Department of Physics, Chemistry and Biology

Bachelor´s Thesis

Olfactory-Related Behaviors in Captive Chimpanzees (*Pan troglodytes*)

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Abstract:
Primates have traditionally been considered having a poor sense of smell compared to other orders of mammals, like carnivores, due to reduced olfactory structures of the primate brain. This thought, however, is slowly changing. There are now a range of studies showing that primates do use their sense of smell, for example in chemical communication. However, few studies have been carried out on olfactory-related behaviors in Great Apes. The aim of this study was to assess the occurrence of olfactory-related behaviors in captive chimpanzees (*Pan troglodytes*). The results do not only show that chimpanzees use their sense of smell, but also a behavioral difference between male and female chimpanzees. There was a significant difference between male to female smelling of the anogenitals and male to male smelling of the anogenitals ($p = 0.0001$) and also a difference between the occurrences of males and females touching an object with the hand and then smelling at the hand ($p = 0.0007$). There was a significant difference between male and female frequency of smelling at an object ($p = 0.001$) and a significant difference between the occurrences of male and female smelling at foods and liquids ($p = 0.003$). There were no observations of chimpanzees performing a scent-marking behavior. These results suggest that chimpanzees use their sense of smell, from investigating new objects to the inspection of food and other chimpanzees. It would be interesting in future studies to study the difference between male and female frequency of olfactory-related behaviors.

Nyckelord

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Contents

1. Abstract
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Key words: Olfaction; Behavior; Chimpanzee; Gender difference

2. Introduction
The general statement about primates is that they are "visual" animals (Laska et al. 2000). They have been considered having a less developed sense of smell than other classes of mammals like the carnivores and rodents (Smith & Bhatnagar, 2004). This thought is partly supported by the findings of reduced olfactory structures of the primate brain (Allman 2000). However, despite these findings, studies show that primates do use their sense of smell (Epple 1986; Epple 1973), and that olfaction may play an important role in the lives of primates and their behavior (Laska et al. 2000).

Nonhuman primates, like the New World primates, communicate with chemical signals like scent marking by rubbing their body against an object or the use of secretions from specialized scent glands (Epple 1976; Epple 1973; Epple 1986). The New World primates, like the marmoset (*Callithrix jacchus*) (Epple, 1973), do not have as many facial expressions as the Old World primates and the Great Apes, which favors chemical signaling in these primates (Epple 1974). Great apes however, like the chimpanzees, are known to use visual communications like facial expressions as well as tactile and vocal communication (Epple 1974; Laska et al. 2000).

An example on an olfactory-related behavior in primates was shown in wild moustached tamarins (*Saguinus mystax*), a New World primate. The study showed that male tamarins smelled significantly more often at scent marks of other tamarins than the female tamarins did, as well as the males smelling significantly more often at scent marks produced by female tamarins than those of male tamarins (Heymann 1998). This study does not only show that this New World primate performed olfactory-related behaviors, but also that there was a behavioral difference between male and female tamarins.

The areas of use of the sense of smell in primates can be seen in a study by Hernandez Salazar et al. (2003) on olfactory sensitivity in spider monkeys (*Ateles geoffroyi*), which is a New World monkey. They used aliphatic esters that are the main components of a variety of fruit odors and showed that the spider monkeys in fact can detect very low concentrations of each

ester. The authors consider these findings a step on the way to understand feeding behavior in primates, and along with Laska et al. (2000) who did a similar study on squirrel monkeys (*Saimiri sciureus*), see this as a step on the way of changing the thought of primates being considered having a poor sense of smell.

To test the sense of smell in western lowland gorillas (*Gorilla gorilla gorilla*), Hepper et al. (2008) impregnated cloths with different odors. These were almond scent and unisex perfume (cK1) as well as one cloth impregnated with distilled water. The gorillas spent significantly more time with the almond scented cloth than with the cloths impregnated with cK1 and distilled water (Hepper et al. 2008). After smelling and licking all of the cloths, the gorillas did not chew or lick the perfume impregnated cloth again. During the following experiments that took place several weeks later, the gorillas did not chew on the cloth that smelled like perfume, indicating a long term memory of ill tasting object and the use of their sense of smell to avoid these (Hepper et al. 2008). This suggests that gorillas use their sense of smell to determine what is edible and what is inedible. This olfactory long-term memory has also been shown by Laska and Hübener (1998) in the squirrel monkey (*Saimiri sciureus*) and the pig-tailed macaque (*Macaca nemestrina*). They concluded that this may be an evolutionary adaption due to seasonal changes and the different odors that comes with these. Though no article has been found on olfactory memory in the chimpanzee, the olfactory memory does exist in gorillas, squirrel monkeys and pig-tailed macaque. One could therefore imagine that an olfactory memory may also exist in the chimpanzee.

