Department of Physics, Chemistry and Biology

Master´s Thesis

The effect of visual barriers, outdoor housing and feeding enrichment on the behaviour of drills (*Mandrillus leucophaeus*) at Parken Zoo

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Sammanfattning/Abstract:

Animals are confronted with potential stressors at zoos compared to in the wild, such as visitors and lack of environmental stimulation. This study included two projects conducted on the drills at Parken Zoo in Eskilstuna where I investigated: 1) the effect of visual barriers on the behaviour of the drills and if the visual barriers can moderate the visitor effect on the drills and 2) how outdoor-only access together with feeding enrichment (frozen fruit and tube feeders) affects the behaviour of the drills. 1/0- sampling method was used when observing the behaviours of the drills with 1 minute-intervals. Resting/Sleeping increased, while social agonistic behaviour and stereotypies decreased with visual barriers. A moderated visitor effect was shown in resting/sleeping and social affiliative behaviour in the drills with visual barriers. However, social agonistic behaviour and visitor interaction were still affected by visitors after the installation of the visual barriers, implying that the drills still find visitors stressful to some extent and that further alterations on the observation area viewing the indoor enclosure is recommended for the welfare of the drills. With outdoor-only access together with feeding enrichment, locomotion, foraging/eating and body-shaking increased, while resting/sleeping, social affiliative and agonistic behaviour, stereotypies, visitor interaction, scratching and self-grooming decreased. This suggests that outdoor-only access and feeding enrichment improve the behaviour of the drills and would be a valid option during summer season for the drills at Parken Zoo.

Nyckelord/Keyword:

Enrichment, Primate, Stress, Visitor effect, Visual barrier, Welfare

Contents

1 Abstract

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2 Introduction

The modern zoos today have four common goals: conservation, public education, research and entertainment (Read and Waran 1996; Hosey et al. 2013). These goals are associated with each other. For example, for conservation to be effective, research is needed and for research to be carried out, resources are needed. Visitors play a major financial role for zoos and for the achievement of these goals. It is therefore important for zoos to make sure that the visitors have a pleasant and entertaining experience (Hosey et al. 2013).

For endangered species like the drill (*Mandrillus leucophaeus*), an African Old World Monkey, conservation breeding in zoos and other institutes is of high importance with the goal to recreate a self-sustaining wild population (Ebenhard 1995). If suffering from poor welfare, the reproductive behaviour of the animals can be reduced resulting in a lower reproductive success (Carlstead and Shepherdson 1994; Morgan and Tromborg 2007). It is therefore important for endangered species in

conservation breeding programmes, like the drill, to maintain a good welfare for the survival of their species.

Allowing animals to perform their natural species-specific behaviours, for example sleep, affiliation, play and forage, is considered highly important for their welfare (Novac and Suomi 1988; Claxton 2011). To assess animal welfare in a behavioural level, the occurrence of abnormal and stereotypic behaviours, aggression and stress-related behaviours (negative welfare indicators) and species-specific behaviours (positive welfare indicators) are commonly measured and analysed (Mason et al. 2007; Izzo et al. 2011). Reducing the stress level of the animals reflected by a positive alteration in these welfare indicators stimulates an improved welfare (Swaisgood and Shepherdson 2005; Gronqvist et al. 2013). Other benefits that arises when zoo animals perform more of their species-specific behaviours are: 1) zoo visitors will be provided with a more accurate picture on how the animals behave in the wild 2) the research conducted at zoos will show more accurate and trustworthy results and 3) it can result in better reproduction for breeding programmes (Hosey 2000; Honess and Marin 2006).

There are several factors that can affect the welfare of zoo animals. Some influential factors are: 1) visitors 2) zoo environment and 3) access to an outdoor enclosure which are further described below.

Every day during opening season zoo animals are confronted with groups of visitors of all ages who have come to see exotic animals. How many visitors there are in a group (visitor density) and how much noise they are creating by the sound of their voices (visitor intensity) are some factors that have been shown to have a large impact on the zoo animals, both behaviourally and physiologically. These effects caused by visitors are usually seen as negative for the animals (Hosey 2000). For zoos to provide a good welfare for the animals and still provide visitors the chance to see the animals, it is highly important to understand the impact visitors have on zoo animals and to create improvements for the benefit of both parts.

Studies of visitor effect on captive animals have shown increased stereotypic behaviours in mandrills (*Mandrillus sphinx*; Chamove et al. 1988), gorillas (*Gorilla gorilla gorilla*; Wells 2005), jaguars (*Panthera onca*; Sellinger and Ha 2005), leopards (*Panthera pardus*; Mallapur and Chellam 2002), increased vigilance behaviour in orangutans (*Pongo pygmaeus*; Birke 2002), increased intragroup aggression in gorillas (Wells 2005), golden-bellied mangabeys (*Cercocebus chrysogaster*; Mitchell et al. 1991) and Indian gaur (*Bos gaurus gaurus;* Sekar et al.

2008), increased aggressive display towards visitors in golden-bellied mangabeys (Mitchell et al. 1991), reduced playfulness in orangutans (Choo et al. 2011) and increased cortisol level in Mexican wolfs (Pifarré et al. 2012) and spider monkeys (*Ateles geoffroyii rufiventris*; Davis et al. 2005). These behavioural and physiological changes can be indicators of stress in an animal (Sellinger and Ha 2005; Wells 2005; Davey 2007) and if an animal is exposed to stressors, such as high visitor density and high noise levels, during longer periods, it may become an animal welfare issue.

To diminish the stress in zoo animals caused by the presence of visitors, visual barriers have been suggested in several studies as a possible solution (Blaney and Wells 2004; Kuhar 2008; Smith and Kuhar 2010). Blaney and Wells (2004) conducted a study on gorillas, where they placed a camouflage net on the enclosure glass wall to investigate any behavioural changes in the gorillas and the visitors' perceptions before and after this modification. The results came out positive from several directions. The gorillas displayed less aggressive and abnormal behaviours with the net placed on the glass than without and the visitors thought it to be more thrilling peeking at the gorillas through the net. This shows that there are possible solutions beneficial for both zoo animals and visitors.

The time budget zoo animals spend on their species-specific behaviours differ from animals living in the wild. At zoos, primates are provided with food that has already been processed and placed out for them, giving the animals no or little opportunity to search, select or process the food themselves. This can lead to a major issue for primates that, in the wild, spend the majority of their day foraging (Honess and Marin 2006). The result from not getting the opportunity to forage can lead to boredom and in the end obesity. Stereotypic behaviours have also been seen to develop when animals are not being able to display their species-specific behaviours, reflecting a poor environment (Mason et al. 2007).

Enriching the environment for animals is one strategy commonly used at zoos, providing suitable environmental stimulation for the animals. There are several varieties of environmental enrichment, such as social (composition of the group of animals), feeding (type of food provided) and physical (natural features) enrichment (Laule 2003). Which enrichment to use as a tool, depends on the species, their species-specific behaviours and previous reported successes. For primates, food and feeding enrichment is the most common enrichment used (Honess and Marin 2006), promoting an increased extraction and processing effort. For example, an increase in foraging and decreased self-directed

behaviour was the result in red-capped mangabeys (*Cercocebus torquatus torquatus*) after being presented with seeds and litter (Blois-Heulin and Jubin 2004).

If a zoo wants to eliminate or at least reduce stereotypic behaviour in an animal through enrichment, the timing and location of the occurrence of these unwanted behaviours influence the choice of enrichment (Mason et al. 2007). Also, it is important to know the background of an animal's developed stereotypies in order to give a fair conclusion when discussing welfare conditions through unwanted behaviours. Stereotypies can be developed through poor enrichment and stimulation in enclosures, but also through maternal deprivation as young which is a common issue in primates (Abello et al. 2007; Mason et al. 2007; Mason and Rushen 2008). When young, the primate infants learn how to behave in different situations through their parents and other conspecifics. Without guidance and physical contact from a conspecific, inappropriate, self-injuring behaviours may develop. With this background, the behaviour may be so deeply rooted that an elimination of the behaviour is not likely. This is fairly a natural way for them to cope with stressful situations (Pomerantz et al. 2012).

