The Elephant in the Room - Use of Enclosure and Activity Budget of a Group of African Savanna Elephants (*Loxodonta africana*) in a Swedish Zoo

*Elefanten i rummet – Hägnutnyttjande och aktivitetsbudget av en grupp Afrikanska stäppelefanter (*Loxodonta africana*) i en svensk djurpark*

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Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal Science
Department of Animal Environment and Health

In memory of
Esmond Bradley Martin
(1941 – 2018)

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1. Abstract

African elephants (*Loxodonta africana*) are social animals that are adapted to life in arid environments. Zoos in northern climates have to keep elephants confined indoors for several months a year due to the risk of cooling down body core temperature and slipping on frozen ground. This study investigated how well a group of six African elephants (3 adult females, 1 juvenile male, 2 female calves) in Borås Zoo, Sweden, accepted their new indoor hall into which they had moved five months prior to the study. This was investigated in three different situations: baseline, visitors present and mature elephant bull using part of the indoor hall. Every animal (except the bull) was observed after 2-min-intervals for 20 minutes twice a day. Similar to the wild, foraging was the most common behaviour over all treatments. Locomotion was registered less compared to the wild but in line with previous studies in captivity. Positive social behaviour was primarily seen between mother and calf. In line with other studies, agonistic behaviour was low. Additionally, the time an individual performed the stereotypy weaving was noted. Only one of the two known weavers was actually seen performing the stereotypy, mostly when neither visitors nor the elephant bull were present. This individual probably developed the stereotypy in the time she was chained overnight. During baseline, the elephants clustered in the afternoon in front of the door to their training quarters, where they usually waited when the caretakers filled up the hall with fresh feed. This was also the setting when most weaving occurred. It was judged that the elephant cow weaved in anticipation of food. Both visitors and elephant bull seemed to disturb the elephants, as less foraging was registered compared to the baseline situation. There was an increase in resting behaviour when visitors were present which might predict a certain visitor effect. However, the zones mainly used were closest to the visitor area which came as a surprise. The only remarkable difference when the elephant bull was using part of the indoor hall was that no performance of stereotypies was registered. The elephant group in Borås Zoo showed a wide range of natural behaviours which indicated that they accepted their new indoor hall quite well.

2. Introduction

Elephants are magnificent to behold in the wild and often the centre of attention in zoos. Keeping elephants in captivity, however, often brings joint and foot problems in its wake (Miller *et al*., 2016). Furthermore, the low reproductive success led Clubb and Mason (2002) to question whether the conservational benefits outweigh the problems of captive elephant keeping. Since zoos' first and foremost task is to conserve endangered species with the goal to one day reintroduce them into the wild (Borås djurpark, 2018), keeping animals should be done in a sustainable way. That includes preserving their natural behaviour and good health as well as helping them to reproduce successfully.

2.1. African elephants in the wild

African elephants (*Loxodonta africana*) are classified to be vulnerable by the IUCN Red List (Blanc, 2008). There are known to be around 400.000 wild living specimen with another 125.000 speculated to exist (Thouless *et al*., 2016). Their numbers have been increasing since the 1990s (Blanc, 2008) but compared to an estimated three to five millions that are thought to have lived in the 1930s and 1940s (WWF, 2004), the species is far from abundant.

In the wild, African elephants form stable social groups made up of related females and their offspring (Moss, 1988). The groups are led by a matriarch which is often the oldest and largest female (Archie *et al*., 2006). African elephants live in a hierarchical society where a female's rank can determine which and how many resources she gets (Archie *et al*., 2006; Wittemyer *et al*., 2007). They spend the majority of their time foraging on a variety of plant species and parts, followed by walking, resting and interacting socially (Leggett, 2008; Siyaya, 2015; Mole *et al*., 2016). Elephants use a wide range of communication methods like an excellent sense of smell with which they can inspect individuals in direct contact and get information about their mating availability over distances (Poole, 1994; Rasmussen & Schulte, 1998). Communication also takes place through both high and low frequency sounds, only the former audible to humans, while the latter can be heard by elephants over long distances (Poole & Moss, 1989; Poole, 1994; Langbauer, 2000). Berg (1983) found a correlation between sound frequency and grade of excitement, meaning the more agitated an elephant is, the higher the noise it makes.

Male elephants become more independent and eventually leave their family group around the age of 14 to live alone or in loose groups of (predominently adolescent) bachelors (Poole, 1994), where they learn appropriate social behaviour by older bulls (Evan & Harris, 2008). Subsequently, males and female groups lead separate lives and only meet occasionally for males to test whether a female is receptive, by smelling her urine and genitals, and, if so, mate (Moss, 1988; Moss & Poole, 1989).

2.2. African elephants in captivity

Currently, there are approximately 300 African elephants on display in over 50 institutions in Europe (Captive elephant database, 2018). Only about 35 % of these were actually born in captivity, the rest are wild-caught (Captive elephant database, 2018). 2.4 % of the European population, or seven animals, are found in Sweden, all in Borås Zoo. African elephants in captivity spend a similar amount of time feeding as in the wild, but they walk less and rest more (Horback *et al*., 2014, Greco *et al*., 2016). In the wild, elephants move mostly out of the need to find food, water and mating partners (Leggett, 2008) which is not necessary in zoos where food is abundant and mating regulated by humans. Social behaviours are also seen to a certain extent and happen primarily between a mother and her calf (Horback *et al*., 2014).

The majority of research on captive elephants is done in the U.S. on the border between the temperate and subtropical climate zone. The largely different climate in Scandinavia (northern temperate to subtropical climate zone) calls for studying elephants in this environment as well. Whereas African elephants are adapted to life in a hot, arid climate (Mole *et al*., 2016), weather conditions in Scandinavia make it impossible to keep elephants outside all year round. They could cool down their body temperature significantly (M. Rhen, Borås Zoo, personal communication, 5 April 2018). If the ground is slippery, the animals cannot even be outside short periods of the day since the injury risk is too high (M. Rhen, Borås Zoo, personal communication, 5 April 2018). Thus, the need for large indoor halls arises. In order for elephants to accept this indoor enclosure as well as possible, these halls should ideally keep the animals occupied by plenty of opportunity to perform natural behaviours.

2.3. Facing new environments

In the wild, African elephants have been seen rejecting new environments by simply moving away from regions they do not like (Pinter-Wollman, 2009). They also explore a new area more intensively the further it is from human activity (Pinter-Wollman, 2009). For zoo elephants, neither option is possible.

When facing new environments, wild African elephants show increased social behaviour the more unfamiliar the new habitat, meaning that they rely on interactions with familiar conspecifics in the habituation phase (Pinter-Wollman *et al*., 2009). This could mean that facing novel situations with unfamiliar conspecifics could make rejection of the area more likely and heighten stress levels. Since it is not implicit that groups in zoos are made up of related, or at least familiar, members (Clubb & Mason, 2002), this is a valid concern. Hence, zoos should take care to not change both environment and group constellation for the elephants.

2.4. The zoo visitor effect

The presence of visitors in zoos can lead to a rise in stress levels and immobility in koalas (*Phascolarctos cinereus*, Larsen *et al*., 2014), monkeys and apes (Quadros *et al*., 2014) as well as lynx, ocelot (*Leopardus pardalis)* and lion (*Panthera leo persica*, Suárez *et al*., 2017) with negative welfare consequences. The search for relevant literature has to date only

yielded one such study on captive African elephants, showing that a group of females moved significantly less with higher visitor numbers (Quadros *et al*., 2014). Wild elephants have been reported to react with heightened stress levels (Tingvold *et al*., 2013, Hunnick *et al*., 2017), vigilance, avoidance or aggression (Kioko *et al*., 2013) to the presence and possible threat of humans. Stressed elephants have in turn been observed to use only 60 to 80 % of their home range (Jachowski *et al*., 2012). It is therefore in the zoos' best interest to prevent such stress levels, both for the elephants' own welfare but also to avoid agonistic interactions in between group members and towards the caretakers.

