Effects of Feeding Enrichment on Behavior in Giraffes (*Giraffa camelopardalis*) in Captivity

Auswirkungen von Feeding Enrichment auf die Verhaltensmuster von Giraffen (*Giraffa camelopardalis*) in Menschenobhut während der Besucheröffnungszeiten

Diplomarbeit

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1 Introduction

Almost 80% of zoo-housed giraffe including the three giraffes of Zoo Vienna, Austria were reported to perform at least one type of stereotypy, with <licking of nonfood objects> (72.4%) and <pacing> (29.2%) being the most common (Fernandez, et al. 2008). Stereotypies are described as stress linked behavior patterns and assumed to indicate poor animal welfare (Broom 1991).

As stereotypic <licking of non-food objects> in giraffe can be reduced by increasing the amount of tongue manipulation for food obtaining (Fernandez, et al. 2008), enrichment devices for giraffes were established during a planned redevelopment of the giraffe’s enclosure of Zoo Vienna and examined for effects on the animal’s behavior.

Hypotheses:

We hypothesize that behavior patterns of giraffe during baseline period differ from those after placement of feeding enrichment devices.

As the enrichment object is promoting the oral manipulation required to obtain the food, it is expected that the frequency of stereotypic <licking of non-food objects> will be decreased.

Initially, an overview of literature including general information of giraffe, taxonomy, distribution and conservation status is provided in the following sections. In order to follow development of stereotypical behavior it is important to give general definitions and explanations of stress, animal welfare and physiological characteristics of the particular species. Subsequently, stereotypical behavior in giraffe and enrichment methods are explained in detail.
2 Literature

2.1 Giraffa Camelopardalis: General information

The first captive giraffe in Europe came from the zoo in Alexandria in 64 BC as a gift from Cleopatra to Julius Caesar (Dagg and Foster 1976). The animal was called “camelopard” as it seemed as big as a camel but spotted like a leopard (Dagg and Foster 1976). With the fall of the Roman Empire, giraffe were forgotten in Europe until 1215, when Frederick II imported giraffe from the Sultan of Egypt in exchange for a polar bear (Dagg and Foster 1976). The first giraffe of Zoo Vienna arrived on 7th of August 1828 after marching from Rijeka, Croatia to Vienna as given by the Viceroy of Egypt (Riedl-Dorn 2008). Its arrival influenced social life, fashion and handicraft industry in Vienna and increased visitor numbers enormously (Riedl-Dorn 2008). Due to its extraordinary look, giraffe have always been a visitor attraction and valuable addition to any zoo (Dagg and Foster 1976).

Taxonomy

Giraffes are African mammals belonging to the order Artiodactyla, the suborder Ruminantia and the family of the Giraffidae. The Giraffidae consist of two species, Okapia johnstoni and Giraffa camelopardalis, which contains nine subspecies (Fennessy 2008) (Table 2.1):

Table 2.1: Taxonomy and conservation status (Fennessy, 2008)

<table>
<thead>
<tr>
<th>Subspecies type</th>
<th>Common name</th>
<th>Conservation status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giraffa camelopardalis angolensis</td>
<td>Angolan</td>
<td>Increasing</td>
</tr>
<tr>
<td>Giraffa camelopardalis antiquorum</td>
<td>Kordofan</td>
<td>Possibly Extinct</td>
</tr>
<tr>
<td>Giraffa camelopardalis camelopardalis</td>
<td>Nubian</td>
<td>Decreasing</td>
</tr>
<tr>
<td>Giraffa camelopardalis giraffa</td>
<td>Cape/ Southern</td>
<td>Stable/ Increasing</td>
</tr>
<tr>
<td>Giraffa camelopardalis peralta</td>
<td>Nigerian</td>
<td>Decreasing</td>
</tr>
<tr>
<td>Giraffa camelopardalis reticulata</td>
<td>Reticulated</td>
<td>Stable/ Decreasing</td>
</tr>
<tr>
<td>Giraffa camelopardalis rothschildi</td>
<td>Rothschild’s</td>
<td>Decreasing</td>
</tr>
<tr>
<td>Giraffa camelopardalis thornicrofti</td>
<td>Thornicroft’s</td>
<td>Stable</td>
</tr>
<tr>
<td>Giraffa camelopardalis tippelskirchi</td>
<td>Masai</td>
<td>Decreasing</td>
</tr>
</tbody>
</table>
2.2 Distribution and conservation status

Giraffe formerly occurred in open woodlands and arid savannah zones throughout the African continent. In the late 1990s, the population of giraffes in Africa was estimated at about 140,000 individuals (East 1999) but today the numbers fell to about 80,000, which means a reduction of 40% (Fennessy 2012). The major reasons for this enormous decline in animal numbers are habitat degradation and poaching (The IUCN Red List of Threatened Species 2014).

The IUCN- (International Union for Conservation of Nature and Natural Resources) Red List of Threatened Species™ provides taxonomy, distribution information and conservation status on animals, plants and fungi in order to determine the relative risk of global extinction which is defined using different categories (Figure 2.1) (The IUCN Red List of Threatened Species 2014). The association declared the Nigerian (2008) and Rothschild’s (2010) race as “Endangered” on the Red List Of Threatened Species ™. The species Giraffa camelopardalis is ranged as “Least Concern”. Giraffe populations are regionally extinct in western parts of the African continent including Mali, Nigeria, Guinea, Mauretania, Angola and Senegal (The IUCN Red List of Threatened Species 2014).

Figure 2.1: Classification scheme IUCN Red List of Threatened species, (The IUCN Red List of Threatened Species)
2.3 Stereotypical behavior

Definition

Stereotypic behavior has been defined as repetitive, invariant behavior patterns without any obvious goal or function in the context in which they are performed (Mason 1991).