The outdoor environment provides more sensory stimulation (visual, olfactory and auditory; Honess and Marin 2006) and environmental stimuli (e.g. grass and sunshine) for zoo animals than the indoor environment. Also, outdoor enclosures mostly have a higher environmental complexity than indoor enclosures (Novak and Suomi 1988) and may therefore provide more opportunities for animals to engage in their species-specific behaviours. Several behavioural studies indicate positive behavioural effects in primates when having access to an outdoor enclosure such as improved reproduction and activity in sifakas (*Propithecus sp.;* Pereira 1991 in Honess and Marin 2006) and increased activity and exploration in rhesus macaques (*Macaca mulatta*; O'Neill et al. 1991). For the rhesus macaques it was also shown that when returned indoors their inactivity increased.

Even though the knowledge of what the outdoor environment provides, some primate studies, for instance on alaotran gentle lemurs (*Hapalemur griseus alaotrensis)* and gorillas, have shown that they tend to spend most of their time indoors when giving the choice of either being indoors or outdoors (Bellingham 1998; Ross et al. 2011). Why they choose to be most of the time indoors when the outdoors provide them with so much more stimulation and complexity is still unknown.

2.1 Aims of this study

This study was conducted on the drills at Parken Zoo in Eskilstuna, Sweden and included two projects in an attempt to increase their welfare.

As an earlier study by Lundin (2013) concluded that the drills at Parken Zoo are stressed by visitors, the aim in the first project was to investigate the effect of visual barriers on the behaviour of the drills and if the visual barriers can moderate the visitor effect on the drills.

As seen in other primates, the drills at Parken Zoo tend to spend most of their time indoors when having access to an indoor-outdoor enclosure, missing out on the opportunities and stimulation the outdoor environment brings. Therefore, the aim in the second project was to investigate how outdoor-only access together with feeding enrichment affects the behaviour of the drills compared to their ordinary indoor/outdoor access without feeding enrichment.

3 Material & methods

3.1 Animals and husbandry

This study was conducted on three drills (*Mandrillus leucophaeus)* at Parken Zoo in Eskilstuna, Sweden between May-September 2013. Of these three drills, one was a male named N'Boa in the age of 15 years during the study. The other two, Kapi and Kuna, were females and they were 15 respectively 13 years old. Kapi and Kuna were sisters and born at a zoo in Barcelona, Spain in 1998 respectively 2000. N'Boa was born at a zoo in Hannover, Germany in 1998 and was transferred to Barcelona the year after to be held with Kapi and Kuna. In 2006, N'Boa and Kapi were transferred to Edinburgh Zoo in the United Kingdom and in 2010 were they both transported to Parken Zoo in Eskilstuna, Sweden. Kuna was transferred to Parken Zoo the year after to join them.

Both Kapi and Kuna carry good genes for the survival of their species and are therefore valuable for the international breeding programs for conservation. It is of great importance that they can reproduce successfully. None of them have yet produced any offspring. They were both hand-raised as young and Kapi, one of the females, developed a stereotypic self-injuring behaviour in her early life most likely due to maternal deprivation. Kuna, however, did not develop any stereotypic behaviour.

At Parken Zoo, the drills were housed together in a mixed species enclosure with a pair of l´Hoest's monkeys (*Cercopithecus lhoesti*). The

female l´Hoest's monkey were sick during the observation period and was separated for veterinary care at different periods of time.

The monkeys had full access to an indoor enclosure that included one smaller area (I1 in Figure 1) and one larger area (I2 in Figure 1). Both areas had straw as ground material, large branches hanging from the roof and cliff structures. In the smaller area they had access to a ladder to climb up to a loft. The larger area had a large window viewing the outdoor enclosure (Figure 1) the monkeys had full access to. Outdoors, near the glass wall that was a barrier between the monkeys and the zoo visitors, wood shavings was used as ground material (zone O1 and O2). Grass was covering the ground in the remaining areas. Also present in the outdoor area was an area of deciduous trees (zone O3) with climbing opportunities and with a newly constructed wind-protection shelter up in the trees. On the ground there was a small wooden house with straw inside for the animals (zone O3), and a large horizontal tree stem lying flat on the ground (zone O2). Zone O4 represents an open grass area. Food was provided about four times a day by care-takers throwing it from the visitors' side of the glass wall of the outdoor enclosure. The food that included a variety of items such as seeds, vegetables, fruits, insects and meat was scattered around different areas. They had ad libitum access to water from two nipple bottles, one at each indoor area.

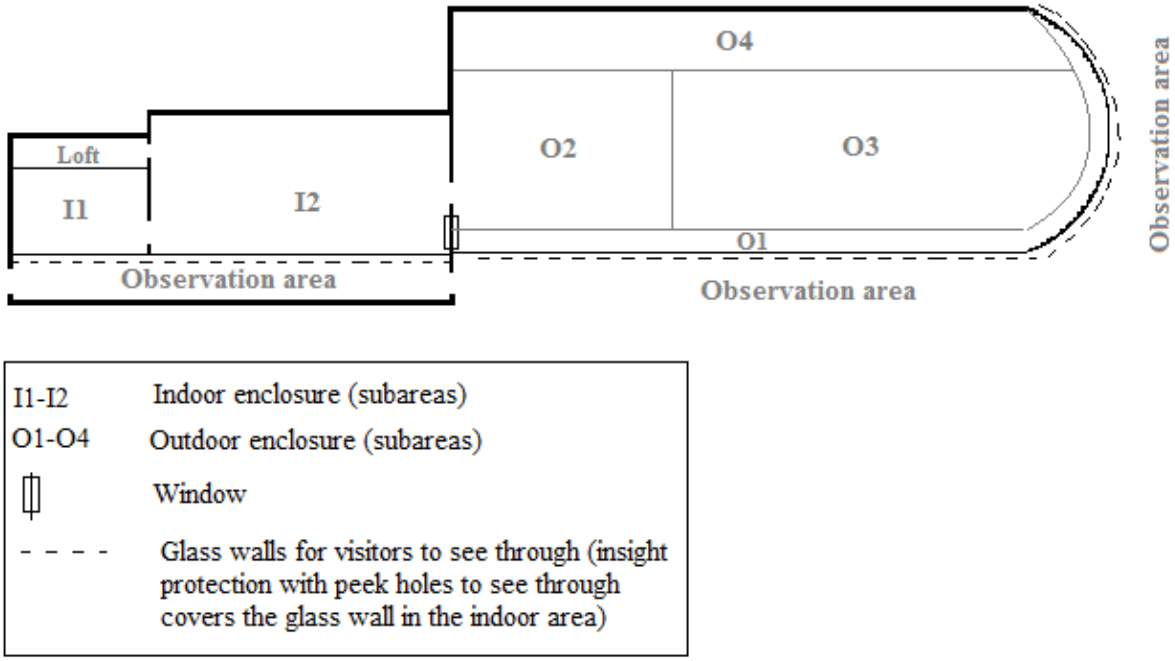

Figure 1. Layout of the enclosure of the monkeys. The letter and numbers represent zones (not visibly marked) with different context and are described in the text.

3.2 Visual barrier project

In this project, wooden square-boards with peek holes were used as visual barriers. They were installed on the glass walls of the indoor enclosures.

The behaviour of the drills was compared between a control condition (without visual barriers) and a barrier condition (with visual barriers installed). The data from the control condition was collected by Lundin (2013) who observed these drills during June-August 2012. The drills were observed in the barrier condition during May-July 2013.