2.5. Consequences of heightened stress levels in elephants

Changes in the physical and social environment can also lead to stress which can cause a variety of health problems, amongst others stillbirths, infanticide, poor mothering and also stereotypies (Clubb & Mason, 2002). Between 44 and 74 % of captive African elephants perform stereotypies (Clubb & Mason, 2002; Greco *et al*., 2016). The most common stereotypy for elephants is weaving, observed for every single elephant that performed any stereotypy (Clubb & Mason, 2002). Weaving is described as repetitively "swaying side to side or backwards and forwards" and "may involve the entire body or just the head and neck" (Clubb & Mason, 2002). Some elephants even lift a foot while weaving (Clubb & Mason, 2002). Studies have found positive correlations between the exhibition of stereotypies and time housed indoors, time housed separately as well as transfers between zoos (Greco *et al*., 2016; Greco *et al*., 2017). Clubb and Mason (2002) name restriction of movement, deprivation of social contact, little enclosure size and unsatisfying complexity of the enclosure as possible causes for the existence of stereotypies in zoo elephants as further possible reasons.

2.6. Enclosure size recommendation

The Swedish Board of Agriculture demands 50 m² per animal but at least 200 m² for indoor enclosures and 4000 m² outdoors (Statens jordbruksverks föreskrifter och allmänna råd [SJVFS 2009:92] om djurhållning i djurparker m.m., saknr L 108). Meanwhile, the European Association of Zoos and Aquaria (henceforth: EAZA) recommends that indoor enclosures measure 36 m² per female and 45 m² per male; outdoor pens should be at least 400 m² for three animals, adding an extra 100 m² per additional animal (cited in Clubb & Mason, 2002).

The elephants in Borås Zoo moved into the new indoor hall in October 2017, having used it a full five months before the start of this study. Since good enclosures appear to be important for elephant welfare, the zoo staff was interested in evaluating how well the elephants have accepted their new enclosure and which parts of the hall they prefer. Of the group of six African elephants, two specimen are known to perform the stereotypy weaving. Here, finding patterns was of interest in order to hopefully be able to prevent it in the future.

2.7. Object and issues

2.7.1. Object

The aim of the study was to see how the elephants used their new enclosure, where they exhibited certain behaviours, and at what time of the day they occurred. It was interesting to see what effect the presence of visitors as well as that of the elephant bull had on the group's behaviour. Additionally, the presence of stereotypies in the older elephant cows was to be studied.

2.7.2. Issues:

1. What behaviours do the elephants exhibit in their new enclosure when there are neither visitors nor elephant bull present?
2. Is there a difference in the group's behaviour when visitors, alternatively the elephant bull, are present?
3. Are there any patterns recognisable in the older elephant cows' expression of stereotypies?

3. Material and method

3.1. Animals

The subjects for this study were seven African elephants in Borås Zoo, Sweden. The group consisted of three adult females, two calves and a young bull (Tab. 1). The mature bull (E7) was kept separately from the group because wild African elephants live sexually segregated lives (Moss, 1988; Siyaya, 2015). Both the bull and the group often had the possibility to hear, smell and see each other.

Table 1: *Key data of elephants observed. No data was collected for E7. * = for more information see Clubb and Mason (2002).*

Individual	Sex	Year of birth	Age at time of study	Origin
E1	Female	1978	40	Orphan, Kruger National Park, SA
E2	Female	1990	28	Orphan, Kruger National Park, SA
E3	Female	2005	12	Born in the zoo, daughter of E2
E4	Male	2013	5	Born in the zoo, son of E2
E5	Female	2017	<1	Born in the zoo, daughter of E3
E6	Female	2017	<1	Born in the zoo, daughter of E2
E7	Male	1996	22	One of the Tuli elephants*, moved to Borås Zoo in 2013

3.2. Enclosure and resources

The elephant enclosure at Borås Zoo consisted of a recently built hall of 980 m² into which the animals moved five months prior to the study, as well as a backyard outdoors area and the training quarters. The hall had a semi transparent roof, letting in a lot of light. Additional lamps ensured illumination even on dark days. In the cold months, the hall was heated which was recovered in the ventilation. The ground was covered with a thick layer of sand. The visitor area was elevated above the elephants' enclosure, giving the visitors a good overview. Between the visitor area and the enclosure was a 3 m strip where only caretakers could go. The fence towards the visitor area was electric wire. In the hall, the elephants had access to nets filled with hay hanging from the ceiling, cones, containers and tubes filled either with hay or with treats (grain pellets, fruits or carrot pieces) (Fig. 1). Outdoors, food was hidden in tubes on the wall and under piles of stones. In both enclosures, browse was laid out on the ground.

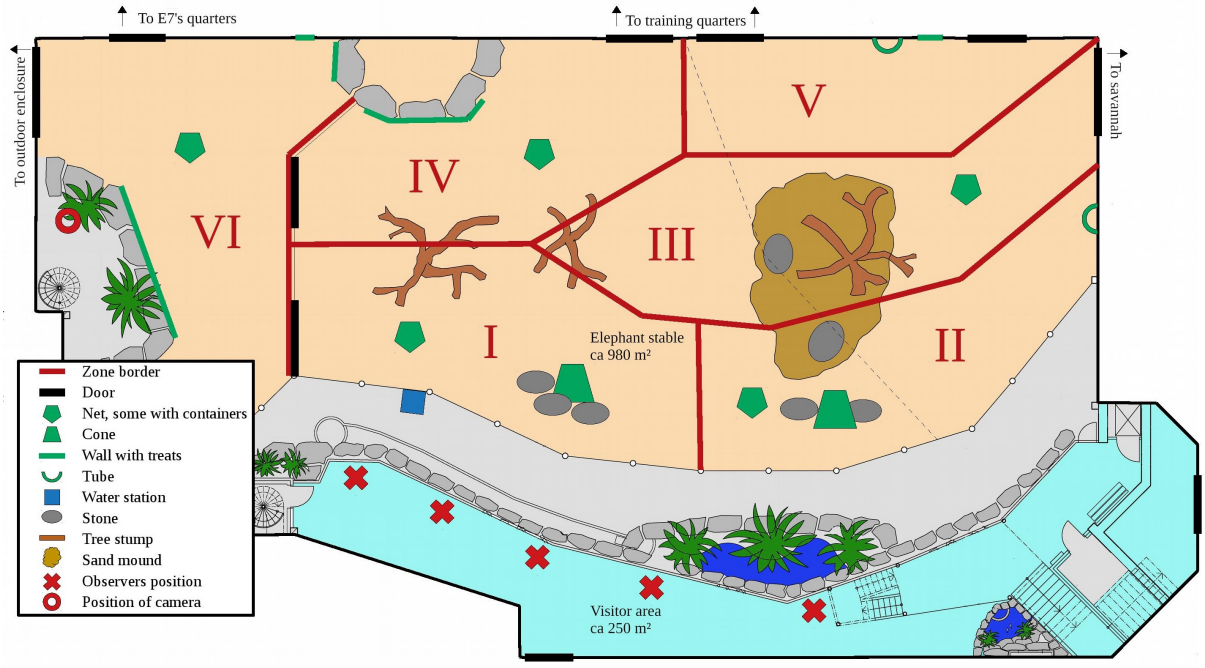

Figure 1: *Map over the elephant enclosure in the indoor hall. The thinly dashed line indicates where E1 was fenced off during treatment Elephant bull.*

3.3. Daily routine

At the time of the study, the daily routine was the following: At 0900 all elephants were transferred into their training quarters while the caretakers prepared the hall for the day. Preparation included removing faeces, filling up resources with food, laying out browse as well as moving around non-edible objects like tires and tree stumps, preferably on top of a resource in order to making it harder for the elephants to reach. When finished, the elephants got access to the hall for the day. At 1530 at the latest, the group was transferred into their training quarters again when the caretakers prepared the hall for the night. This was done in the same way as in the mornings. Afterwards, the elephants got access to the hall where they spent the night.

3.4. Experimental design

This study was performed in three different settings during three weeks, one setting per week, with four, three and three observation days per week.

3.4.1. Treatment Baseline

The group in their traditional composition, i.e. E1 through E6, had access to the whole hall, zones I through VI (Fig. 1). The daily routine was as described under section *3.3. Daily routine*. For this situation, videos were recorded in March. The camera of type Avigilon was placed at the southern end of the hall, about 5 m above the ground (Fig. 1). No visitors were present as the zoo was closed to the public at this time.