These specific behavior patterns are linked to physiological changes that are usually caused by stress (Mason 1991). Therefore, stereotypical behavior is associated with poor animal welfare because it occurs in situations that are obviously threatening, frustrating or severely lacking in stimulation (Broom 1991). Stereotypies do not imply abnormal behavior patterns per se, as some of them have been documented as well in the wild (Veasey, Waran und Young 1996). However, stereotypical behaviors are behaviors that do not occur in the wild at all or that are performed at inappropriate high rates in captivity (Broom und Johnson 1993).

Stereotypic behaviors are amongst the most important indicators of long-term welfare problems (Broom und Johnson 1993). Some of the best known stereotypies are crib-biting and wind-sucking in horses (Brion 1964) and bar-biting in sows (Fraser 1975). Humans also show intermittent stereotypic behavior like key jangling or pacing, especially in situations where they lack of control (Broom 1991).
2.4 Stress and animal welfare

Definition
Stress is described to be an important factor developing stereotypical behavior (Mason, 1991). Hans Selye defined stress for the first time in 1936 as the non-specific response of the body to any demand for change (Selye 1936). Later on, he adjusted the formulation and suggested that stress was the biological consequence of exposure to adverse environments (Selye 1976).

Selye described the adverse conditions themselves as <stressors> and the process of responding to stress as <stress response> (Selye 1976). Broom and Johnson define stress in a short and very precise way considering ethological usage: Stress is stimulation beyond the capacity for complete adaption (Broom und Johnson 1993).

Biochemical pathway
One of the most important functions of the hypothalamus, a part of the diencephalon, is to link the nervous system to the endocrine system via the sympatho-adreno-medullary axis (Broom und Johnson 1993). Exposure to a stressor results in a coordinated response of both the autonomic nervous system and the medulla of the adrenal glands releasing the adrenal hormones adrenaline, noradrenaline and dopamine (Broom und Johnson 1993). These catecholamines cause an increase of heart rate and blood flow and numerous metabolic adjustments that prepare the animal to cope with emergencies (Broom und Johnson 1993). This reaction of the body is called <short-term> (Broom und Johnson 1993) or <fight or flight> reaction (Cannon 1935).
The biochemical pathway process is illustrated in Figure 2.2. During long-term stress response, the adrenal cortex is activated via hypothalamic-pituitary-adrenocortical axis (Moberg 2000). At first, the corticotrophin releasing factor (CRF) is produced in the hypothalamus (Broom und Johnson 1993). This results in a secretion of adrenocorticotropic hormone (ACTH) by the adenohypophysis (anterior pituitary) that stimulates the adrenal cortex producing glucocorticoids (Broom und Johnson 1993) and leads to an increased secretion of glucocorticoids (Möstl und Palme 2002). Increased cortisol concentrations are used as an indicator of stress which is measurable in blood (Hopster, et al. 1999), feces (Palme et al, 1996), urine (Hay, Mormède, 1998), saliva (Cooper et al, 1989) and milk (Verkerk, 1998).

![Figure 2.2: Biochemical pathways of stress reaction](image-url)
Caution is required, since a high concentration of cortisol is also existent in exciting situations that are not primarily stressful (Moberg, 2000) including courtship, copulation and hunting (Broom 1993). Therefore, stress is a physiological mechanism which improves fitness by energy mobilization (Moberg, 2000).

However, chronic stress, positive as well as negative, associated with permanent high cortisol concentrations might cause illness by immunosuppression (Munck et al, 1984) or development of stereotypical behavior (McBride, Cuddelford, 2001). It is assumed that the performance of stereotypies decreases sensitivity of the adrenal cortex linked with a decreased cortisol secretion that makes the animal feel less stressed (Dantzer, Mittleman, 1993).

Mason and Lambton (2004) concluded that the presence of stereotypical behavior is not equal with poor animal welfare and the absence of stereotypies is not an indicator of welfare.
Animal Welfare

Definition
Welfare of an individual means its state as regards its attempts to cope with its environment (Broom 1986b).

Welfare varies between very poor and very good and can be measured objectively and completely independent of moral considerations based on the knowledge of the biology of the particular species (Broom 1986b). Poor welfare is characterized by having difficulty in coping or by failing to cope entirely and is not always linked with poor fitness (Broom und Johnson 1993).

Table 2.2: Measures of poor animal welfare (Broom 1991)

<table>
<thead>
<tr>
<th>Measures of poor welfare</th>
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</thead>
<tbody>
<tr>
<td>Reduced life expectancy</td>
</tr>
<tr>
<td>Reduced ability to grow or breed</td>
</tr>
<tr>
<td>Body damage</td>
</tr>
<tr>
<td>Disease</td>
</tr>
<tr>
<td>Immunosuppression</td>
</tr>
<tr>
<td>Physiological attempts to cope</td>
</tr>
<tr>
<td>Behavioral attempts to cope</td>
</tr>
<tr>
<td>Behavior pathology</td>
</tr>
<tr>
<td>Self-narcotization</td>
</tr>
<tr>
<td>Extent behavioral aversion shown</td>
</tr>
<tr>
<td>Extent of suppression of normal behavior</td>
</tr>
<tr>
<td>Extent to which normal physiological processes and anatomical development are prevented</td>
</tr>
</tbody>
</table>
Table 2.3: Measures of good welfare, (Broom 1991)

<table>
<thead>
<tr>
<th>Measures of good welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety of normal behaviors shown</td>
</tr>
<tr>
<td>Extent to which strongly preferred behaviors can be shown</td>
</tr>
<tr>
<td>Physiological indicators of pleasure</td>
</tr>
<tr>
<td>Behavioral indicators of pleasure</td>
</tr>
</tbody>
</table>

It is assumed that the wild environment represents optimal animal welfare and captive behavioral comparisons are widely used to assess zoo animal well-being (Broom, 1993). Differences that might exist between behavior patterns in the wild and in captivity do not imply poor animal welfare for several reasons (Veasey et al, 1996). Stress of free-living animals is not adequately documented and intervening to estimate an animal’s stress level might cause stressors at the same time (Broom 1991). Altered circumstances that went along with the millennia of domestication cause difficulties in comparison to our animals nowadays (Broom und Johnson 1993). Another fact is that animals often die in the wild because of disease or predation but get medical care in captivity (Broom und Johnson 1993). Because of these practical difficulties, relating animal welfare to experience in the wild is acceptable only in order to set a minimum standard (Broom 1991).