When it comes to identification of different individuals among Old World primates, it has been shown by Hepper and Wells (2010) that humans can significantly discriminate between odors of different lowland gorillas (*Gorilla gorilla gorilla*) of varying age and sex, with the adult silverback as the easiest individual to identify. Although more difficult to identify, there was a difference in the smell of the other gorillas in the experiment (Hepper & Wells 2010). One could assume that gorillas as well as humans can detect these individual odors. These results, however, do not show the importance of olfaction when it comes to individual recognition in gorillas, only that they all produce different body odors. Considering the fact that humans can detect differences in body odors of gorillas, one can hypothesize that chimpanzees may as well be able to detect these differences due to the fact that humans and chimpanzees share 99 % of their DNA (Ki et al. 1999).

There are studies on olfactory-related behaviors in primates but not a lot of them deal with olfactory-related behaviors in chimpanzees. It is therefore the aim of this study is to assess the occurrence of olfactory-related behaviors in captive chimpanzees (*Pan troglodytes*), and to make first assumptions as to the functional context they may serve.

3. Material and Method

3.1. Animals

22 captive chimpanzee (*Pan troglodytes*) were studied at Kolmården Zoo in Sweden. The chimpanzees ranged from an age of 6 months to 39 years, and the group was comprised of 9 male chimpanzees and 13 female chimpanzees. All except one of the oldest females, aged 39, were captive born.

3.2. Maintenance of the animals

The chimpanzees were kept indoors in an enclosure which enabled them to sometimes be non-visible to the observer. This was due to interior design in the form of a mountain which the chimpanzees could walk behind. All the chimpanzees were kept in the same enclosure which held a small stone mountain, trees, ropes, tires, a hammock and a ditch. The floors and walls of the enclosure were made of stone, and the floor of the ditch was filled with sand.

Hay- like bedding material was offered to the chimpanzees on a daily basis. The enclosure was cleaned approximately at 10:00 am to 11:00 am each day. During this time the chimpanzees were moved to a different enclosure where they were fed various fruits. The chimpanzees had one water outlet in the ditch and were fed at approximately 11:30 am each day. The composition of the food, which was mainly vegetables and pellets, was the same each day. The animals also received a mid day snack at approximately 13:00 pm which was carrots or apples, as well as a late snack of pellets, sunflower seeds and peanuts at around 16:00 pm.

3.3. Material

Based on a previous study of olfactory behavior in the New world primate, the howler monkey (*Alouatta palliata*) (Baltisberger 2003), an ethogram was designed to cover a range of olfactory-related behaviors that might occur within the group of chimpanzees studied. A protocol was made based on the ethogram, in which each occurrence was marked with a line. The letters M or F were also written to mark if the chimpanzee that was smelled at were male or female, and if possible, if urine, faeces and scent marks were deposited by a male or female chimpanzee.

3.4. Ethogram

Title	**Description**
Anogenital rubbing	Rubbing of the anogenital area against an object
Back rub	Rubbing of the back against an object
Breast rub	Rubbing of the breast against an object
Head rub	Rubbing of the head, neck and face against an object
Smelling at urine	Smelling at the urine from another chimpanzee
Smelling at faeces	Smelling at the faeces of another chimpanzee
Smelling at anogenitals	Smelling at the anogenital region of another chimpanzee
Smelling at head	Smelling at the head, face or neck of another chimpanzee
Smelling at back	Smelling at the back of another chimpanzee
Smelling at breast	Smelling at the breast of another chimpanzee
Smelling at other body part	Smelling at another body part of another chimpanzee
Smelling at blood	Smelling at blood on a con specific or at an object
Touch, then smelling hand	Touching an object with the hand and then smelling the hand
Smelling the own body	Smelling at own body parts
Smelling at object	Smelling at a non- food object (ex. branches, stones, fabrics, the floor or walls and other materials that are mainly un- editable). The behavior is not followed by ingestion of the object.
Smelling at food and liquids	Smelling at editable objects (ex. Liquids, fruit, leaves, vegetables, insects, honey and sweets).
Smelling an anogenital spot	Smelling a spot which has recently been in contact with another individual's anogenital area (within 5 minutes).
Smelling a marked area	Smelling at a spot which has been rubbed by another individual's body, back, breast or head (within 5 minutes).
Copulation and smell	Smelling at another chimpanzee or being smelled at by another chimpanzee, directly followed by copulation (within 2 minutes).