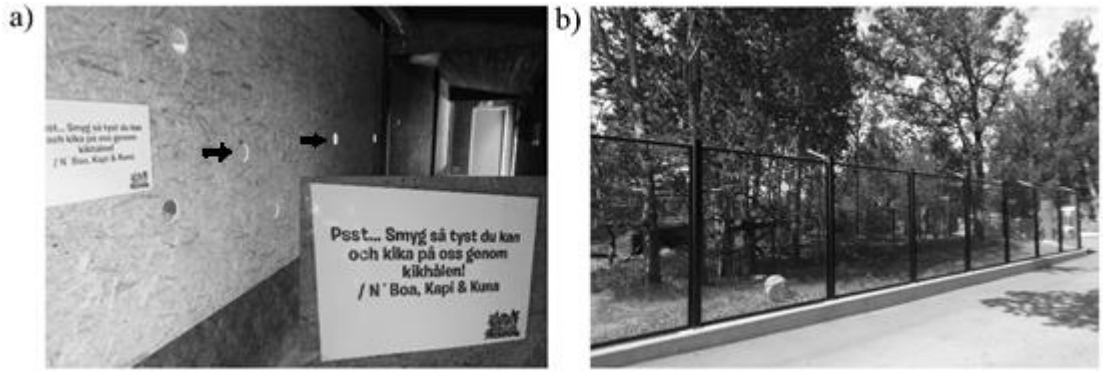

Figure 2. a) Picture of the visual barrier made out of wooden square-boards in the indoor enclosure. Peek holes (see black arrows in picture) were added in different heights for visitors of all ages and lengths to spot the monkeys in their enclosure. Notes from the zoo were put up making visitors aware of which sound level to use when looking at the monkeys (Translation: "Psst… come in as quietly as you can and see us through the peek holes /N'Boa, Kapi & Kuna"). b) Picture of the outdoor enclosure and the glass wall visitors could see through to observe the monkeys.

A rotating focal sampling method was used where each animal was observed in 5 minute-intervals. Each session went on for 30 minutes with six sessions during one observation day – three in the mornings and three in the afternoons. 1/0- sampling method was used when observing the behaviours of the drills (Table 1) with 1 minute-intervals. Each behaviour observed (states only) had to be performed by the individual for at least 3 seconds before it could be noted. Visitor intensity was recorded continuously (the highest intensity level under each minute of observation was noted) and was ranked after the sound level of the visitors present (Table 2).

The behaviours observed and analysed in this project were based on the earlier study on the drills by Lundin (2013) and are shown in Table 1. Note that for this project, locomotion, foraging/eating, body-shaking, scratching and self-grooming (the three latter are commonly known to be stress-related in primates; Veenema et al. 1997; Castles and Whiten 1998;

Mason et al. 2007) described in the ethogram were not analysed (only in the enrichment project). Instead, this project focused more on the behaviours normally shown to be affected by visitors in previous research. Locomotion, foraging/eating and the stress-related behaviours were, however, observed during the barrier condition in order to analyse it further in the enrichment project discussed later on.

Also regarding the ethogram, stereotypic behaviour was only displayed in one of the female drills, Kapi, having a history of displaying these behaviours before transferred to Parken Zoo. Therefore, this behaviour was only recorded on her alone.

Table 1. Observed behaviours of drills and their description. Stereotypic behaviour was only recorded in one individual. 'Foraging/Eating', 'locomotion', 'body-shake', 'self-grooming' and 'scratching' was only analysed in the enrichment project.

Behaviour		Description
Resting/Sleeping		Lying or sitting with eyes fully closed or half open most of the time
Locomotion		Change of location when not performing any of the other behaviours mentioned in the ethogram
Foraging/Eating		Searching or eating food
Social affiliative behaviour		Friendly or non-aggressive behaviour within species
	Allogrooming	Cleaning another individual, including licking and biting
	Copulation	Sexual intercourse between two individuals
	Anogenital presentation	A female displaying its anogential/perineum to a male
	Anogenital inspection	A male touching a female's anogenital
Social agonistic behaviour		Aggressive or threatening behaviour within species. Submissive behaviour is also included
	Bared teeth	Exposure of the teeth
	Crest raise	Raising the fur on the forehead
	Chase	Rapidly go after an individual in order to chase away or to overtake
	Rump presentation	Submissive behaviour where the animal exposes its behind towards another group-member
	Slamming	Moving hands in a hasty and strong movement down to the ground towards the threat
Stereotypic behaviour		Stereotypic or abnormal behaviour
	Self-directed biting	Biting on arms, hands or legs. Sometimes it is performed with violent flexing of upper body

	Repetitive movement of hand on object	Quickly moving a hand back and forth on a wall or another object in a repetitive pattern
	Floating limb	Unusual movement pattern of a limb. May bite the limb afterwards
Visitor interaction		Gazing, aggressive or threatening behaviour towards visitors
L'Hoest's interaction		Interactions with l'Hoest's monkeys
Vocalisation		Making noise with mouth
Body-shaking		Shaking movement of the upper body
Self-grooming		Cleaning its own body, including licking and biting, with full attention on the manipulated area
Scratching		Repeated movement of hand or foot back and forth through the fur or the skin of the animal without eye contact on the manipulated area

The classification of levels of visitor intensity (Table 2) was based on the earlier study on the drills by Lundin (2013) and a study by Sellinger and Ha (2005) with some modifications.

Table 2. Levels of visitor intensity. A bout of noise must last up to 5 seconds for it to be defined as a bout.

Level	Description
Low	Quiet whispers or quiet talking, a maximum of two bouts of normal talking
Medium	Normal talking, no shouting
High	Normal talking, with at least one bout of shouting, or loud talking

3.3 Enrichment project

In this project the drills' behaviour were recorded and compared between two conditions: the control condition where the drills had their ordinary indoor-outdoor access without added feeding enrichment and the enrichment condition where the drills had an outdoor-only access together with added feeding enrichment. When recording the behaviours in the enrichment condition, after the last session of each observation day the drills (and the l'Hoest's monkeys although not included in this project) were allowed access to the indoor enclosure again after the last session each day until the first session the next observation day.

Tube feeders and frozen fruit and vegetables (frozen fruit and vegetables are from now on called 'frozen fruit') were the feeding enrichments used in this project. Every morning before the first session of observation, the

enrichment objects were cleaned and filled with different food items (the tube feeders in order to use them the same day; the frozen fruit were prepared for the next day). The food was taken from the animals' daily allowance to prevent overfeeding. Five tube feeders and five frozen fruit objects were then placed out in the outdoor enclosure. The number of objects of each enrichment were determined in relation to the number of animals in the enclosure in order to minimize the risk of aggressive encounters between individuals during feeding time. The locations of the objects were decided due to the ability to hang them up in the most stable and secure way and with the possibility to expand the enclosure usage of the drills.

The data from the control condition was taken from the first project in this study with visual barrier installed. The methods used and the behaviours observed and analysed were the same as in the visual barrier project but with the adding of the behaviours locomotion, foraging/eating, body-shaking, self-grooming and scratching (Table 1).

3.3.1 Set up - frozen fruit

Each day, five frozen fruit objects (Figure 3) were set up in the outdoor enclosure. For the next day's frozen fruit object to freeze properly a new set of objects had to be prepared the day before usage. The equipment for the frozen fruit enrichment included plastic buckets (7-10 L), ropes as hanging equipment and the daily fruit and vegetables for the drills. The daily amount of food was divided into the five buckets and water was filled up to the limit of covering the food items. Before placed in the freezer, the end of a rope (one rope per bucket) were tucked in between the food items in the bucket (if not done properly the food will fall off the rope when hanged up in branches). When placed in the enclosure the objects hanged about half a metre above the ground to make sure all the monkeys in the enclosure could get access to the food.