2.5 Stereotypical behavior in giraffe

A survey on stereotypical behavior conducted in 49 North American zoos revealed that 72% of 214 giraffe (Giraffa camelopardalis) and 29 okapi (Okapia johnstoni) perform stereotypical <licking of non-food objects> and 29% were reported to perform stereotypical <pacing>. Additionally, 3% of the observed animals in the survey demonstrated stereotypes of self-injury <head tossing> and <tongue playing> (Bashaw, Tarou und Maki 2001).
**Licking of non-food objects**

>Licking of non-food objects> is defined as using the tongue on an object that is neither food nor mineral, repeatedly and persistently over a lengthy period of time (Seeber, Cifolo und Ganswindt 2012).

Among the significant predictors of <stereotypic licking of non-food objects> in giraffes are feeding method, frequency of feeding and type of food provided. Therefore, feeding motivation seems to be related to oral stereotypic behavior (Bashaw, Tarou und Maki 2001).

Giraffes in the wilderness feed at every hour of the day (Dagg and Foster 1976), mainly on the leaves of *Acacia*, *Balanites* and *Scutia* plants (A. I. Dagg 2014). As these species have long thorns and acacias are often inhabited by stinging ants (*Crematogaster spp.*), feeding a high amount of those tiny leaves require a high degree of manipulation by giraffes and long periods of time spent feeding (A. I. Dagg 2014). Feed provided in zoos is usually easy to access and quick to consume. Giraffes are mainly fed alfalfa, concentrated feed and occasionally browse (Bashaw, Tarou und Maki 2001) among none of them is difficult to process (Fernandez, et al. 2008). Acacias contain a high amount of protein (A. I. Dagg 2014) contrary to roughage fed in captivity. Therefore, manufactured concentrated feed is widely used in zoos to meet giraffes´ energy requirement.

In a survey in which complexity of feeders was manipulated showed that even simply changes to existing feeders reduce the motivation for <licking of non-food objects> significantly (Fernandez, et al. 2008). It was concluded that the amount of tongue manipulation to obtain food and overall time spent feeding by altering giraffe´s feeders decrease stereotypic <licking> behavior without changing feeding and ruminating behavior even when nutritional value is constant (Fernandez, et al. 2008).

Diets containing a high amount of carbohydrates like manufactured concentrated feed lead to excess acid production in the gut (Mason und Latham 2004) and have been linked to
stereotypical behavior in horses (Redbo, et al. 1998). They are processed quickly and therefore insufficient acid buffering saliva is produced during chewing process and ruminating. It is assumed that giraffes perform oral stereotypies to increase saliva secretion and buffer gut acidity (Mason und Latham 2004).

**Pacing**

The second most common abnormal repetitive behavior in giraffe is *pacing*. *Pacing* is defined as follows: The animal walks a definite short path, repeatedly and without a discernible purpose (Seeber, Cifolo und Ganswindt 2012). Stereotypic *pacing* appears to be associated with environmental conditions including enclosure size and environmental changes (Bashaw, Tarou und Maki 2001). Animal housing seems to be an important factor influencing stereotypies (Broom 1991). More complex environments give the animal the possibility to express their full behavioral repertoire and decrease stereotypical behavior patterns (Broom 1991).

Stereotypical behavior is often reduced significantly in enrichment studies, but it is often reported that these behaviors are mostly not eliminated entirely (Mason et al, 2007).
2.6 Enrichment

Definition

Enrichment was defined by the Behavior Scientific Advisory Group of the Association of Zoo and Aquariums (AZA®) as a dynamic process for enhancing animal environments within the context of the animas’ biology and natural history (Association of Zoos and Aquaria 2014). Enrichment contains environmental changes with the goal of increasing animal’s behavioral choices and express their species-appropriate behavior (Association of Zoos and Aquaria 2014).

Enrichment programs for giraffe

Stimulation for giraffes can be addressed by using nutritional, sensory, physical, occupational and social stimulatory tools (Rose and Roffe 2007). It is important to consider all possible dangers that might lead to injuries when planning enrichment programs such as strangulation, head hooking, ingestion, choking, tripping, entrapment, facial scraping, cutting or slipping (Porterfield 2012). Giraffe tend to panic quickly, so each new innovation or device needs to be introduced slowly (A.I. Dagg 2014). Successful tested innovations for giraffe enrichment can easily be fashioned by hand (Porterfield 2012):

Table 2.4: Successful innovations for giraffe enrichment, (Porterfield 2012)

<table>
<thead>
<tr>
<th>Enrichment innovations for giraffe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasten browse bunches together in a holder</td>
</tr>
<tr>
<td>Treats provided in a paper bag</td>
</tr>
<tr>
<td>Wind chimes made of lengths of dry bamboo hanging down in a bunch</td>
</tr>
<tr>
<td>Treats provided in a hung up wide pipe with small holes in it</td>
</tr>
<tr>
<td>Coarse mats on the fence at different heights for scratching</td>
</tr>
<tr>
<td>Inducing a new device into giraffe paddock every few days to attract attention</td>
</tr>
</tbody>
</table>
A survey conducted in Zoo Atlanta showed that stereotypic <licking of non-food objects> can be decreased by altering the giraffe’s roughage feeders to increase the amount of tongue manipulation (Fernandez, et al. 2008). Even fairly simple changes to existing feeders, such as adding slatted tops to open- topped feeders reduced licking behavior significantly (Fernandez, et al. 2008).