3.4.2. Treatment Visitors

Borås Zoo was open to the public during this treatment. Visitors had access to the hall from 1000 to 1600. The daily routine was essentially the same as in treatment A (see 3.3. *Daily*

routine), the only exception being that the group got access to a small outdoor area at the northern end of the hall on one afternoon due to a shortage in browse. The elephants were still mostly visible from the observer's position. This situation was studied with direct observations in April. The observer was standing in the visitors area (Fig. 1).

3.4.3. Treatment Elephant bull

The elephant bull E7 was housed in the mornings in zone VI, next to the group. The door to his training room stood open, giving him the opportunity to choose whether or not to be close to the group. In this setting, E1 was limited to the northern end of the hall, by means of an electric wire, to prevent agonistic interactions between these two individuals. E1's area spanned zone V as well as parts of zones II and III (Fig. 1). Otherwise, the cleaning routine was the same in the mornings as in the other two settings. In the afternoons, from around 1300 to 1530, both the elephant bull and the group were in their backyard outdoors area. E7's yard was separated by a stone wall and a gate from the group's bigger enclosure. No visitors were allowed inside the zoo during that time. This situation was studied directly in April.

3.5. Data collection

3.5.1. Observation method

Data was collected in the pre-season during four days for treatment *Baseline* and three days each for treatments *Visitors* and *Elephant bull*. The elephants were observed during two hours after and before major changes occurred in their enclosure, i.e. after getting access to the hall (observation from 1000 to 1200) and before leaving it (observation from 1300 to 1500). Every animal was observed individually for 20 minutes, making it a focal animal. Behaviour was registered according to an ethogram (Tab. 2) with instantaneous sampling using 2-min-intervals. The ethogram was constructed after the pilot study five days prior to the start of the study. Additionally, literature on elephant behaviour was consulted for any behaviour that did not occur during the pilot study.

Table 2: *Ethogram*

Behaviour	Description
Forage	
Net	Pulling hay from a net hanging from the ceiling
Container	Shaking a container filled with treats inside a net
Wall	Searching for treats in holes in the wall
Cone	Extracting hay from cones on the ground
Tube	Searching for hay or treats in half tubes on the wall
Branch	Manipulating branches on the ground
Net + Branch	Pulling hay from a net while chewing on a branch
Ground	Eating fallen hay or treats

Chew	Standing and chewing
Sniff	Exploring food or an object with the trunk or holding the trunk in the air
Dig	Digging into the ground using the trunk, tusks or feet
Drink	Drinking from the water station
Locomotion	
Go	Moving with at least two feet on the ground
Back up	Going backwards
Run	Moving faster than 1m/s around the room
Head	Shaking the head while standing or walking
Ears	Flapping ears while standing or walking
Hygiene	
Dust bath	Spraying sand with the trunk over one's body
Water bath	Spraying water with the trunk over one's body
Scratch	Rubbing body against a wall, an object, another elephant or against oneself
Roll	Rolling around in the sand on the floor
Rest	
Stand	Standing motionless for at least 2 s
Lie	Any part of the body other than feet or legs touching the ground
Positive social	
Friendly contact	Trunk or head touching any part of another elephant's body
Nurse	Interaction between a cow and a calf while the calf suckles milk
Play	
Play fight	Shoving or pushing head or body into another elephant with slow movements
Object	Manipulating a non-edible object
Bar	Chewing on a bar
Agonistic	
Throw	Throwing food or an object with trunk through air
Fight	Shoving another elephant or rapid movements of the head or tusks towards or onto another elephant's body
Under attack	Being the recipient of a fight or throw event by another elephant

Chase away	Chasing away another individual from a resource with the purpose of using that resource him-/herself
Chased away	Being chased away by another individual from a resource
Others	
Vocalise	Making noises in the human auditory receptive region
Eliminate	Urinating or defecating
Stereotypy	Weaving, pacing or other non-natural behaviour
Watch	Eyes directed at visitor area or caretaker
Not visible	Elephant not visible from the observer's position
Other	Any other, not mentioned behaviour

The order in which the focal animals were observed was chosen randomly. A total of 1200 behaviours over 2400 observation minutes (400 per animal) were registered. Additionally, the start and end time of the occurrence of stereotypies was noted. For simplicity, only the minutes were noted. Data registration was done on paper, time was kept with the stopwatch on the observer's mobile phone.

3.5.2. Segmentation

In order to see in which part of the indoor hall resources were used most often, it was divided into six zones (Fig. 1). The division was chosen so that every zone contained at least two resources and not two of a kind, with the exception of zone VI that contained two separate walls filled with treats. Browse was often moved by the elephants out of zones they originally were placed in by the caretakers. Since Borås Zoo was interested in which parts and resources the elephants used in their indoor hall, only this area was divided into zones. Everything outside these zones was denoted "out".

3.6. Data analysis

The collected data was analysed manually and with Minitab 18. The relative frequencies for every behavioural category were calculated per individual. Based on that, the average frequency and standard deviation were manually calculated.

Differences in behavioural categories and forage resource use over the three treatments were graphically presented. Since the elephants spent morning and afternoon in different enclosures during elephant bull days, the behavioural categories were graphically compared between time of day. The average frequencies spent in the different zones of the enclosure were calculated. Differences in zone usage between treatments were graphically analysed. The minutes and relative frequencies spent performing stereotypies were manually calculated.

4. Results

4.1. Activity budget

4.1.1. General activity

The behaviours Head, Ears, Lie, Throw, Fight and Roll did not occur and were therefore excluded from the analysis. The elephants in Borås Zoo spent the majority of the observation time foraging (Tab. 2). Of all foraging behaviours, pulling hay out of one of the nets hanging from the ceiling was the most common (18 %), followed by eating browse (11.5 %), eating from the ground (10.42 %) and eating from a cone on the floor (9.17 %).
The second most common category was Others where the behaviour Not visible occurred most often (10.17 %). The category Locomotion followed. There, Walk was the most common behaviour (8.17 %). In the remaining categories, Stand and Object were the most frequent behaviours (2.58 % & 2.75 % respectively). There was no difference in the Positive social behaviours observed (1.5 % each).

Table 3: *Relative frequency distribution f_i of all observed behavioural categories for every individual (columns 2 - 7). Column 8 shows the average relative frequency f_m of categories and the standard deviation s_f of the average frequency of all elephants (E1 - E7).*

Category	f_{E1}	f_{E2}	f_{E3}	f_{E4}	f_{E5}	f_{E6}	$f_m \pm s_f$
Forage	87.5	72	76	72	53	43	67.25 ± 16.27
Locomotion	2.5	6	9.5	10	15	11.5	9.08 ± 4.35
Hygiene	1.5	2	2.5	0	0.5	0	1.08 ± 1.07
Rest	3	3.5	3	0	2.5	3.5	2.58 ± 1.32
Positive social	0.5	1	0	0	6	10.5	3 ± 4.32
Play	0	0.5	0.5	1	10	8	3.33 ± 4.45
Agonistic	0.5	0.5	1.5	1.5	1	1.5	1.08 ± 0.49
Others	4.5	14.5	7	15.5	12	22	12.58 ± 6.29

There were individual differences in which behaviour was most common. Generally, the juveniles moved and played more often than the adults and they initiated more positive social contact (Tab. 2). In turn, the registration of them foraging was lower than for the adults.

4.1.2. Differences between treatments

Most behaviours differed numerically between treatments. There was generally more foraging, marginally more playing and other behaviours seen during baseline (Fig. 2). There was a small increase in resting and agonistic behaviour on visitor days, whereas hygiene was most common on elephant bull days. Positive social behaviour increased slightly but constantly over the treatments (Fig. 2).