Figure 3. Frozen fruit as a feeding enrichment.

3.3.2 Set up - tube feeder

Five tube feeders made of bamboo were set up in the outdoor enclosure during each observation day. These tube-shaped objects were approximately half a metre long with a diameter of 10-15 centimetres (Figure 4). They were horizontally cut into two pieces with around 20 small holes (along the upper side of the tube feeder) and a rope tied to the upper piece as hanging equipment. Cable ties were used to hold the two pieces together (one cable tie on each side of the rope) after being filled with amount of 1 decilitre seeds. The seeds included wheat, corn, pumpkin seeds and oat. When placed in the enclosure the objects hanged about half a metre above the ground to make sure all the monkeys in the enclosure could get access to the food.

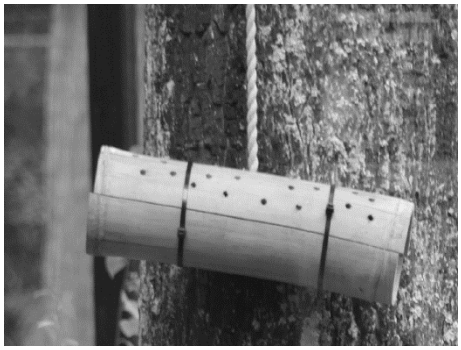

Figure 4. A bamboo tube feeder filled with several types of seeds as a feeding enrichment.

3.4 Statistical analysis

With the limitation of only three individuals, descriptive statistics were used in both projects (Kuhar 2006).

4 Results

Regarding both projects, the behaviours ‘vocalisation’, and ‘l’Hoest’s interaction’ were not analysed as a result of too few data points.

4.1 Visual barrier project

As mentioned before, all data revolving the control condition were collected by Lundin (2013) for her study and is borrowed for this project with her permission.

An increase of resting/sleeping was indicated in the barrier condition compared with the control condition (Figure 5). Social agonistic behaviour decreased in barrier condition compared with in control condition (Figure 5). No clear difference was shown between conditions in social affiliative behaviour and visitor interaction (Figure 5).

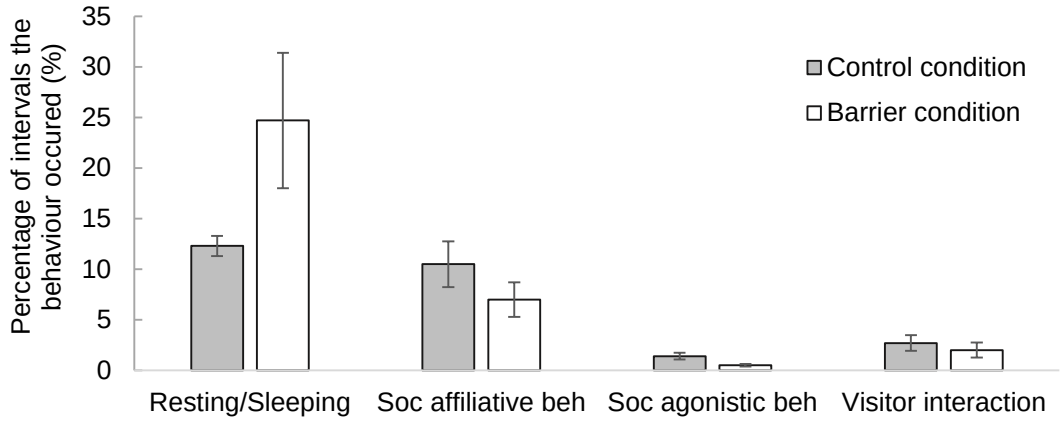

Figure 5. Percentage (±SE) of intervals each observed behaviour of the drills occurred in control condition and barrier condition.

Stereotypic behaviour in one of the females, Kapi, showed a clear decrease in barrier condition compared with in control condition (Figure 6).

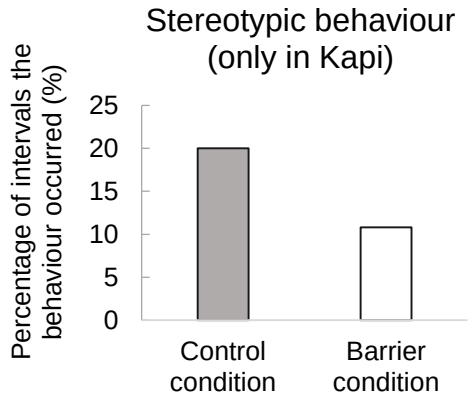

Figure 6. Percentage of intervals stereotypic behaviour occurred (only in Kapi) in control condition and barrier condition.

In control condition, resting/sleeping showed a decrease between all visitor intensities compared in barrier condition where no difference was indicated (Figure 7). Social affiliative behaviour decreased between visitor intensities low and high in control condition compared in barrier condition where no differences were found between visitor intensities (Figure 7). Social agonistic behaviour increased between visitor intensities medium and high in both conditions (Figure 7). In both conditions, visitor interaction increased between all visitor intensities (Figure 7).

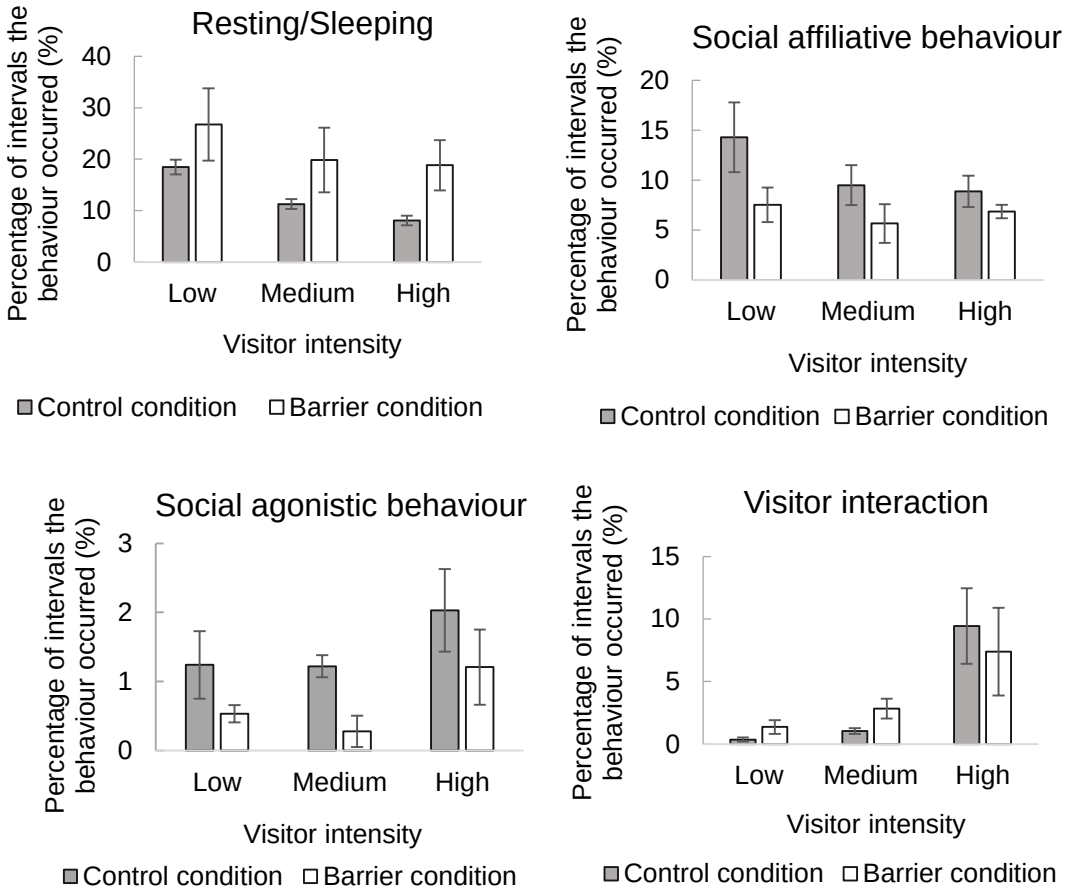

Figure 7. Percentage (±SE) of intervals the behaviours resting/sleeping, social affiliative, social agonistic and visitor interaction occurred in the drills in the control condition and barrier condition during visitor intensities low, medium and high.