At Twycross Zoo, England, lavender oil (*Lavandula angustifolia*) was tested to see if it attracts giraffe’s attention as it does some other species. The oil was mixed with barley straw and hung up in an unreachable area in the giraffe house. The giraffe fed and moved less than before and increased stereotypic <pacing> behavior (Rose and Roffe 2007).
In another project by Zoo Atlanta, fence areas used for <licking> were applied with Grannicks Bitter Apple©, a bitter but nonpoisonous chemical substance in order to reduce stereotypic <licking> in giraffes (Tarou, Bashaw und Maple 2003). The observed giraffe reduced <licking> in sprayed areas but continued this behavior pattern at non treated objects. The authors concluded that motivation of performing oral stereotypic behavior in giraffe cannot be decreased by an aversive stimulus.

Mixed species exhibits provide sustainable enrichment for all species concerned (Veasey, Waran und Young 1996). Species that are suitable for housing together with giraffes include impala (*Aepyceros melampus*), white rhino (*Ceratotherium simum*), plains zebra (*Equus burchellii*) and pygmy hippo (*Hexaprotodon liberiensis*) (EAZA 2006). In mixed exhibits, interactions between giraffes and other species like grooming or playful sparring are seen (EAZA 2006). Nevertheless, fights between giraffe and other species have been reported occasionally and occur more often in smaller enclosures. (EAZA 2006).

Training using positive reinforcement method by way of clicker and treats is widely used as giraffe enrichment (A. I. Dagg 2014). Careful training can also prevent giraffe from panicking and running amok, hurting itself and others, facilitate medical interventions as well as daily handling and manipulation (A. I. Dagg 2014).

Sylvia Reiter carried out a study at Zoo Vienna in 2010 evaluating the effects of positive reinforcement training on stereotypic behavior in giraffes. The results showed that training reduced <licking of non-food objects> but increased stereotypic <pacing>. It was concluded that a provided stimulus to tongue manipulation during training leads to a decrease in <licking> and that restricted moving while training triggered locomotor stereotypies (Reiter 2010).
3 Material and Methods

3.1 Experimental design

Three adult giraffes (*Giraffa camelopardalis*) were observed during opening hours in Zoo Vienna, Austria. At the beginning of the study, all three individuals (subspecies hybrids) had been documented to perform stereotypic <licking of non-food objects> and <pacing>.

Giraffes were observed during visitor time from 9am to 6pm between July and September 2012 from a position in the visitor area with a good overview around the whole exhibit. There was no data recorded if the animals were inside or not visible and between 3pm and 4pm during feeding indoors. A few times a week, training enrichment using positive conditioning method by clicker was performed with the giraffes. These days were also excluded from observations.

The survey was divided into 3 phases: one initial baseline observation period of 64 hours earlier to any placement of enrichment devices, an adaptation phase of 14 days and an observation period of 64 hours after adaptation to the enrichment devices.

First of all, an ethogram of giraffe was developed and a log sheet was created for recording the observations (see appendix for ethogram and log sheet). The giraffes’ behavior was recorded using instantaneous scan sampling method with 95-second intervals using a Gymboss® interval timer. Ten behavior patterns per animal per hour were noted. Additionally, factors that might influence behavior including weather, wind, rainfall, temperature, position in the enclosure and the number of visitors were recorded once every hour. Following behavior patterns were noted during both observation phases: licking of non-food objects, pacing, resting, locomotion, feeding, ruminating, social interactions and sexual behavior (see appendix for ethogram and log sheet).
In this survey, only the most important and relevant behavior pattern was recorded at one scan moment. As an exception, social interactions were registered additionally as they are often linked to usual behavior patterns. Therefore, following cascade was used if the animal was showing more than one action at the same time:

1. Licking, Pacing
2. Feeding, Ruminating, Resting
3. Locomotion, Alert
4. Comfort behavior, Exploration
5. Others

In the beginning of a two-week adaption phase, one feeding enrichment device for each giraffe was installed as far as possible apart in the enclosure and filled with food daily. The period of adaption had been defined as follows: all three individuals feed on the enrichment object for a minimum of 5 days continuously showing normal behavior.

Filling time of the enrichment devices was determined by the results of the first observation phase before placement. We focused on stereotypic <licking of non-food objects>. Frequency of object-licking behavior in this phase shows a sharp increase from 12 am to 2 pm and only one peak at 1 pm (Table 4.5). Therefore, it was decided to fill the three boxes once a day at 12 am.
3.2 Animals

The group of three adult giraffes (*Giraffa camelopardalis*) in Zoo Vienna consists of two adult female individuals, and an adult bull. The three giraffes (hybrid subspecies) are easily distinguished via appearance and temperament.

Karla

Karla was born in 1999 at the safari park in Dvur Cralove, Czech. At the age of seven, she moved to Zoo Vienna together with her one year old daughter Rita in 2006. Karla is darker brownish colored than Rita and has very short hair on the horns. An elongate cut in her right ear makes it easy to distinguish Karla from Rita. She seems relaxed most of the time and behaves usually friendly or neutral with the others. She was reported to perform intense <pacing> and occasional <licking of non-food objects>.

Rita

Rita was born in 2005 and came together with her mother Karla to Austria. Rita is lighter brownish colored than Karla, has a triangular patch on her upper left neck side and four characteristic patches on the right cheek. She is the shyest individual of the group and pays attention to her surroundings frequently. She shows both stereotypic <licking> and <pacing> behavior.

Figure 3.1: Female giraffes, Karla (front) and Rita (back), Photo by Erwin Gruber, May 30th, 2014, (www.zoovienna.at 2014)
Kimbar

Kimbar is born in Zoo Emmen, Netherlands in 1993 and came to Zoo Vienna in 1995. Kimbar is the tallest and darkest colored of all three giraffes. His head looks massive because of the big bony lumps. Due to his tempered mood he shows least interest in his surroundings even when the others are on alert. Kimbar regularly shows excessive sexual behavior and needs to be separated from the group. He is reported to perform <pacing> indoors and frequently <licking of non-food objects>.