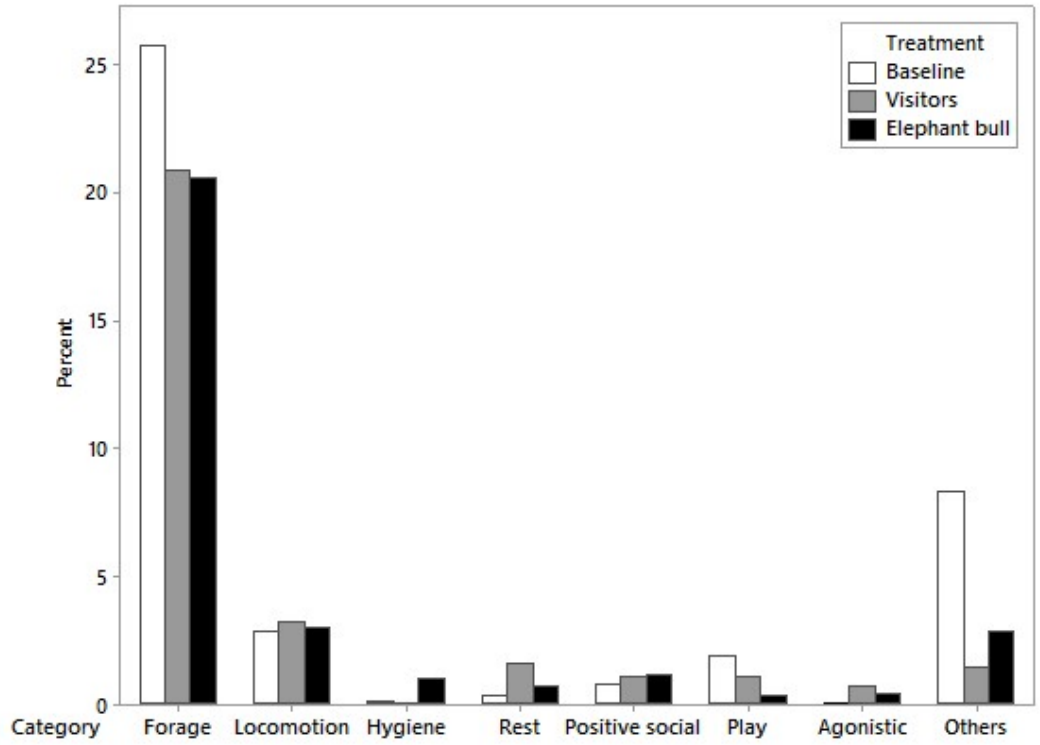

Figure 2: *Relative frequencies of behavioural categories for all treatments. The relative frequency for Hygiene on visitor days and for Agonistic behaviour in Baseline were zero.*

During the time, the elephant bull was next to the group, the animals spent mornings and afternoons in different locations. Therefore, the behavioural categories were compared for morning and afternoon observations. There was more foraging and resting registered in the mornings when the elephants were in the hall (Fig. 3). In the afternoons, spent in the outdoor enclosures, locomotion, hygiene and other behaviours increased (Fig. 3).

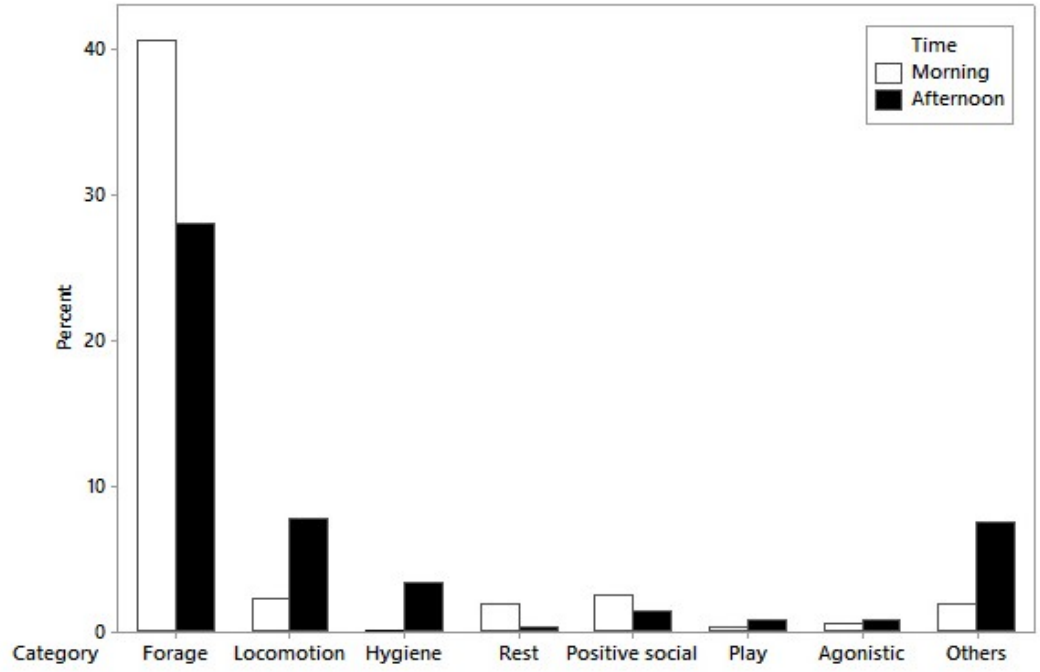

Figure 3: *Relative frequencies of behavioural categories for morning and afternoon observations during treatment Elephant bull. The relative frequency for Hygiene in the mornings was zero.*

4.2. Use of enclosure

4.2.1. General zone usage

Since the aim of this study was to see in which parts of the indoor hall the elephants in Borås Zoo spent their time, the zone *out* was not included in the analysis. The most frequented zones in the Borås indoor hall were zones IV, I and II respectively (Fig. 4).

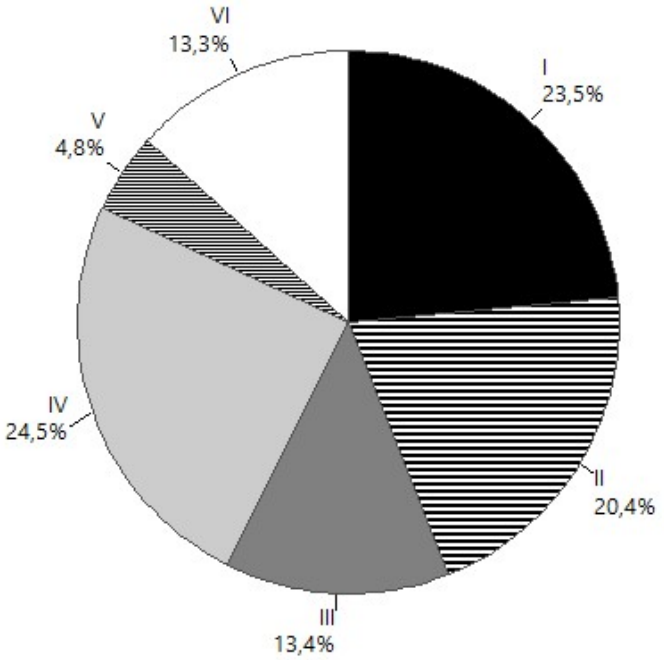

Figure 4: *Relative frequencies of zone usage over all treatments.*

4.2.2. Differences in zone usage between treatments

Zones II & IV were clearly more used in baseline, whereas zone VI was more popular with visitors present (Fig. 5). Surprisingly, zone V was not registered at all in the time the elephant bull shared the indoor hall with the group (Fig. 5).

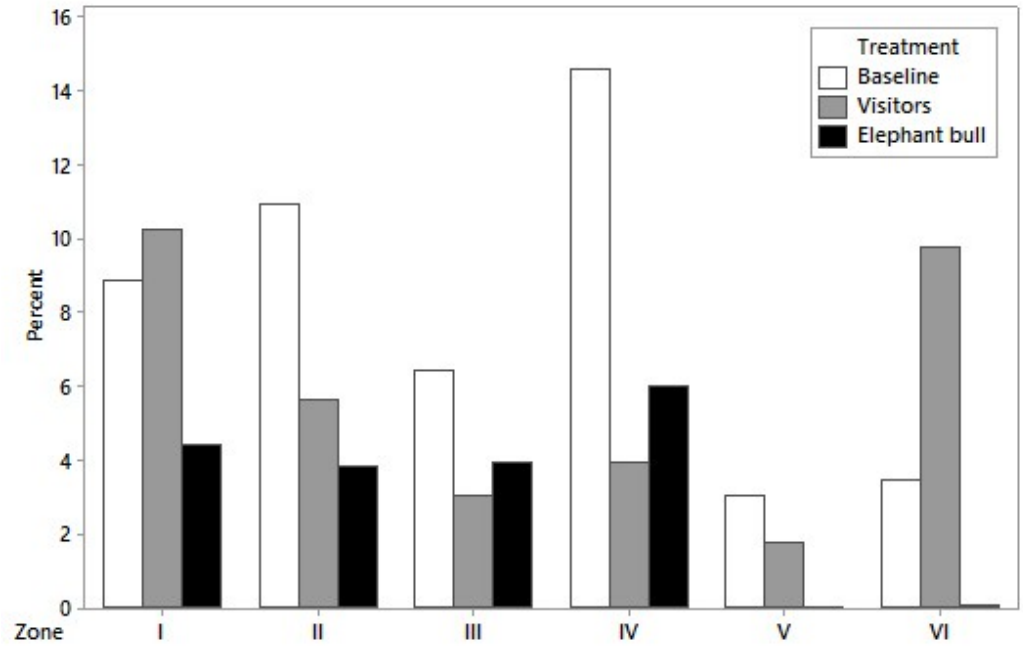

Figure 5: *Differences in relative frequencies of zone usage between treatments. The relative frequency for zone V for treatment Elephant bull was zero.*

