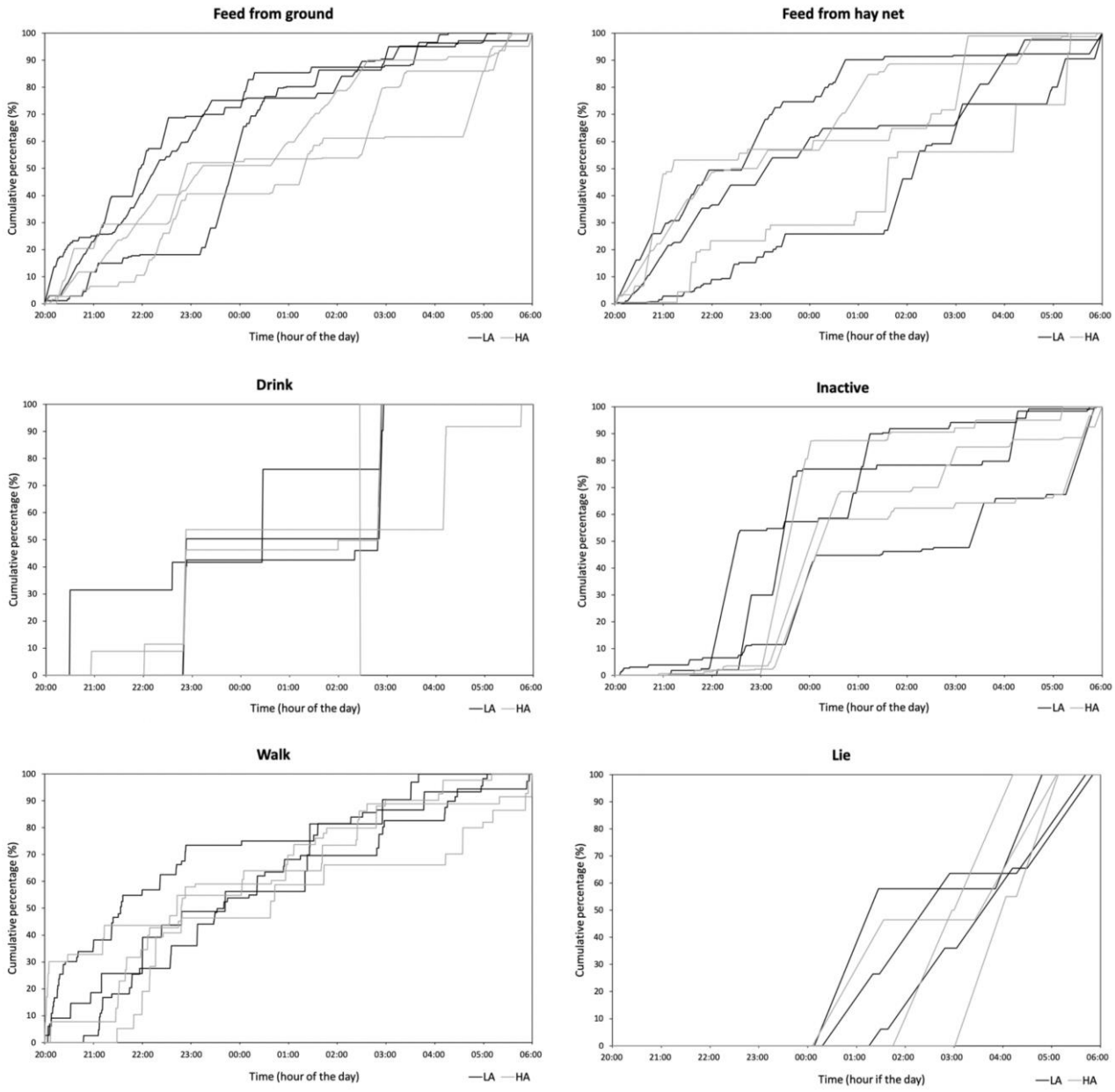


Figure 4. Cumulative percentages of the intervals of observed nocturnal behaviour, between 20:00-06:00, for E1 shown as a function of time. The black curves indicate the periods with a normal number of visitors during the day (LA) and the grey curves indicate the periods with a higher number of visitors during the day (HA). Curves in "Stereotypy" are missing for LA because the behaviour was only shown one day.