Figure 3.2: Giraffe bull Kimbar (back) and Karla (front), Photo by Franz Wunsch, July 8th, 2014; (www.zoovienna.at 2014)

3.3 Enclosure

The giraffe’s enclosure of Zoo Vienna was relatively small and in need of renovation at the time the survey was conducted. Reconstruction and enlargement are in progress since December 2014 and completion is scheduled for spring 2017 (www.zoovienna.at 2014). The giraffes were housed in a 10 000 square feet exhibit during summer and a small area inside for spending nights, rainy and cold days, daily feeding and separating individuals. The outdoor exhibit consists of a roofed shelter and access to gravel area and a meadow. Giraffes share the outdoor facility with a pair of southern ground hornbills (<i>Bucorvus abyssinicus</i>) and three African marabous (<i>Leptoptilos crumeniferus</i>).
Giraffes are fed ad libitum alfalfa provided outdoors in an elevated hanging round slatted-top wire basket feeder. At 3pm concentrated pellets feed, fruits and vegetables were provided indoors and browse was offered occasionally. Since 2008, positive reinforcement training enrichment with all three giraffes is performed a few days a week.
3.4 Enrichment devices

The idea for the enrichment devices was created by the curator and animal trainer of Zoo Vienna, Dr Eveline Dungl who had seen this kind of enrichment device in Zoo Odense, Denmark.

The construction is built up of a pulley including a guide frame that make the enrichment device adjustable in height and easily refilled with feed. One device consists of a rectangular box including three compartments. The wooden front board as well as the compartments is entered for the giraffes’ tongue via holes located in different positions. The transparent back board made of Plexiglas allows zoo visitors to observe feeding manipulation of the animals. Usual manufactured concentrate feeding pellets were used for filling.

Figure 3.5: Animal keeper Irene Greter filling an enrichment device (a), Photo by Irene Greter, November 27th 2013, (www.zoovienna.at 2014); Giraffe bull Kimbar manipulating (b), Photo by Daniel Zupanc, September 2012
3.5 Data analysis

In the beginning of the analysis, data of all three observed individuals were transmitted into digital form using IBM SPSS Statistics (IBM SPSS Statistics, IBM Inc., Armonk, NY, USA). Data were aggregated per hour and data of all three animals were consolidated. Descriptive statistics was also performed in SPSS.

The next step was performed in order to assess how behavior patterns before and after providing enrichment devices changed and if factors influence this change. Therefore, generalized additive mixed models (R Development Core Team, GNU General Public License, 1993, package mgcv) were used for six dependent variables (feeding, ruminating, locomotion, resting, pacing, licking of non-food objects) and the following independent variables: enrichment, temperature, precipitation, wind, cloudiness, number of visitors, days and hours. The individual animals were used as random factors. The behaviors resting, comfort, exploration and alert were not examined due to the small amount of data and relevance.

Additionally, the variable <licking> has been investigated using a logistic regression with the single (non-aggregated) values in two different approaches. The variables days and hours took the time series structure of these data into account. In the first approach, a linear model was used. Due to uncertain results, in a second approach an additive model with log-link and hours as non-parametric spline has been estimated.

Residuals of the models were checked for normality and independence by a visual interpretation of residual plots. In case of deviations, the dependent variable has been transformed (arcsine and/ or boxplot, see results).
Due to the high model selection uncertainty, techniques for multi-model inference and model averaging were applied (Burham und Anderson 2002). In particular, all potential model based on the full model with all independent variables described above were estimated and ranked based on AICc (Akaike information criterion corrected for small sample sizes, (Akaike 1979)). Then averaged estimates and adjusted p-values were calculated as well as the relative variable importance (RVI), i.e. the probability (given these data and the set of candidate models) for a given variable to be in the best model explaining the data. In the following, percentage of deviance of the full model and adjusted p-value and RVI of the variable “placement” are reported.
4 Results

In total, 3840 scans were recorded during observations, 1920 each before and after placement of the enrichment devices. The animals were not visible for 335 scans (17.4%) before and 264 times (13.4%) after placement.

4.1 Influencing factors

Wind and rainfall

Rainfall was noticed 120 times (light rainfall 3.1%, heavy rainfall 3.1%) before placement of the enrichment devices but was never observed after placement.

Concerning wind, calm (1170 times, 60.9%), light wind (660 times, 34.4%) and high wind (90 times, 4.7%) were noticed in the first observation phase whereas the second phase after providing enrichment revealed calm (1560 times, 81.3%), light wind (360 times, 18.8%) but no high wind at all.

Number of visitors

Table 4.1: Number of visitors before (without enrichment) and after (with enrichment) placement of enrichment objects

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10 visitors</td>
<td>270</td>
<td>14.1</td>
<td>450</td>
</tr>
<tr>
<td>10-20 visitors</td>
<td>90</td>
<td>4.7</td>
<td>450</td>
</tr>
<tr>
<td>20-50 visitors</td>
<td>810</td>
<td>42.2</td>
<td>720</td>
</tr>
<tr>
<td>&gt;50 visitors</td>
<td>750</td>
<td>39.1</td>
<td>300</td>
</tr>
<tr>
<td>Total</td>
<td>1920</td>
<td>100</td>
<td>1920</td>
</tr>
</tbody>
</table>
Temperature

Figure 4.1: Mean temperature before (upper figure) and after (lower figure) providing enrichment
Cloudiness

Figure 4.2: Mean cloudiness before (upper figure) and after (lower figure) providing enrichment
Enclosure position

Table 4.2: Enclosure position before (without enrichment) and after (with enrichment) placement of enrichment objects

<table>
<thead>
<tr>
<th></th>
<th>without enrichment</th>
<th>with enrichment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>not visible</td>
<td>337</td>
<td>17.6</td>
</tr>
<tr>
<td>A</td>
<td>581</td>
<td>30.3</td>
</tr>
<tr>
<td>B</td>
<td>278</td>
<td>14.5</td>
</tr>
<tr>
<td>BA</td>
<td>26</td>
<td>1.4</td>
</tr>
<tr>
<td>C</td>
<td>92</td>
<td>4.8</td>
</tr>
<tr>
<td>D</td>
<td>8</td>
<td>0.4</td>
</tr>
<tr>
<td>E</td>
<td>598</td>
<td>31.1</td>
</tr>
<tr>
<td>Box 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Box 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Box 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1920</td>
<td>100</td>
</tr>
</tbody>
</table>
Figure 4.3: Enclosure position before (upper figure) and after (lower figure) providing enrichment
4.2 Behavior patterns

Feeding

<Feeding> frequency did not change significantly after providing the enrichment devices. Residuals of data were normally distributed. The GAM model revealed 38.7% of the deviance explained. After model reduction to variables with a RVI smaller the RVI of placement (before and after placement of enrichment devices), the variable placement revealed a RVI of 0.51 and an averaged p-value of 0.770.