In baseline, zone II was most popular in the morning and zone IV was favored in the afternoon (Fig. 6a). On visitors days, zone I was mostly used during morning observation and zone VI was registered most often in the afternoon (Fig. 6b). Comparisons between zones when the elephant bull was next to the group were not possible since morning and afternoon observations were spent in different locations.

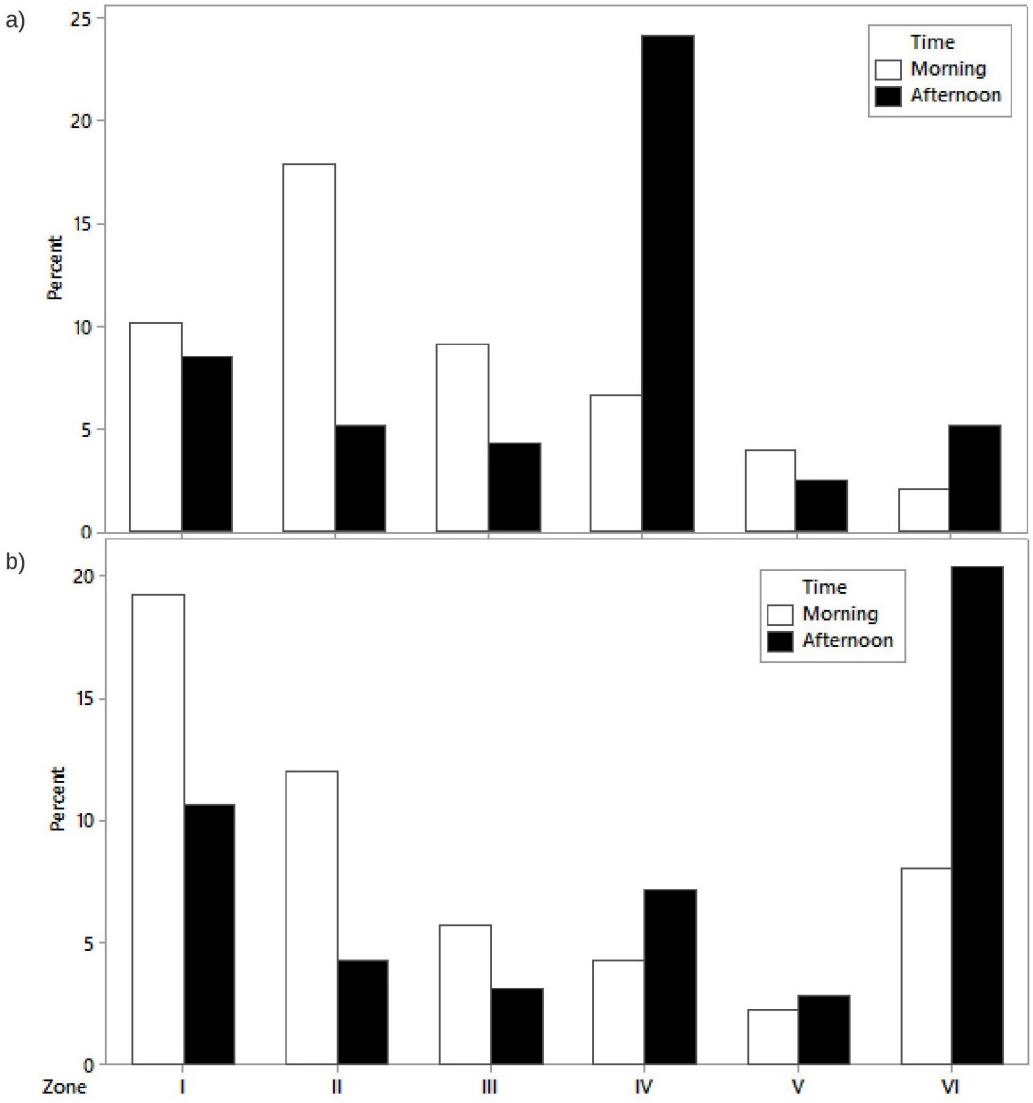

Figure 6: *Relative frequencies of zone usage for a) treatment Baseline; and b) treatment Visitors.*

4.3. Stereotypic behaviour

Only one of the six individuals (16.7 %), i.e. E2, was seen performing the stereotypy weaving. The majority of minutes spent weaving occurred during baseline afternoons (Tab. 3). On visitor days, weaving occurred only in the afternoons whereas no weaving was seen when the elephant bull was near (Tab. 3). E2 spent 16.6 % of the whole observation time weaving.

Table 4: *Minutes spent weaving by E2 by treatment and time of day.*

	Treatment			
Time	Baseline	Visitors	Elephant bull	Total
Morning	54	0	0	54
Afternoon	249	95	0	344
Total	303	95	0	398

No other individual was seen performing the stereotypy weaving. However, E1 had a bout of 15 minutes where she stood apathetically still facing one of the doors. It was judged that she was not resting because the elephants usually did this in the middle of the hall, not with their head against a wall or door. Additionally, E2 was weaving next to her and would probably have bothered an elephant who was trying to relax. This occurred one afternoon when visitors were present.

5. Discussion

5.1. Behavioural activity

The aim of this study was to see how the elephants spent their time in their new enclosure and whether the presence of visitors or that of a mature elephant bull has any effect on the group's behaviour. The older elephant cows that were known to weave were studied for patterns in the expression of their stereotypic behaviour.

The results show that the elephants in Borås Zoo spent the majority of the observation time foraging. This is in line with other studies done on elephants in captivity (Horback *et al*., 2014; Boyle *et al*., 2015; Greco *et al*., 2016) as well as in the wild (Leggett, 2008; Hunnick *et al*., 2017). This is a valuable result as it discloses that the elephants spent the majority of their time in captivity performing natural behaviours. In recent years, the activity budget of elephants in captivity seems to have shifted towards more foraging as older studies reported lower frequencies and only just started giving browse as feeding enrichment (Stoinski *et al*., 2000).

The second most common category was *Others* which is due to the high occurrence of *Not visible*. *Locomotion* was the third most common category. Studies have shown that African elephants in the wild walk a considerable amount, between four and seven km a day (Wyat & Eltringham, 1974 in Clubb & Mason, 2002) or 26 % of their time (Leggett, 2008). Home ranges can stretch from 14 km² (Douglas-Hamilton, 1972) to 5900 km² for adult females (Leggett, 2006). Wild juveniles move more than adults (Leggett, 2008) which was even the case in this study. Compared to the wild, the Borås elephants moved noticeably less. Leggett (2008) argued that wild elephants move mostly due to the necessity of finding food, thus the decrease in zoos where food is abundant. Hutchins (2006) calls elephants "energetically conservative", meaning that elephants are smartly saving energy when moving long distances in search of food, water or mating partners is not necessary. This would explain the relatively low frequency of locomotion registered in this study. To what extent Hutchins' (2006) claim holds true is debatable as previous studies have shown both lower, similar and higher amounts of walking (Horback *et al*., 2014; Boyle *et al*., 2015; Greco *et al*., 2016). More research on whether elephants would prefer bigger over smaller enclosures is needed, especially in Scandinavia or similarly cold climates. Even if Hutchins' (2006) should be right in his assertion, one should not forget, that lack of exercise can lead to a range of health problems in elephants, such as foot problems and arthritis (Clubb & Mason, 2002).