Stereotypic behaviour increased with increased visitor intensity in control condition and showed no clear difference between visitor intensities in barrier control (Figure 8).

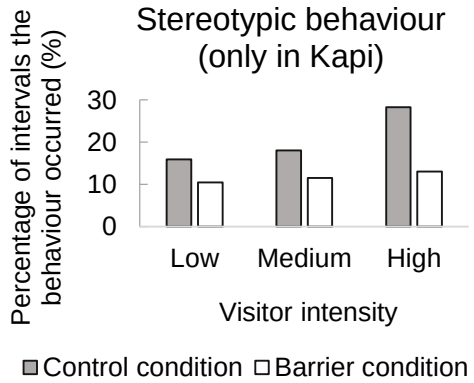

Figure 8. Percentage of intervals stereotypic behaviour occurred (only in Kapi) in the control condition and barrier condition during visitor intensities low, medium and high.

4.2 Enrichment project

There was a clear decrease of resting/sleeping, social affiliative behaviour, visitor interaction, scratching and self-grooming in enrichment condition compared with in control condition (Figure 9 and 10). Locomotion, foraging/eating and body-shaking increased in enrichment condition compared with in control condition (Figure 9 and 10). There were no clear difference in social agonistic behaviour between conditions (Figure 9 and 10).

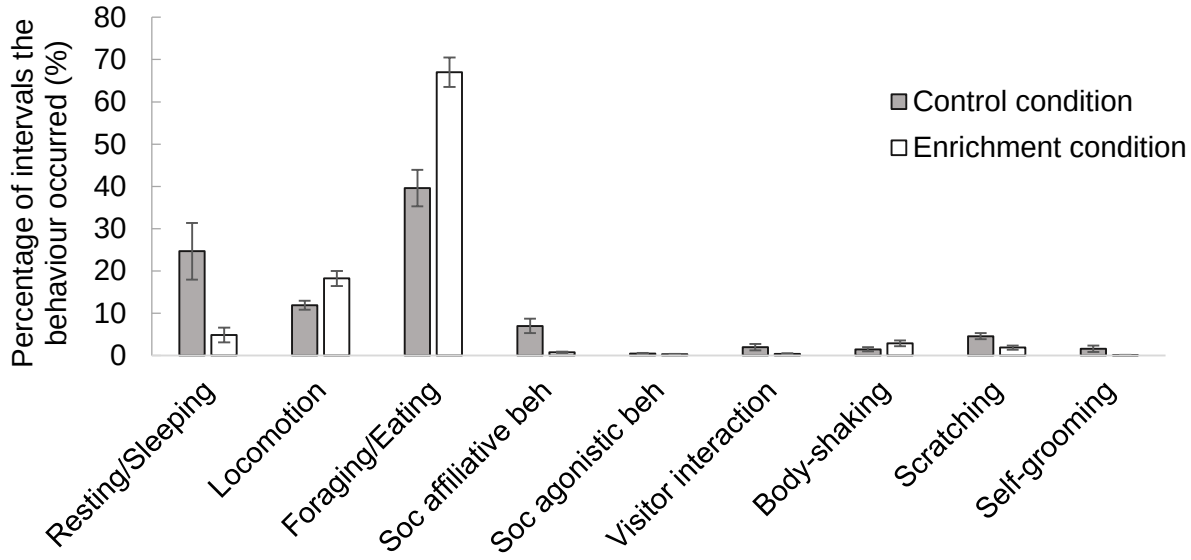

Figure 9. Percentage (±SE) of intervals each behaviour of the drills occurred in control condition and enrichment condition.

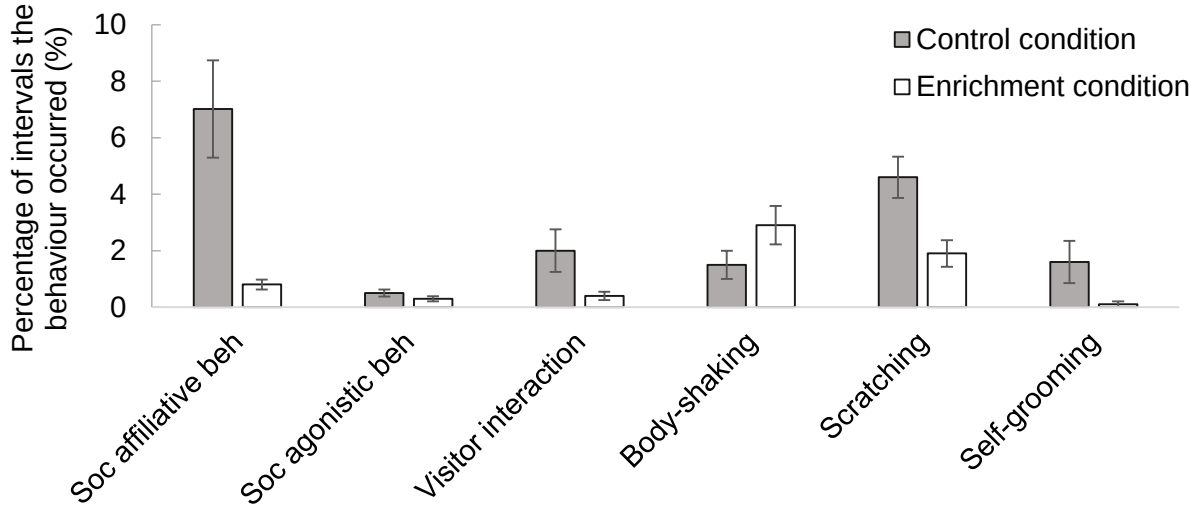

Figure 10. Enlargement of the behaviours social affiliative, social agonistic, visitor interaction, body-shaking, scratching and self-grooming presented in figure 9.

Stereotypic behaviour in one of the females, Kapi, showed a clear decrease in enrichment condition compared with in control condition (Figure 11).

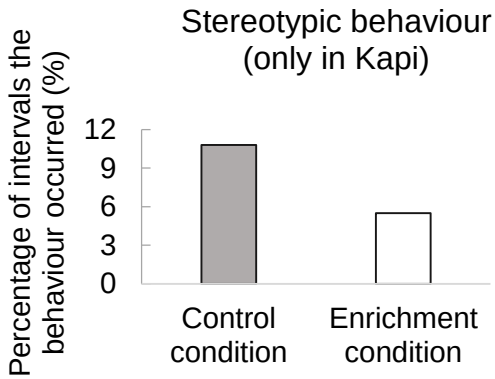

Figure 11. Percentage of intervals stereotypic/abnormal behaviour occurred (only in Kapi) in control condition and enrichment condition.

5 Discussion

In the visual barrier project, the drills at Parken Zoo showed to rest/sleep more and perform less social agonistic behaviours with visual barriers installed. The level of visitor interaction and social affiliative behaviour in the drills did not differ with or without visual barriers. Stereotypic behaviours was also seen to decrease in one of the female drills with visual barriers present. The visitor effect on the behaviour in the drills

was diminished in all observed behaviours except visitor interaction and social agonistic behaviour.

In the enrichment project when kept outdoors together with feeding enrichment, the drills rested less, were more active, foraged more and showed less affilative and agonistic behaviour towards each other compared to when having an indoor-outdoor access without feeding enrichment. The drills also showed to focus less on visitors and were less stressed when being outdoors with feeding enrichment. For one of the females, she displayed less stereotypic behaviour in the new condition.