Table 4.3: Feeding frequency before (without enrichment) and after (with enrichment) placement of enrichment objects

<table>
<thead>
<tr>
<th></th>
<th>without enrichment</th>
<th></th>
<th>with enrichment</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>not visible</td>
<td>335</td>
<td>17.4</td>
<td>264</td>
<td>13.8</td>
</tr>
<tr>
<td>no feeding</td>
<td>855</td>
<td>44.5</td>
<td>725</td>
<td>37.8</td>
</tr>
<tr>
<td>feeding</td>
<td>730</td>
<td>38.1</td>
<td>931</td>
<td>48.4</td>
</tr>
<tr>
<td>Total</td>
<td>1920</td>
<td>100</td>
<td>1920</td>
<td>100</td>
</tr>
</tbody>
</table>
The frequency of the behavior pattern <ruminating> decreased significantly after providing enrichment (p=0.003). Normal distribution requirements for data were not met but could be approximated using arcsine transformation. The GAM model showed 23.9% of the deviance explained. After model reduction to variables with a RVI smaller the RVI of placement (before and after placement of enrichment devices), the variable placement revealed a RVI of 0.97 and an averaged p-value of 0.003.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>not visible</td>
<td>335</td>
<td>17.4</td>
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<tr>
<td>no ruminating</td>
<td>1185</td>
<td>79.2</td>
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<td>ruminating</td>
<td>400</td>
<td>20.8</td>
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<tr>
<td>Total</td>
<td>1920</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4.4: Ruminating frequency before (without enrichment) and after (with enrichment) placement of enrichment objects
Figure 4.5: Ruminating frequency before (upper figure) and after (lower figure) providing enrichment.
Licking of non-food objects

The frequency of the behavior pattern <licking of non-food objects> did not alter significantly. Data of this behavior pattern did not follow a normal distribution. An arcsine and afterwards a box- cox transformation were conducted. The GAM model revealed 19.8% of the deviance explained. The variable placement revealed a RVI of 0.75 and an adjusted p-value of 0.176.

Using the single, non-aggregated data, the linear model with log-link gave indication for an enrichment effect (RVI=0.72 and adjusted p=0.054). For clarification an additive model with hours as non-parametric spline showed clearly non-linear effects of hours, but a potential effect of enrichment was less probable (RVI=0.44 and adjusted p=0.227).

Figure 4.6: Significant decrease of ruminating frequency before (0) and after (1) providing enrichment devices (P=0.003).
Table 4.5: Licking frequency before (without enrichment) and after (with enrichment) placement of enrichment objects

<table>
<thead>
<tr>
<th></th>
<th>without enrichment</th>
<th>with enrichment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>not visible</td>
<td>335</td>
<td>17.4</td>
</tr>
<tr>
<td>no licking</td>
<td>1465</td>
<td>76.3</td>
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<tr>
<td>licking</td>
<td>120</td>
<td>6.3</td>
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<tr>
<td>Total</td>
<td>1920</td>
<td>100</td>
</tr>
</tbody>
</table>

Figure 4.7: Licking frequency before (upper figure) and after (lower figure) providing enrichment
Pacing

The Wilcoxon test did not show significant differences between the two observation periods concerning <pacing> behavior. Normal distribution requirements were not met. In order to stabilize variance of data, several transformations including arcsine, logarithm and combination were conducted but there was no satisfactory result achieved.

Table 4.6: Pacing frequency before (without enrichment) and after (with enrichment) placement of enrichment objects

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<thead>
<tr>
<th></th>
<th>without enrichment</th>
<th>with enrichment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>not visible</td>
<td>335</td>
<td>17.4</td>
</tr>
<tr>
<td>no pacing</td>
<td>1514</td>
<td>78.9</td>
</tr>
<tr>
<td>pacing</td>
<td>71</td>
<td>3.7</td>
</tr>
<tr>
<td>Total</td>
<td>1920</td>
<td>100</td>
</tr>
</tbody>
</table>
Figure 4.8: Pacing frequency before (upper figure) and after (lower figure) providing enrichment
**Locomotion**

The frequency of <locomotion> behavior did not show significant changes after enrichment placement. Data of this behavior pattern did not follow normally distribution requirements. In order to stabilize data, several transformations (arcsine, logarithm, box-cox) were performed but this did not lead to an acceptable result. The GAM model revealed 5.23% of the deviance explained and a RVI of 0.32 and an averaged p-value of 0.280.

<p>| Table 4.7: Locomotion frequency before (without enrichment) and after (with enrichment) placement of enrichment objects |
|-------------------------------------------------|-------------------------------------------------|</p>
<table>
<thead>
<tr>
<th><strong>without enrichment</strong></th>
<th><strong>with enrichment</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td><strong>Percent</strong></td>
</tr>
<tr>
<td>not visible</td>
<td>335</td>
</tr>
<tr>
<td>no locomotion</td>
<td>1476</td>
</tr>
<tr>
<td>locomotion</td>
<td>109</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1920</strong></td>
</tr>
</tbody>
</table>
Figure 4.9: Locomotion frequency before (upper figure) and after (lower figure) providing enrichment
Resting

<Resting> frequency did not change significantly after providing the enrichment devices. Residuals of data were not normally distributed. Several transformations including arcsine, logarithm and box-cox were conducted. The GAM model revealed 21.4% of the deviance explained and the variable placement showed a RVI of 0.72 and an averaged p-value of 0.03.