Positive social behaviours were the fourth most common behaviour category. Horback *et al*. (2014) reported that most positive social behaviours happened between a mother and her calf, including nursing, which was also the case in this study. However, the calves in Borås were even seen suckling either of the two mothers. Allosuckling is part of the phenomenon allomothering which is common in elephants (Lee, 1987). Allosuckling itself is rare, seen in only 3.7 % of nursing bouts where the majority was unsuccessful as it happened with a non-lactating female (Lee, 1987). The author judged that the behaviour is only meant for comfort,

not to give the calf extra nutrition. She also found out that calves spent more than 80 % of their time within 5 m of their mother until they are 8 years old (Lee, 1987), which can even be said about the Borås calves although they did not have the possibility to move much further away in the enclosure.

The low amount of agonistic behaviours registered was in accordance with Horback *et al*. (2014). There were only two bouts of fighting seen but when studying a different focal animal and were therefore not registered. In both cases E1 attacked E3 which is, according to the caretakers, the only constellation fights ever happen in the group (M. Rhen, Borås Zoo, personal communication, 5 April 2018). Aggression can be a sign of frustration (Fraser & Broom, 1990 in Mason & Clubb, 2002), stress or pain (Toates, 1995 in Mason & Clubb, 2002). It seems to be common that mostly younger, subordinate herd members receive aggression (Adams & Berg, 1980; Garaï, 1992) which was also the case noticed in the current study. Garaï (1992) named unrelatedness in the groups as one possible cause although her study was mostly done on Asian elephants (*Elephas maximus*). Nonetheless, it seems to be applicable on the African elephants in this study as well since E1, despite being the matriarch, is the only individual that is not at all related to the rest of the group. Small enclosure size, or rather the receiver not having the possibility to retreat, is another setting where heightened aggression was witnessed (Garaï, 1994). In the confinement of the Borås indoor hall, E3 clearly did not have the possibility to retreat. Even competition can play a roll since both attacks happened in the afternoon when resources started to become scarce (Garaï, 1994).

5.2. General zone usage

That zones I and II were among those most used was surprising since these two were closest to the visitor area. Pinter-Wollman (2009) found out that elephants explored an area less the closer it is to human activity. Although the Borås elephants cannot leave their enclosure, they did have the possibility to stay further away from the visitor area. It could be that these animals were quite used to the presence of humans, not only visitors but also the caretakers, which they associated with something positive. This is likely, seing that they have a strong connection to their caretakes (M. Rhen, Borås Zoo, personal communication, 5 April 2018).

African elephants in captivity have been observed to show greater motivation to explore novel objects when having watched a role model beforehand, implying the capability of social learning to a certain degree (Greco *et al*., 2013). Even Pinter-Wollman *et al*. (2009) proved that wild elephants benefit from social contact with conspecifics when in a novel environment. Therefore, the fact that the group moved into the hall in an existing, well known constellation can have helped. Pinter-Wollman *et al*. (2009) also reported more sociality in the wet than the dry season when food is abundant, showing that competition might influence sociality. In the Borås hall, under these regulated circumstances, food is always abundant, giving the group the opportunity to be social and not competitive.

5.3. Differences between treatments

In baseline, the category *Others* was registered more often which was due to the higher amount of time they were not visible from the camera's perspective. This is also the reason why zone IV was most popular (in the afternoons) seeing that the animals often stayed in front of the door to their training quarters (where they would go when the hall was prepared, see 3.3 *Daily routine*). Undoubtedly, the animals heard noises that they associated with something they were motivated to get. Bassett and Buchanan-Smith (2007) believe it essential to hold involuntary pre-feeding signals to a minimum, since they are unreliable and can create frustration and aggression (Carlstead, 1986). One solution might be a clear reliable signal for food delivery replacing the involuntary signals. This is a good topic for future studies.

The elephants in Borås Zoo foraged and played more when they were neither disturbed by visitors nor the elephant bull. Rest was registered more often when visitors were present which could point to a certain visitor effect as was the case in the, to date, only existing study done on visitors' influence on captive African elephants (Quadros *et al*., 2014). There, the elephant exhibit was amongst the most popular with sound levels registered around 62.5 dBA. 70 dBA is the threshold where human hearing can take damage although the authors caution that this might be different for animals (Quadros *et al*., 2014). Zone VI was used more in the afternoons on visitor days. This could simply be assigned to the fact that food was becoming scarce in the other five zones. Considering that the animals clustered in front of the doors in this zone and both weaving and E1's apathetical bout occurred there (see 4.3 *Stereotypic behaviour*), this could also point to the animals being stressed and choosing an area as far away as possible from the visitors.

Zone V was not registered on elephant bull days which can be explained by the fact that the entire zone was in the section where E1 was fenced off. However, E1 spent most of the registration time in zone III. In the afternoons, when both the elephant bull and the group were in their outdoor enclosure, locomotion and hygiene increased. The reason for this seems to be the larger space of the outdoor enclosure that forced the animals to walk marginally longer distances to the forage hiding places as well as giving them the opportunity to dust and water bath with substrates that probably are more attractive. Although the floor of the indoor hall is covered in a thick layer of natural self-cleaning sand (M. Hjelm, Borås Zoo, personal communication, 29 March 2018), the elephants probably appreciated the opportunity to dig their own mud wallows, which they were seen rolling in. Also, the treatment *Elephant bull* was observed last in April, by which time the temperatures had risen. It could be that the Borås elephants dust bathed more in response to the weather as Asian elephants have been noticed to do (Rees, 2002).

Pinter-Wollman *et al*. (2009) observed increased social behaviour when elephants are facing unfamiliar environments. If this can be interpreted as a general reaction to stress, their study could explain the increase in social behaviour for treatment *Visitors*. The presence of the elephant bull, on the other hand, allows for more greeting and investigating socially. E7 is not

just a possible mate for the adult cows but also a role model to the juvenile bull E4 (Evan & Harris, 2008).

5.4. Stereotypic behaviour

5.4.1. Weaving

Of the two individuals that were reported weavers, only one was seen performing the stereotypy. Across all observations, E2 had most weaving bouts during baseline and not, as the caretakers had feared, on visitor days. Most weaving occurred in the afternoon. Surprisingly, no weaving was seen in treatment *Elephant bull*.

Studies showed that between 44 and 74 % of African elephants in North American and European zoos performed stereotypies for a total of 4 to 8.5 % of the observation time (Clubb & Mason, 2002; Greco *et al*., 2016). In the present study, only 16.7 % of studied animals performed stereotypies, i.e. less individuals, but for a greater part, namely 16.6 % of the observation time.

There is a correlation between the risk for elephants developing stereotypies and the time they spent indoors (Greco *et al*., 2017). Unfortunately, the time spent indoors is a factor not likely to change because the scandinavian climate does not allow for it. In a similar context, Rees (2004) found out that the performance of stereotypies can be provoked by thermal stress in temperatures colder than the elephant's normal range. Despite the fact that elephants can experience temperatures close to or below zero even in their native habitat (Spinage, 1994 in Rees, 2004; Mole *et al*., 2016), they are not used to being exposed to cold climate for a longer period. Rees' (2004) study was done on Asian elephants and it remains to be seen whether both species are comparable in this regard. It could be a possible trigger, though, since most weaving was registered in baseline which was recorded a few weeks before the other treatments when temperatures were close to zero throughout the day.

Another possible reason for developing a stereotypy is frustration which could be induced by E2 being motivated to join a partner (Greco *et al*., 2017). Since African elephants come into oestrus for only two to six days once every approximately four years, they utilise a range of communication methods (see 2.1 *African elephants in the wild*) in their pro-oestrus period to make sure to attract a partner until the narrow time window opens (Moss, 1983; Poole & Moss, 1989). This could explain why stereotypies were seen in baseline and on visitor days but not when the elephant bull was next to the group because, from E2's perspective, she was successful in finding a mate. Further research is necessary to fully disclose a connection.