5.1 Visual barrier project

In the present study, the drills showed to rest/sleep more and the occurrence of social agonistic behaviours reduced with visual barriers installed. With previous visitor effect studies showing visitors to negatively affect these behaviours seen through a decrease in resting (Wells 2005) and an increased intragroup aggression (Chamove et al. 1988; Wells 2005), these results suggest visual barriers to positively improve these behaviours in the drills. A decrease of social agonistic behaviours in the presence of visual barriers is in accordance with a previous study by Blaney and Wells (2004) who investigated if visual barriers in the shape of camouflage nets affect the behaviour of lowland gorillas. However, they did not find their visual barriers to affect the gorillas' resting behaviour. The stereotypic behaviours displayed in one of the female drills in the present study reduced with visual barriers, suggesting visual barriers to benefit the female and the reduction of her undesirable behaviours. Blaney and Wells (2004) saw similar results in gorillas, although their stereotypic behaviours were not the same as for the female drill. Affiliative behaviours and visitor interaction did not seem to be influenced by the installation of visual barriers, as in agreement with Blaney and Wells (2004).

The impact of visual barriers on visitor effect on the behaviour of the drills differed between behaviours in this study. Previous studies have shown that visitors affect resting behaviour in primates, seen through a decrease in this behaviour (Chamove et al. 1988; Wells 2005). In the present study, resting/sleeping decreased with increasing visitor intensity without visual barriers. This is in agreement with previous research and suggests that the drills at Parken Zoo are stressed by visitors in the absence of visual barriers. With visual barriers, however, there was no indication of visitor influencing resting/sleeping in the drills, suggesting the visual barriers to help the drills not to be disturbed by visitors when wanting to rest.

Social behaviours in animals are commonly used as welfare-indicators (Chamove et al. 1988; Sellinger and Ha 2005; Wells 2005) where a lower occurrence of affiliative behaviour or a higher occurrence of agonistic behaviour in animals can be an indication of stress (Sade 2013). Without visual barriers in the present study, affiliative behaviour decreased with increasing visitor intensity, showing visitors to have an effect on this behaviour in the drills in the absence of visual barriers. With visual barriers, however, there was no sign of visitors influencing these positive social behaviours in the drills. This suggests that visual barriers moderate the visitor effect on social affiliative behaviour in the drills.

Social agonistic behaviour in primates is shown in previous studies to increase in the presence of visitors (Chamove et al. 1988; Mitchell et al. 1991; Kuhar 2008). This is in agreement with the present study that indicated agonistic behaviour to be affected by visitors without the visual barriers installed. Unfortunately, a visitor effect was also seen with visual barriers installed, suggesting that the visual barriers appear not to be helpful in reducing the visitor effect on social agonistic behaviour in the drills at Parken Zoo.

Captive animals interacting with visitors is used as an indicator of stress (Sade 2013). A study by Mitchell and colleagues (1991) conducted on golden-bellied mangabeys showed interaction towards visitors to increase significantly with increased visitor intensity. Another study reported mandrills to interact more with visitors with increased visitor density (Chamove et al. 1988). In the present study visitor interaction increased with increased visitor intensity both with and without visual barriers. This indicates that even after the installation of visual barriers visitor interaction in the drills is still affected by visitors. A possible reason why this behaviour is still affected by visitors after the installation may be the design of the visual barriers with the peek holes and the close proximity visitors must have to the drills as a result. A study by Choo and colleagues (2011) showed orangutans to pay more attention to visitors in close proximity, confirming my suggestion.

Stereotypic behaviour in captive primates is shown in several studies to be affected by visitors (Chamove et al. 1988; Blaney and Wells 2004; Mallupur et al. 2005; Wells 2005) and is one of the most commonly used welfare indicators in animals (Morgan and Tromborg 2007). In the present study, the stereotypic behaviour in one of the females increased with increasing visitor intensity without visual barriers. It suggests that visitors are stressful to her and that stereotypic behaviour is displayed by her as a way to cope with the stressful situation visitors may bring. However, with visual barriers her stereotypic behaviour showed not to be

affected by visitors, suggesting the visual barriers to moderate the visitor effect on her stereotypical behaviour.

As perhaps seen in this discussion, there are not many published studies that have investigated in the effect visual barriers have on behaviour in zoo animals even though authors have suggested visual barriers to reduce stress responses caused by visitors (Kuhar 2008; Smith and Kuhar 2010). A possible explanation could be that even though visual barriers may benefit the zoo animals, the visitors may not be as delighted with a more or less blocked view of the animals. This would therefore be a problem for zoos with some of their common goals to educate and to entertain visitors. In the present study, the visitors' perceptions regarding the visual barriers were noted during the observation period. Many of the visitors' perceptions were negative where visitors complained about the uncomfortable heights of the peek holes and that they did not see any monkeys at all. Visitors disliking not having a clear view of the zoo animals was also the case in a study by Farrand (2007). In her study camouflage nets were used as visual barriers where she saw visitors lifting up the net and tearing them up to get a better view of the animals.

To sum it up, the visual barriers affected the drills' behaviour in many positive ways and do function to moderate the visitor effect in several behaviours of the drills at Parken Zoo. However, the negative welfare indicators social agonistic behaviour and visitor interaction were still affected by visitors after the installation of the visual barriers. With these results and with the perceptions of visitors, I advice the observation area viewing the indoor enclosures of the drills to be altered in a way to further reduce the visitor effects and also to decrease the visitors' proximity to the drills. A suggestion is to remove three of the four walls covering the observation area viewing the indoor enclosure (Figure 1) only leaving the inner wall combined with the indoor enclosure. This would open up and expand the observation area and also drastically reduce the sound reflection that a small room contribute to and with that a possible reduced influence of visitor intensity on the drills. The visual barriers is also suggested to be removed since I believe that the close proximity the peek holes encourage is a contributing factor to the drills' increased focus on visitors with visual barriers present. However, several improvements in the drills' behaviour after the installation of the visual barrier show that a form of visual barrier may be beneficial for the welfare of the drills and a suggestion would be to hang artificial vines over the viewing windows in order to diminish the view of visitors for the drills and in the same time modify it to look more naturalistic for the eye of the visitors.

5.2 Enrichment project

Enrichment for primates can help to reduce inactivity and boredom (Honess and Marin, 2006), keeping them stimulated and occupied. Resting/Sleeping in the drills decreased in the enrichment condition. This is in accordance with previous enrichment (Schapiro et al. 1996) and outdoor-only access studies (Hoff et al. 1997). Schapiro and colleagues (1996) for example showed rhesus macaques to be less inactive with feeding enrichment present. They found the time the rhesus macaques spent on being inactive were reduced to a level similar as in wild rhesus macaques.

Although not many studies have been conducted on wild drills due to the difficulties observing them in the heavily forested terrain they live in, it is known that they are very mobile and travel long distances for food (Caldecott et al. 1996). Locomotion and foraging/eating increased in the enrichment condition as in agreement with previous enrichment studies (Schapiro et al. 1996; Birke 2002; Gronqvist et al. 2013) and with previous studies on the effect of outdoor-only access (O'Neill et al. 1991; Hoff et al. 1997) in primates. With especially foraging increasing with 68% in the enrichment condition, this is a very positive result showing these enrichments to promote foraging behaviour in the drills. Through observations, it was also seen that the drills put a physical effort in getting to the food in the objects and sometimes standing in a bipedal position to get to the food parts sticking out from a frozen object, a position and effort not promoted by the freely distributed food items in the control condition.