Feed from ground
Feed from hay net
Drink
Inactive
Walk
Lie
Cumulative percentage (%)
Time (hour of the day)
Time (hour if the day)
—LA —HA

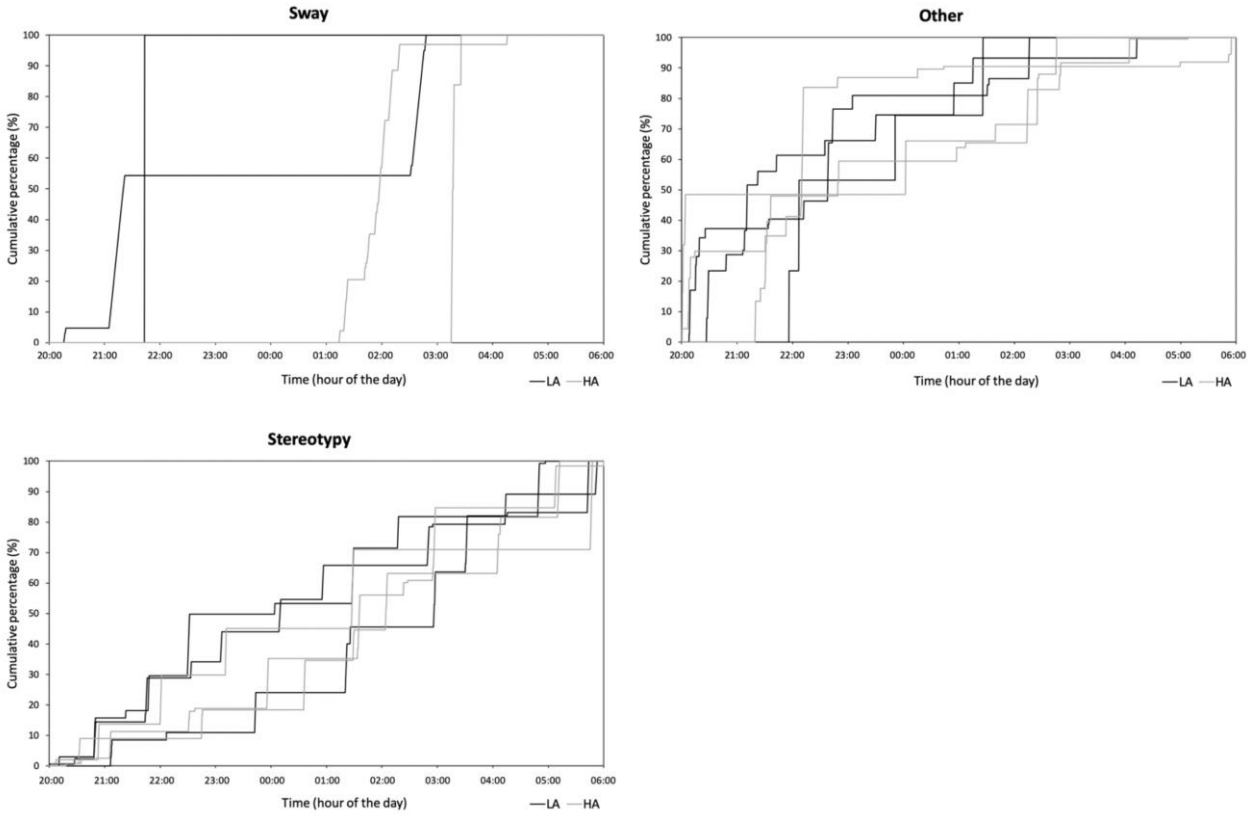
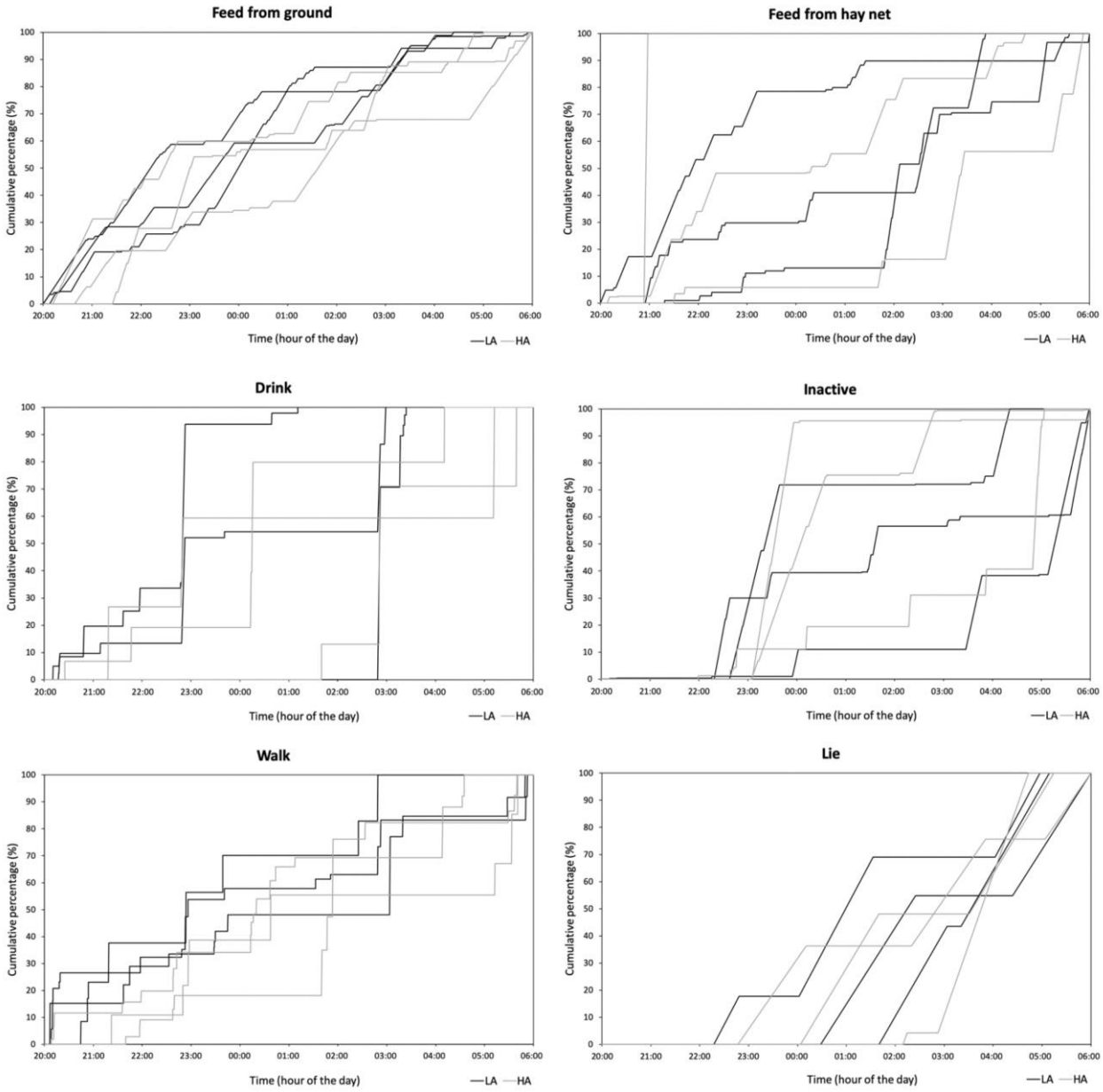