Looking at the data, one can see that the majority of weaving bouts occurred in the afternoons. While the outdoor enclosure seemingly gave them other occupations, which was reflected in no afternoon registrations of weaving in treatment *Elephant bull*, this does not appear to be the case in afternoons spent indoors. Anticipating a possibly rewarding situation is one more thinkable reason to perform stereotypies (Greco *et al*., 2017). Since E2 was weaving mostly in zone IV, it is likely that she awaited something that was coupled with the opening of the door to the training quarters. Spatial and temporal predictability of the feeding

schedule can lead to food-anticipatory activity (FAA) like wheel running and feeding trough manipulation in rodents (Mistlberger, 1994) and an increase in aggression in pigs (Carlstead, 1986). FAAs are assumed to be a derivation of natural foraging behaviours (Mistlberger, 1994), like walking in elephants. Weaving, in turn, is described as the expression of a motivation to walk when restrained, as seen in chained Asian elephants (Kurt & Garaï, 2001). Although it is not implied that African and Asian elephant behaviour is analogous, this may explain the weaving for E2 who was chained nighttime as was common practice until 2005 (M. Hjelm, Borås Zoo, personal communication, 29 March 2018). She seems to have developed the stereotypy during this time.

Some of the other behaviours, like rest and agonistic behaviour, were registered more during treatment *Visitors* (see 5.3. *Differences between treatments*). This could explain why less stereotypies were registered in this treatment. One should not forget that stereotypies can become learned behavioural patterns that are expressed even if there are no outside cues to provoke the behaviour (Mason & Veasey, 2010). In this case, the individual's welfare might not really be jeopardised but rather a reflection of its unlucky past which is highly likely for E2 (Clubb & Mason, 2002; Mason & Veasey, 2010).

5.4.2. Other abnormal behaviours

Whereas no other elephant was seen weaving, yet, some individuals were seen throwing faeces onto themselves which is classed by Clubb and Mason (2002) as a stereotypy as well. However, since the observer did not know this until the data registration was done, this was recorded as *Dust bathing*. Still, it is unclear whether the act of dusting oneself with faeces had a stereotypical background or if this was done for want of a more suitable dust bathing substrate. To find the answer, more research is needed.

E1 was not seen weaving, despite the caretakers reporting that she also performed this stereotypy. Instead, she was seen standing apathetically still for a full 15 minutes one visitor afternoon. Although standing still does not fit the description of a stereotypy (”a repetitive and invariant” behaviour, Mason, 2006), apathy is seen as an abnormal behaviour (Mason & Veasey, 2010) and might be triggered by the presence and noise level of the visitors. Fortunately, this single bout is not enough material to justify worrying about E1’s welfare.

5.5. Welfare assessment

Stereotypic behaviour has been the indicator of bad welfare for a long time since it evidently evolves out of frustration over not being able to express motivated behaviours (Mason & Veasey, 2010). The authors caution that stereotypic behaviour might rather be the reflection of an animal’s past and advise consulting physiological changes that indicate stress. In the case of E2, it cannot be definitely said that she has bad welfare. Her stereotypy has likely developed in the time she was chained overnight, and while the other elephant that was chained during nighttime, E1, does not seem to show traces of this time, E2 integrated the stereotypy in her behavioural repertoire.

Mason and Veasey (2010) add that performance of stereotypies might actually improve an animal's welfare seeing that it gives the animal some form of outlet for its frustration. In that case, the animal might have better welfare than individuals not performing stereotypies since they can have learned their helplessness and possibly harbour considerable levels of stress. Therefore, E2's situation might not be as bad as it seems. She appears to perform the stereotypy in anticipation. My suggestion is to eliminate the cues that make her anticipate food or going outside as much as possible.

The elephant herd in Borås Zoo spent the majority of their time foraging, showed the right amount of sociality and a low degree of agonistic behaviour. According to the reasoning of Horback *et al*. (2014), this proves that the group had decent possibilities to express natural behaviours. This, together with the fulfillment of the other four freedoms (Farm Animal Welfare Council, 2009) and the fact that no other animal was seen performing a stereotypy, indicates positive welfare.

5.6. Management implications

Hutchins (2006) declares that some of the most successful African elephant programmes are found in colder climate, for example in Portland, USA. One suggestion is to find out how these became so prosperous and if some of their procedures are applicable in Borås. When moving elephants to new enclosures, this should be done in existing, well known groups of preferably related individuals (Pinter-Wollman *et al*., 2009).

As named under section *5.5. Welfare assessment*, the involuntary pre-feeding signals should be avoided in order to minimise anticipatory behaviour, especially E2's weaving in front of the door in zone IV. A bell anouncing the appearance of the caretakers could be a reliable signal when it is time for the elephants to wait in their training quarters for the preparation of the hall.

It would have been desirable that the elephants had the opportunity to choose between the indoor hall and an outdoor enclosure. At present, this is impossible due to the way the buildings are arranged. However, if further alterations are conducted, this should be taken into account. Since the elephants performed more dust and water bathing in the outdoor enclosure, which possibly shows a preference for moist substrates, it is recommended that they be given access to a small pool indoors which could make them want to dust bath more.

One way to get the elephants used to visitors and calm in their presence could be training them in the hall for all to see. This could be a daily event for visitors to witness. Additionally, this opportunity could be used to educate people about the negative effects of noise on not only elephants' but also other animals' hearing.

5.7. Sustainability

Zoos constantly work with the conservation of endangered species, hoping to one day be able to reintroduce them to the wild (Borås djurpark, 2018). This is part of the 15th global sustainability goal, aiming for the preservation of biodiversity until 2030 (United Nations,

UN, 2018a). African elephants are a key species in their natural habitat (WWF, 2004). Their extinction could therefore have unpredictable consequences that affect a range of other species, both fauna and flora. Thinking about how difficult elephant keeping still is (Miller *et al*., 2016), this study could be the basis for further research done on keeping elephants in indoor halls and ensuring their welfare. Working on improving elephant reproduction in captivity is also essential to secure the survival of the species. Using zoos as a platform for education even incites the fullfillment of the 4th goal: ”Ensure that all learners acquire the knowledge and skills needed to promote sustainable development” (UN**,** 2018b). The jeopardy wild elephants live in by poaching and habitat degredation should be taken up in zoo education, as well as what can be done to improve this situation.

5.8. Application of this study and proposals for future research

This study is a valuable contribution to the existing literature on what aspects to consider by zoos before moving elephants to new enclosures. It can also be used to ease the minds of those concerned about confining elephants to indoor halls for several months since it shows that this is possible. Although the study subjects and the data collected were few, this study can be an important base for discussion and future research.

One study that is overdue is one focusing solely on African elephants in captivity and the way they react to visitors. Preferably such a study is carried out in a number of zoos with different settings where not only the effect of different numbers of visitors, and consequently their noise level, is evaluated but also whether the placement of the visitor area makes any difference to elephants.

It would also be very interesting to investigate the effect a mature, or even a musth, elephant bull has on the behaviour of a group of female elephants and their calves, as no such study seems to exist.

A preference test would be of interest, to see whether elephants in cold climate zones would choose small indoor halls over larger outdoor enclosures and whether that would make indoor confinement over several months superfluous.

As most articles on animal welfare in general, and the few on elephant welfare specifically, still define good welfare as the absence of a range of indicators for bad welfare, it would be beneficial to study indicators for good welfare in elephants. To take this one step further, signs of positive emotions in elephants should be a priority in order to make judging their state of mind easier and aid in avoiding fatalities in the future.

The welfare report of the Royal Society for the Prevention of Cruelty to Animals (RSPCA), written by Clubb and Mason (2002), is a thorough and handy overview of both husbandry and health of captive elephants in Europe. Unfortunately, dating back to 2002, it is long outdated. A revision would therefore be desirable.

5.9. Advantages and disadvantages with the chosen method and possible error sources

Most modern studies (e.g. Greco *et al*., 2016, 2017; Horback *et al*., 2014) used a different approach where behaviour was differentiated between states and events. There, elephants were observed continuously for behavioural events during 15 min while at the same time behavioural states were registered after one-minute-intervals. This method would surely have given more exact results even in this study. However, the pilot study was using one-minute-intervals but gave mainly the same result for two consecutive minutes which is why a two-minute-interval was deemed sufficient. The author is convinced that even the used method gave reliable results as the aim of this study was to see how, when and where the elephants used resources in their indoor hall which was achieved. However, a higher number of observations, study subjects and zoological institutions as well as an actual statistical analysis would have given a more statistically representative result.