The level of social behaviours in captive animals is used as a welfare indicator. Previous studies show agonistic behaviour in primates to decrease in the presence of feeding enrichment (Chamove et al. 1982) and with an outdoor-only access (Nieuwenhuijsen and De Waal 1982; Hoff et al. 1997). In the present study, social agonistic behaviour in the drills did not differ between conditions. There were some concerns that competition of the food would occur even though the number of enrichment objects were twice as many as the animals in the exhibit (including the l'Hoest's monkeys) as a way to prevent this situation. But even though some occasions of competition were observed, the aggression within the group did not differ from the control condition. And also with the social agonistic behaviour to be in such a low level, it suggests competition or other aggressive encounters in the group not to be an issue for the well-being of the drills. The affiliative behaviour in the drills showed to decrease in the enrichment condition. A decreased social affiliation can be an indication of stress in captive animals. However,

when observing the drills, I did not observe any allogrooming in the enrichment condition which was a common affiliative behaviour in the control condition which I found interesting. A study by Shino and colleagues (1988) concluded that allogrooming may be a way for captive animals to release tension or stress. An increasing allogrooming was found in chimpanzees by Nieuwenhuijsen and de Waal (1982) when moved from a summer residence on an island to a smaller indoor enclosure for the winter. This suggests that allogrooming may have been a method for the drills in the present study to release the tension and stress (Schino et al. 1988) caused by possible boredom and lack of stimulation. In the enrichment condition, the drills were seen more by themselves, walking around, seeking for food and exploring the area. This would imply that being kept outdoors with enrichment stimulates the drills and that the decrease of social affiliative behaviour, or perhaps only allogrooming, is a positive result showing a reduced boredom in the drills. In addition, forage traveling with high individual distribution seen in the drills at Parken Zoo is also seen in drills in the wild (Caldecott et al. 1996) suggesting that the drills display more of their species-specific behaviour in the enrichment condition.

The behaviours visitor interaction, body-shaking, scratching and self-grooming are some common stress indicators. Previous studies have reported these behaviours to decrease with enrichment (Bloomsmith et al 1988; Schapiro et al. 1996; Glick-Bauer 1997; Crocket and Gough 2002) and outdoor-only access (Hoff et al. 1997). Also, a study by Goerke and colleagues (1987) found stress-related behaviours in a juvenile gorilla to decrease when kept in a larger and more naturalistic environment compared to a concrete cave. In the present study, all of the mentioned behaviours decreased in the enrichment condition, except body-shaking that did not differ between conditions. These results show that the drills focus less on visitors and that the drills have a lower stress-level when kept outdoors with enrichment. Even though body-shaking increased in the enrichment condition, the positive results of the other behaviours would indicate this increase not to be a sign of stress and that body-shaking is more likely to be affected by some other factor related to being kept outside, such as the weather. As mentioned earlier, the drills were provided with wind-shelters in the outdoor enclosure. However, these were not often used by the drills, making themselves more exposed to abiotic factors, such as wind and rain.

Previous studies on enrichment effects and effects of outdoor-only access have shown enrichment and outdoor housing to reduce stereotypic behaviour in primates (Bloomsmith et al 1988; Boccia and Hijazi 1998;

Fontenot et al. 2006). For example, Boccia and Hijazi (1998) reported a reduction of stereotypical behaviours in a group of pigtail macaques when introduced to a foraging task (sunflower seeds in a woodchip litter) and concluded them to explore the environment more instead of performing stereotypies. These findings are in accordance with the present study showing stereotypic behaviour to decrease with almost 50% in the female drill when kept outdoors with enrichment. This may suggest outdoor-only access together with enrichment to be beneficial for the female and the reduction of her stereotypical behaviour, implying a possible improved welfare.

When comparing the results from this project with previous research on outdoor housing for primates, readers should realise that the control conditions in previous research differ from this project. In this project, the drills had both access to an outdoor enclosure and an indoor enclosure while in the compared previous research the test-subjects had only an indoor access in the control condition. However, since the drills in this study spend almost all their time indoors (did not use the outdoor enclosure for much more than receiving and collecting food items when given and then returned inside to eat) I believe that this study can be compared to the previous studies mentioned above in the discussion.

The visitors' perceptions seeing the drills outdoors were also noted during the observation period. Besides the visitors finding an interest in the feeding enrichment and the purpose of those, several of them were amazed to see the drills outdoors since they have never seen them outside during their visits earlier seasons. The visitors were thrilled and I believe seeing the drills outside in a more naturalistic environment positively affects the visitors' thoughts on the welfare of the drills.

The overall results in this project, indicate that the drills are more stimulated, more active and are more engaged in their species-specific behaviours with an outdoor-only access and feeding enrichment as in agreement with previous studies. This would also imply a possible improvement in the welfare of the drills.

5.3 Societal & ethical considerations

The experiments in this study comply with current Swedish laws on animal welfare.

Research at zoos can contribute to more knowledge in areas such as animal husbandry and welfare. For zoos that are involved in breeding programs for endangered species, it is highly important that the animals have a good welfare in order for them to reproduce successfully.

Research on these animals in the area of animal welfare is therefore highly significant. Also, since there are very few studies conducted on wild drills due to the difficult terrain they live in it is very important for us to study drills that are kept at zoos and other institutes in order to gain more information about their ecology and behaviour.

5.4 Conclusions

The visual barriers affect the drills' behaviour in many positive ways and appear to diminish the visitor effect in several behaviours of the drills at Parken Zoo as previous studies suggested. However, the negative welfare indicators social agonistic behaviour and visitor interaction were still affected by visitors after the installation of the visual barriers, implying that the drills still find visitors stressful and that further improvements on the observation area indoors should be considered for the welfare of the drills at Parken Zoo.

With outdoor-only access together with feeding enrichment, the drills showed to be more active, forage more, be less stressed and focus less on visitors compared to with an indoor/outdoor access without added feeding enrichment. This suggests that outdoor-only access and feeding enrichment would be a valid option during summer season for the drills at Parken Zoo for the benefit of their welfare.

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7 References

Abello MT, Colell M and Martin M (2007) Integration of one hand-reared Cherry-crowned mangabey *Cercocebus torquatus torquatus* and two hand-reared Drills *Mandrillus leucophaeus* into their respective family groups at Barcelona Zoo. International Zoo Yearbook 41, 156-165

Bellingham L (1998) Behavioural adaptation of a group of Alaotran gentle lemurs *Hapalemur griseus alaotrensis* to a large, naturalistic enclosure at the Jersey Wildlife Preservation Trust. Dodo 34, 167–168

Birke L (2002) Effects of browse, human visitors and noise on the behaviour of captive orang-utans. Animal Welfare 11, 189-202

Blaney EC, Wells DL (2004) The influence of a camouflage net barrier on the behaviour, welfare, and public perceptions of zoo-housed gorillas. Animal Welfare 13, 111–118

Blois-Heulin C and Jubin R (2004) Influence of the presence of seeds and litter on the behaviour of captive red-capped mangabeys *Cercocebus torquatus torquatus*. Applied Animal Behaviour Science 85, 349-362

Bloomsmith MA, Alford PL and Maple TL (1988) Successful feeding enrichment for captive chimpanzees. American Journal of Primatology 16, 155-164

Boccia ML and Hijazi AS (1998) A foraging task reduces agonistic and stereotypic behaviors in pigtail macaque social groups. Laboratory Primate Newsletter 37, 1-4

Caldecott JO, Feistner, ATC, Gadsby EL. A comparison of ecological strategies of pig-tailed macaques, mandrills and drills. In: Fa JE and Lindburg DG, editors (1996) Evolution and ecology of macaque societies. Cambridge University Press. Page 369-88

Carlstead K and Shepherdson D (1994) Effects of environmental enrichment on reproduction. Zoo Biology 13, 447-458

Castles DL and Whiten A (1998) Post-conflict behaviour of wild olive baboons. II. Stress and self-directed Behaviour. Ethology 104, 148–160