Table 4.8: Resting frequency before (without enrichment) and after (with enrichment) placement of enrichment objects.

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<thead>
<tr>
<th></th>
<th>without enrichment</th>
<th>with enrichment</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>not visible</td>
<td>335</td>
<td>17.4</td>
</tr>
<tr>
<td>no resting</td>
<td>1455</td>
<td>75.8</td>
</tr>
<tr>
<td>resting</td>
<td>130</td>
<td>6.8</td>
</tr>
<tr>
<td>Total</td>
<td>1920</td>
<td>100</td>
</tr>
</tbody>
</table>
Figure 4.10: Resting frequency before (upper figure) and after (lower figure) providing enrichment
5 Discussion

Nearly every giraffe in captivity shows stereotypical behavior (Fernandez, et al. 2008). In this survey, it was assumed that stereotypies in giraffe are stress related behavior patterns (Mason 1991) that arose from frustration of not being able to adequately perform physiological foraging behavior (Broom 1991). As the stereotypical <licking of non-food objects> seems to be related to feeding behavior (Bashaw, Tarou und Maki 2001), enrichment devices were established to increase the amount of tongue manipulation and therefore decrease frustration by satisfying the giraffe’s need by imitation of physiological feeding behavior.

Only one behavior pattern, <ruminating>, changed significantly after providing enrichment and we could not statistically demonstrate a decrease in stereotypical behavior patterns and change in other behaviors. This fact might be due to small amount of data recorded which was exacerbated by a relatively high frequency of non-visibility of the individuals (17.4% before and 13.8% after placement of enrichment). Another reason might be a weak experimental design caused by influencing factors that were recorded but did not influence behavior or factors that were not considered at all. As the interference factors rainfall, wind, cloudiness and temperature did not reveal considerable differences between the two observation periods, the comparability of the two phases does seem valid. However, visitor numbers revealed a marked decrease in the second observation period (>50 visitors: 39.1% before and 15.6% after placement of enrichment) which may have influenced the behavior of the giraffes.

By monitoring the usage of the exhibit before placement, it was apparent that the giraffes highly favored the feeding and resting areas (sections A and E, Figure 3.4) and that other sections were hardly ever used. As the enrichment devices were placed in sections that were mostly not in use, we could achieve a better spatial utilization of the exhibit using enrichment devices (Sections B1, B2, B3, Figure 3.4).
Physiological behavior patterns

A decrease of the <ruminating> frequency turned out to be the only significant change after providing enrichment in this study. As <ruminating> indicates good animal welfare, a reduction of the <ruminating> rate is not a desirable outcome. The most likely reason for this decrease might be an inappropriate device filling time. We had decided to fill the enrichment devices at 12pm, just before the stereotypic rate increased sharply (Figure 4.7) but this also led to a decrease and an interruption of the giraffes <ruminating> cycle (Figure 4.5). Therefore, we might not have chosen the optimal filling time.

<Feeding> (31.1% before and 48.4% after providing enrichment) rate did not reveal any significant change but a slight upward trend after providing enrichment. This increase might be due to additional feed provided by the enrichment devices. <Locomotion> (5.7% before and 5.3% after providing enrichment) and <resting> (6.8% before and 5.7% after providing enrichment) occurred very rarely and showed a minimal decrease, but this was not statistically significant.

Stereotypical behavior patterns

Data revealed that the giraffes of Zoo Vienna regularly show a low degree of stereotypic <licking> and <pacing> behavior (10% before and 5.8% after providing enrichment). Stereotypical behavior patterns are often significantly reduced in enrichment studies but are mostly reported to not be eliminated entirely (Mason und Latham 2004). In this study, unfortunately, we could not show a significant decrease in the <licking of non-food objects>. However, a reduction tendency of this behavior pattern is discernible as the <licking> rate decreased from 6.3% to 2.3%. An optimal filling time of the devices might lead to a significant reduction of stereotypic <licking> and a physiological ruminating cycle. Therefore, further investigation is needed.
<Pacing> frequency showed a pronounced maximum between 2pm and 3pm and did not differentiate after enrichment placement (3.7% before and 3.5% after providing enrichment). Therefore it is likely that feeding enrichment does not influence stereotypic locomotion behavior. Suggestions for <pacing> reduction are discussed below.

Management advices

The enrichment devices were well received by the giraffes and all three of them were used regularly. The degree of difficulty to obtain the pellets by tongue manipulation seemed to be appropriate as the giraffes spent some time at one device trying to get the food. Most of the time, the devices were found empty at the next filling what means that it was not too difficult for the giraffes to reach the food. The zoo visitors seemed to enjoy observing the manipulations of the giraffe’s through the transparent back board as a lot of people were watching them after filling. The enrichment devices proved very suitable for feeding enrichment of giraffe as well as visitor education. I would recommend implementing them in the new enclosure.

A high number of giraffes in captivity perform stereotypies due to a lack of the possibility to adequately perform their wide range of behavior patterns (Fernandez, et al. 2008). Stereotypical <pacing> behavior revealed a high maximum between 2pm and 3pm along the doors and walls of the inside area, just before feeding indoors. This behavior is also recognized as abnormal behavior by the zoo visitors. <Pacing> was not influenced by our feeding enrichment at all but there are several possibilities worth trying to improve this situation. I would recommend canceling the daily indoor grain feeding. On the one hand, giraffes need a high amount of food to meet their energy requirements, but on the other hand concentrated grain feed might increase stereotypic <licking> behavior due to a reduced manipulation stimulus, excess gut acidity and shorter feeding times leading to behavioral and health issues. Small amounts of food provided using different feeding enrichment methods (Table 2.4: Successful innovations for giraffe enrichment, throughout the day might be a good alternative and suggestion for further study. Additionally, the new
enclosure should include locomotor stimuli for the giraffes as they walk 3 to 5 kilometers daily in the wild and hardly ever in our survey. This requirement might be met by installing the giraffe’s functional areas as far apart from each other as possible. Therefore, I would recommend equipping the new enclosure with variations of enrichment possibilities to offer different stimuli and meet the giraffe’s appropriate behavioral requirements.
6 Summary

Almost 80% of zoo-housed giraffe including the three adult giraffes of Zoo Vienna, Austria were reported to perform at least one type of stereotypy, with <licking of non-food objects> and <pacing> being the most common (Fernandez, et al. 2008). Stereotypies are described as stress linked behavior patterns that do not occur in the wild at all, that are performed in inappropriate high rates in captivity (Broom und Johnson 1993) and that they are assumed to indicate poor animal welfare (Broom 1991).