Comparing the category *Locomotion* to studies from the wild could have been misleading since studies done on wild African elephants only registered walking. The locomotion category used in this study included behaviours like backing up (which probably is rarely seen in the wild), running as well as shaking body parts which are mostly used as warning signals. Although none of the last were observed during this study, when repeating it, they should be classified differently.

Another source of errors was the measuring of whole minutes for the registration of stereotypic behaviour. This was done out of simplicity as no stop watch to time the behaviour exactly was available. It is possible and likely that this behaviour was overrepresented since E2 could stop weaving for more than half a minute but within the same time on the observers mobile phone, and start again the next minute, resulting in two whole minutes weaving registered.

Unfortunately, the placement of the camera did not allow for all behaviours to be observed. Instead, a lot of *Not visible* was registered, resulting in a possible overrepresentation of the category *Others*. When repeating this study or implementing a similar one, the placement of the camera should be carefully chosen or, ideally, be replaced by direct observations.

5.10. Strengths and weaknesses with the used literature

Most research used in this study was thoroughly planned and implemented. Data was collected for the whole day and then compared for daytime and nighttime activity. One study even compared behaviour between seasons (Greco *et al*., 2017). Both are positive assets, giving a comprehensive picture of captive elephant behaviour. Greco *et al*.s studies (2013, 2016, 2017) generally spanned a range of zoos, leading to a large sample size and can be said to be representative for the North American captive elephant population. A weakness was that observations were executed by the local zoo staff and, despite clear instructions, there can have been inter-observer-differences. Another weakness is that Horback *et al*.s study (2014) was done on the elephant group living in San Diego Zoo Safari Park, a group of different aged, familiar individuals. It is possible that these elephants influenced each other so that they no longer are independent samples. When concerned with elephant foot and joint

health, studies mostly considered flooring alternatives to concrete, like rubber mats (Boyle *et al*., 2015). Since neither concrete nor rubber mats were used in Borås Zoo, these studies did not prove useful in comparisons.

The literature that concerned itself with the so-called basic research, like elephant herd structure and mating behaviour, was done between the 1970s and 1990s and not repeated since as it is unlikely that these kinds of behaviours would yield different results today. Their age led to them largely being unavailable in the databases which is why second-hand sources had to be cited. Contemporary literature on wild African elephants' behaviour, in this study's case from 2006 to 2016, investigated elephant behaviour under extreme conditions. It is questionable whether this can represent the wild African elephant population since the majority probably lives under less extreme conditions. One study even used accelerometers to measure activity levels over the day but the specific behaviour could only be guessed at, eliminating the possiblity to use this study as a reference.

Some studies collected data on both African and Asian elephants. Either, the results were mixed for both species, making it questionable whether they are representable for the captive African elephant population, or this resulted in a low number of African elephants studied, which might not be representing the population either (as in Mason & Clubb, 2002). Concerning stereotypies, most studies were on Asian elephants since more Asian elephants exist in captivity than Africans. Still, it is not implicit that African and Asian elephants behave in the same way and have the same motivational factors for their behaviour which is why one should be careful with comparisons until the opposite is proven.

6. Conclusion

Looking back at the questions investigated, it can be established that the elephants in Borås Zoo spent the majority of their time foraging, followed by locomotion and positive social behaviours, which is in line with earlier studies done on elephants in captivity. Visitors seemed to have an effect on the elephants behaviour to some extent since more rest and less foraging was registered. That the zones closest to the visitor's area were amongst those most used came as a surprise. It could be that humans do not have an aversive effect on the elephants as a consequence of their tight bond with the caretakers. When the elephant bull was next to the group, more locomotion and hygiene behaviours were registered in the afternoons but this is likely ascribed to the larger space in the outdoor pen. Only one individual was seen weaving, mostly during baseline and not at all next to the elephant bull. In the afternoons, this could also be explained by the larger space which gave the elephant cow different occupations but warmer temperatures could also be a cause. Her weaving was likely developed during the time she was chained overnight and now only expressed when anticipating food. To sum up, it can be said that the elephants in Borås Zoo have accepted their new indoor hall well as they show a decent amount of natural behaviours and only one individual was seen weaving.

7. Populärvetenskaplig sammanfattning

Afrikanska elefanter (*Loxodonta africana*) är sociala djur som lever i stabila familjegrupper av relaterade honor. De är anpassade till ett liv i torra, varma områden. Djurparker i kalla klimat såsom Skandinavien är tvungna att hålla elefanter inomhus under flera månader eftersom det finns en risk att djuren skulle kyla ner kroppstemperaturen för mycket samt kunna halka på isig mark. Eftersom bra hägndesign verkar vara viktig för elefanters välfärd ville Borås djurpark veta hur bra elefanterna hade accepterat sin nya inomhushall som de flyttade in fem månader innan denna studie påbörjades.
Denna studie undersökte vilka beteenden elefanterna utförde i hallen och vilka delar av hallen de använde mest. Det studerades även om elefanterna visade såkallade stereotypier, repetitiva beteenden utan uppenbarligt syfte. Studiesubjekt var Borås djurparks elefantgrupp som består av 3 vuxna honor, en ungdomshane och 2 kalvar. Studien indelades i 3 situationer för att se om närvaron av besökare eller en vuxen elefanttjur har någon påverkan på gruppens beteende. I den första situationen var elefantgruppen själv i hallen. I andra situationen hade besökare tillgång till hallen mellan kl. 10 och 16. I tredje situationen fanns inga besökare på plats men Borås djurparks vuxna elefanttjur fick tillgång till en del av hallen.
Studiens resultat visar att elefanter på Borås djurpark spenderade mesta delen av tiden åt att söka föda vilket är bra eftersom det liknar rapporter från det vilda. De gick dock mindre än i det vilda. En studie påstår att det inte är nödvändigt för elefanter att röra sig mycket i fångenskap när det finns gott om föda, andra uppmanar till att brist på motion kan leda till fotproblem och artritis. Förhoppningsvis kan framtida forskning upplyser om elefanters plats- och rörelsebehov. Det fanns också en del positiva sociala beteenden, främst mellan moder och kalf. Agonistiska interaktioner var få vilket är bra för att då sjunker risken att elefanterna kan skada varandra.
Både besökare och elefanttjuren verkade störa elefanterna eftersom mindre födosök registrerades i de två sista situationerna. När besökare var i hallen, ökade tiden elefanterna vilade. Detta visades även i en tidigare studie och kan tyda på att besökare påverkar elefanterna till mer inaktivitet. Under hela studiens gång, inte minst så i denna situation, ävändes dock mest de zoner som låg närmast besökarytan. Detta betyder att Borås djurparks elefanter inte uppfattade besökare lika besvärlig som det antogs. När den vuxna elefanttjuren gick bredvid gruppen, registrerades mer motion och självvårdnadsbeteenden på eftermiddagar jämfört med morgonobservationer. Detta berodde troligtvis på att de gick i sitt utebakhägn på eftermiddagen de dagar. Utomhushägnet är större och kan ha krävt mer motion för att nå resurser samt erbjuder andra, framförallt blöta substrat att sandbada med som elefanterna verkade ha föredragit sanden som fanns i hallen.
Det var endast en individ som visade stereotypin vävning, trots att skötarna rapporterade att det var två individer som gjorde det. Troligtvis har denna elefant utvecklat stereotypin när hon hölls fastkedjat under nätterna som tyvärr var helt vanligt att göra tills 2005. Vävning registrerades främst på eftermiddagar, mest när elefanterna var helt själva i hallen, men också till viss del när besökare var i hallen. Hon vävde oftast framför dörren till sitt träningsrum, där elefanterna brukade vänta tills skötarna hade fyllt på maten inne i hallen. Därför dras slutsatsen att hon gjorde så i förväntan av mat. Utförning av stereotypier behöver nämligen

inte alltid betyda att det är någonting fel med miljön djuret lever i, utan det kan också läras in och tyder i så fall på djurets förflutna.
Eftersom elefanterna på Borås djurpark visade en rad naturliga beteenden och endast lite agonistiska interaktioner samt att bara en individ i hela gruppen visade en stereotypi, som troligtvis utvecklades under andra omständigheter långt innan denna studie påbörjades, bedöms det att de har accepterat hägnet bra.

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