Chamove AS, Anderson JR, Morgan-Jones SC and Jones SP (1982) Deep woodchip litter: hygiene, feeding and behavioural enhancement in eight primate species. International Journal for the Study of Animal Problems 3, 308-318

Chamove AS, Hosey GR and Schaetzel P (1988) Visitors excite primates in zoos. Zoo Biology 7, 359-369

Choo Y, Todd PA and Li D (2011) Visitor effects on zoo orangutans in two novel, naturalistic enclosures. Applied Animal Behaviour Science 133, 78– 86

Claxton AM (2011) The potential of the human–animal relationship as an environmental enrichment for the welfare of zoo-housed animals. Applied Animal Behaviour Science 133, 1-10

Cooke CM and Schillaci MA (2007) Behavioural responses to the zoo environment by white handed gibbons. Applied Animal Behaviour Science 106, 125-133

Crockett CM and Gough GM (2002) Onset of aggressive toy biting by a laboratory baboon coincides with cessation of self-injurious behaviour. American Journal of Primatology 57, 31-59

Davis N, Schaffner CM and Smith TE (2005) Evidence that zoo visitors influence the HPA activity in spider monkeys (*Ateles geoffroyii rufiventris*). Applied Animal Behaviour Science 90, 131-141

Ebenhard T (1995) Conservation breeding as a tool for saving animal species from extinction. Trends in Ecology and Evolution 10, 438-443

Farrand A (2007) The effect of zoo visitors on the behaviour and welfare of zoo mammals. (Ph. D. Thesis) University of Stirling

Fontenot MB, Wilkes MN and Lynch CS (2006) Effects of outdoor housing on self-injurious and stereotypic behavior in adult male rhesus macaques (*Macaca mulatta*). Journal of the American Association for Laboratory Animal Science 45, 35-43

Glick-Bauer M (1997) Behavioural enrichment for captive cotton-top tamarins (Saguinus oedipus) through novel presentation of diet. Laboratory Primate Newsletter 36, 1-5

Goerke B, Fleming L and Creel M (1987) Behavioral changes of a juvenile gorilla after a transfer to a more naturalistic environment. Zoo Biology 6, 283-295

Gronqvist G, Kingston-Jones M, May A and Lehmann J (2013) The effects of three types of environmental enrichment on the behaviour of captive Javan gibbons (*Hylobates moloch*). Applied Animal Behaviour Science 147, 214– 223

Hoff MP, Powell DM, Lukas KE and Maple TL (1997) Individual and social behavior of lowland gorillas in outdoor exhibits compared with indoor holding areas. Applied Animal Behaviour Science 54, 359-370

Honess PE and Marin CM (2006) Enrichment and aggression in primates. Neuroscience and Biobehavioral Reviews 30, 413-436

Hosey GR (2000) Zoo animal and their human audiences: What is the visitor effect? Animal Welfare 9, 343-357

Hosey G, Melfi V and Pankhurst S (2013) Zoo animals: behaviour, management and welfare. Oxford University Press, United Kingdom

Izzo GN, Bashaw MJ and Campbell JB (2011) Enrichment and individual differences affect welfare indicators in squirrel monkeys (*Saimiri sciureus*). Journal of Comparative Psychology 125, 347–352

Kuhar CW (2006) In the deep end: Pooling data and other challenges of zoo and aquarium research. Zoo biology 25, 339-352

Kuhar CW (2008) Group differences in captive gorillas' reaction to large crowds. Applied Animal Behaviour Science 110, 377-385

Laule GL (2003) Positive reinforcement training and environmental enrichment: enhancing animal well-being. Journal of the American Veterinary Medical Association 223, 969-973

Lundin L (2013) Visitor effects on the behavior of drills (Mandrillus leucophaeus) and petting zoo animals at Parken Zoo. (Student paper). Linköping University.

Mallapur A, Chellam R (2002) Environmental influences on stereotypy and the activity budget of Indian leopards (*Panthera pardus*) in four zoos in Southern India. Zoo Biology 21, 585-595

Mason G, Clubb R, Latham N and Vickery S (2007) Why and how should we use environmental enrichment to tackle stereotypic behaviour? Applied Animal Behaviour Science 102, 163–188

Mason G and Rushen J (2008) Stereotypical animal behaviour: Fundamentals and Applications to welfare (2nd ed.) CAB International, Wallingford, UK.

Mitchell G, Herring F, Obradovich S, Tromborg C, Dowd B, Neville LE and Field L (1991) Effects of visitors and cage changes on the behaviors of mangabeys. Zoo biology 10, 417-423

Morgan, KN and Tromborg CT (2007) Sources of stress in captivity. Applied Animal Behavior Science 102, 262-302

Nieuwenhuijsen K and de Waal FBM (1982) Effects of spatial crowding on social behavior in a chimpanzee colony. Zoo Biology 1, 5-28

Novak, MA and Suomi SJ (1988) Psychological well-being of primates in captivity. American Psychologist 43, 765-773

O'Neill, PL, Novak, MA, Suomi SJ (1991) Normalizing laboratory-reared rhesus macaques (*Macaca mulatta*) behaviour with exposure to complex outdoor enclosures. Zoo Biology 10, 237–245

Pereira, ME (1991) Primate preference for outdoors. Humane Innovations and Alternatives 5, 313-315

Pifarré M, Valdez R, González-Rebeles C, Vázquez C, Romano M and Galindo F (2012) The effect of zoo visitors on the behaviour and faecal cortisol of the Mexican wolf (*Canis lupus baileyi*). Applied Animal Behaviour Science 136, 57-62

Pomerantz O, Paukner A and Terkel J (2012) Some stereotypic behaviors in rhesus macaques (Macaca mulatta) are correlated with both perseveration and the ability to cope with acute stressors. Behavioural Brain Research 230, 274-280

Reade LS and Waran NK (1996) The modern zoo: How do people perceive zoo animals? Applied Animal Behaviour Science 47, 109- 118

Ross SR, Calcutt S, Schapiro SJ and Hau J (2011) Space use selectivity by chimpanzees and gorillas in an indoor-outdoor enclosure. American Journal of Primatology 73, 197-208

Sade C (2013) Visitor effects on zoo animals. The Plymouth Student Scientist 6, 423-433

Schapiro SJ, Suarez SA, Porter LM and Bloomsmith MA (1996) The effects of different types of feeding enhancements on the behaviour of single-caged, yearling rhesus macaques. Animal Welfare 5, 129-138

Schino G, Scucchi S, Maestipieri D and Turillazzi PG (1988) Allogrooming as a tension-reduction mechanism: a behavioural approach. American Journal of Primatology 16, 43-50

Sekar M, Rajagopal T and Archunan G (2008) Influence of zoo visitor presence on the behavior of captive Indian gaur (*Bos gaurus gaurus*) in a zoological park. Journal of Applied Animal Welfare Science 11, 352-357

Sellinger RL and Ha JC (2005) The effects of visitor density and intensity on the behavior of two captive jaguars (*Panthera onca*). Journal of Applied Animal Welfare Science 8, 233-244

Smith KN and Kuhar CW (2010) Siamangs (*Hylobates syndactylus*) and white-cheeked gibbons (*Hylobates leucogenys*) show few behavioral

differences related to zoo attendance. Journal of Applied Animal Welfare Science 13, 154-163

Swaisgood RR and Shepherdson DJ (2005) Scientific approaches to enrichment and stereotypies in zoo animals: What's been done and where should we go next? Zoo Biology 24, 499-518

Veenema HC, Spruijt BM, Gispen WH and van Hoof JARAM (1997) Aging, Dominance History, and Social Behavior in Java-Monkeys (*Macaca fascicularis*) Neurobiology of Aging 18, 509–515

Wells DL (2005) A note on the influence of visitors on the behaviour and welfare of zoo-housed gorillas. Applied Animal Behaviour Science 93, 13-17