As stereotypic <licking of non-food objects> in giraffe can be reduced by increasing the amount of tongue manipulation for food obtaining (Fernandez, et al. 2008), enrichment devices for giraffes were established during a planned redevelopment of the giraffe’s enclosure of Zoo Vienna. The survey was divided into three phases: one observation period before placement of enrichment devices, an adaptation phase and one observation phase after adaption to the enrichment devices. Stereotypies and physiological behavior including factors that could influence the behavior patterns of giraffes (position, weather, rainfall, temperature, visitor numbers) using scan sampling method were recorded. After a baseline period, one enrichment device for each giraffe was placed and filled with food once a day. After the second observation period data of the two phases before and after placement was examined for differences.

We hypothesized that behavior patterns of giraffe during baseline period differed from those after providing feeding enrichment devices and that the frequency of stereotypic <licking of non-food devices> would be decreased. A decrease in <ruminating> frequency after enrichment placement was the only significant result. No significant differences before and after providing the devices were found concerning <licking of non-food objects>, <pacing>, <feeding>, <locomotion> and <resting> behavior frequency.

Stereotypical behavior could not be decreased significantly by providing enrichment devices for an increase of tongue manipulation in this study.
7 Zusammenfassung


Eine Reduktion der Verhaltensweise <Wiederkäuen> stellte sich als einzige signifikante Veränderung heraus. Es konnten keine signifikanten Veränderungen der Verhaltensweisen <Licking of non-food objects>, <Pacing>, <Fressen>, <Lokomotion> und <Ruhren> festgestellt werden.

Eine Verminderung von stereotypem Verhalten sowie eine Änderung der physiologischen Verhaltensweisen, konnte in dieser Studie durch das Anbieten von Enrichment-Objekten, die den Manipulationsgrad beim Fressen erhöhen, nicht erreicht werden.
8 Table of Literature


Reiter, Slvia. "Effects of positive reinforcement training on stereotypic behavior in Giaffes (Giraffa camelopardalis)." Masterarbeit, 2010.


9 Appendix

9.1 Ethogram of giraffe

Feeding
Giraffe take up food by grabbing it with its flexible lips and/or by wrapping the prehensile tongue around to bring it into the mouth. Immediately afterwards, the food is chewed which is characterized by masticatory jaw movements and then swallowed. In this study, feeding behavior includes browsing, feeding, drinking and grazing.

Ruminating
Boluses of already eaten food are brought up to the giraffe’s mouth and chewed again. Regurgitation is usually visible from the outside of the esophagus. Chewing movements of ruminating are independent from food intake and need to be distinguished from feeding behavior. Ruminating in giraffe is seen while walking, standing or lying (Seeber, Cifolo und Ganswindt 2012).

Resting
Resting giraffe stands with a lowered head and relaxed neck position and without scanning their environment. Resting phases are often followed by rumination. Giraffe also rest in sternal lying position with the head erect, bend or positioned on the hip, especially for sleeping (Seeber, Cifolo und Ganswindt 2012). Eyes are either open or closed and ears are relaxed, yawning is shown occasionally.

Locomotion
Giraffes move legs repeatedly to move forward to another position. Head and neck of the move in synchrony for maintaining balance (Estes 1991). Ambling walk is a four-beat locomotion that is distinct from the faster three-beat gallop which also characterized by a moment of suspension (Seeber, Cifolo und Ganswindt 2012). Canter is shown on rather short
distances for short periods of time and mostly used as an escape movement (Seeber, Cifolo und Ganswindt 2012).

**Exploration**

Giraffes explore things by using their tactile, olfactory, visual senses for example by touching, licking, manipulating or sniffing at objects.

**Interactions**

Interactions between giraffes are divided in this study in positive, negative and sexual interactions and characterized by mutual or reciprocal actions. Positive interactions contain mutual behavior patterns that are performed in a close position to each other without any aggressive component (feeding, ruminating, resting, comfort behavior, stereotypical behavior, locomotion, nuzzling, grooming, etc.). Negative interactions are always linked with adverse gestures (displace, fighting, biting, fleeing, sparring, etc.). Sexual interactions contain flehmen, urine testing, investigation of a conspecific’s anogenital region or flanks, mounting, urine testing, tolerating affiliation and stimulated urination (Seeber, Cifolo und Ganswindt 2012).

**Alert**

Giraffe shows high body tension while standing still with an erect head and neck while facing potential threatening object or object of interest. The eyes are wide open and the ears erected and faced forward. Giraffe do not show chewing movements at the same time. Snorting occurs occasionally.

**Comfort behavior**

Giraffes comfort behavior includes self- grooming by licking or biting the animals own body to provide relief from an unpleasant sensation (Seeber, Cifolo und Ganswindt 2012) and rubbing itself on appropriate objects (Seeber, Cifolo und Ganswindt 2012).
**Pacing**

<Pacing> is defined as follows: The animal walks a definite short path, repeatedly and without a discernible purpose (Seeber, Cifolo und Ganswindt 2012). Giraffes often walk in eights, circles and along walls or objects. Walking direction is changes occasionally.

**Licking**

<Licking of non-food objects> is defined as using the tongue on an object that is neither food nor mineral, repeatedly and persistently over a lengthy period of time (Seeber, Cifolo und Ganswindt 2012).

**Others**

Contains all behavior patterns that cannot be assigned to a category above.
## 9.2 Log sheet

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