Figure 5. Cumulative percentages of the intervals of observed nocturnal behaviour, between 20:00-06:00, for E2 shown as a function of time. The black curves indicate the periods with a normal number of visitors during the day (LA) and the grey curves indicate the periods with a higher number of visitors during the day (HA). One curve in "Sway" are missing for both LA and HA because the behaviour was only shown two out of three days.


Feed from ground
Feed from hay net
Drink
Inactive
Walk
Lie
Cumulative percentage (%)
Time (hour of the day)
20:00
21:00
22:00
23:00
00:00
01:00
02:00
03:00
04:00
05:00
06:00
LA
HA

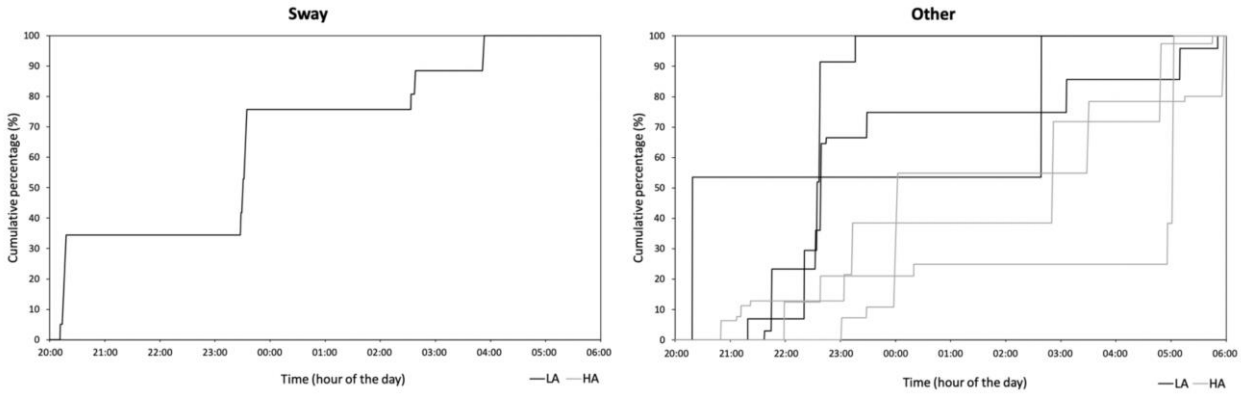


Figure 6. Cumulative percentages of the intervals of observed nocturnal behaviour, between 20:00-06:00, for E3 shown as a function of time. The black curves indicate the periods with a normal number of visitors during the day (LA) and the grey curves indicate the periods with a higher number of visitors during the day (HA). Curves in "Sway" are missing for both LA and HA because the behaviour only was shown one day in LA.