3.5. Observation method

The chimpanzees were studied by one observer who sat fully visible and audible to the chimpanzees at a distance of approximately two to twenty meters from the chimpanzees. The

distance depended on where the chimpanzees were located in the enclosure. The ditch, which was situated beneath the lower stairs in figure 1, was approximately two meters wide, which was the closest the visitors could stand from the animals.

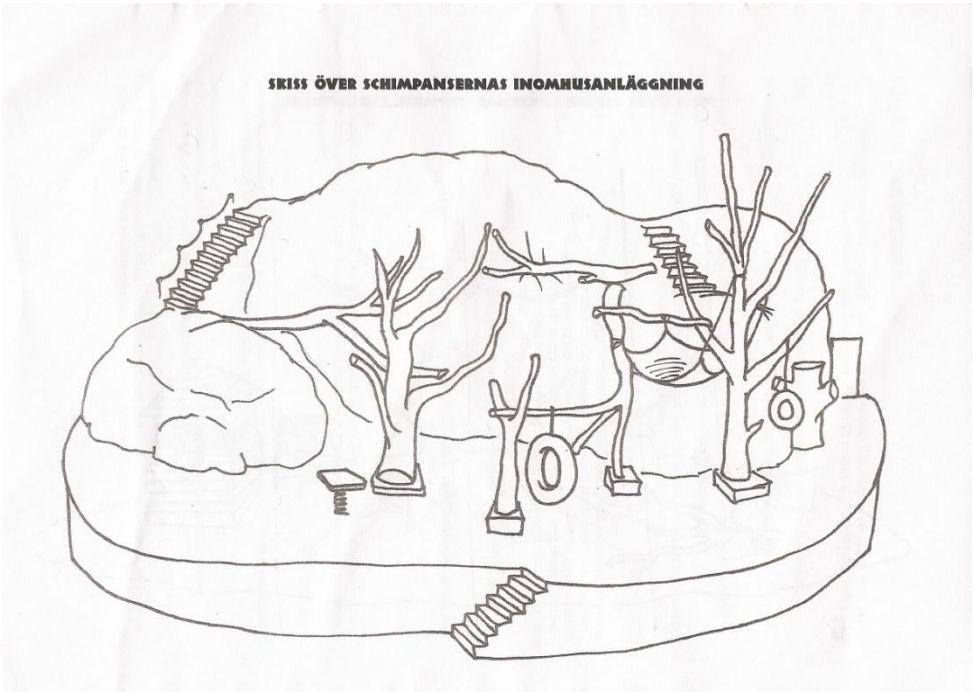

Figure 1. A sketch of the chimpanzees' enclosure. Picture by Mats Amundin

The chimpanzees were studied between 8:00 am and 17:00 pm with group sampling of all 22 chimpanzees. Visitors in the form of school classes, zoo keepers and other persons were also fully visible and audible to the chimpanzees during some time of the observations. The chimpanzees were studied for 45 hours spread over 10 days at various times of the day. Each time a chimpanzee performed a behavior that matched the described behavior in the ethogram, a notice was made in the protocol.

During the first week of observation, behavioral tests were conducted on the chimpanzees by a group of students, which included the presentation of mirrors in the chimpanzee enclosure. During this time there was also environmental enrichment for the chimpanzees in the form of fresh tree branches that were placed in the enclosure, the hiding of food in various places and some objects being smeared with caramel sauce. During the second week, no enrichment was presented for the chimpanzees except for one occurrence of caramel sauce being smeared on the floor, walls and some objects in the enclosure.

4. Results

Figure 2 illustrates all olfactory-related behaviors observed in the captive chimpanzees. The most frequent behavior among both male and female chimpanzees was the smelling at an object. Other behaviors observed more than 20 times were the smelling of food and liquids for both male and female chimpanzees, as well as male and female chimpanzees touching an object and smelling at the hand. All other behaviors were observed fewer than 20 times except the male chimpanzees smelling at the anogenitals of a female chimpanzee, which occurred 50 times.

There was a difference in the number of observations of olfactory-related behaviors in the group of chimpanzees from week one to week two. Week one had environmental enrichment

and week two had no environmental enrichment for the chimpanzees, except the first day during week two, when the chimpanzees had caramel sauce smeared in the enclosure. During week one, the chimpanzees smelled 247 times at objects, compared to week two, when the chimpanzees only smelled at objects 49 times. 10 out of the 49 observations during week two were observed during the first hour that the chimpanzees spent with the objects smeared in caramel sauce.

Behaviors that were not observed in the captive chimpanzees were anogenital rubbing, back rubbing, breast rubbing, head rubbing, the smelling at faeces, the smelling at an area marked by rubbing and the smelling at an area marked by the anogenitals of another chimpanzee. No copulation was observed among the chimpanzees.

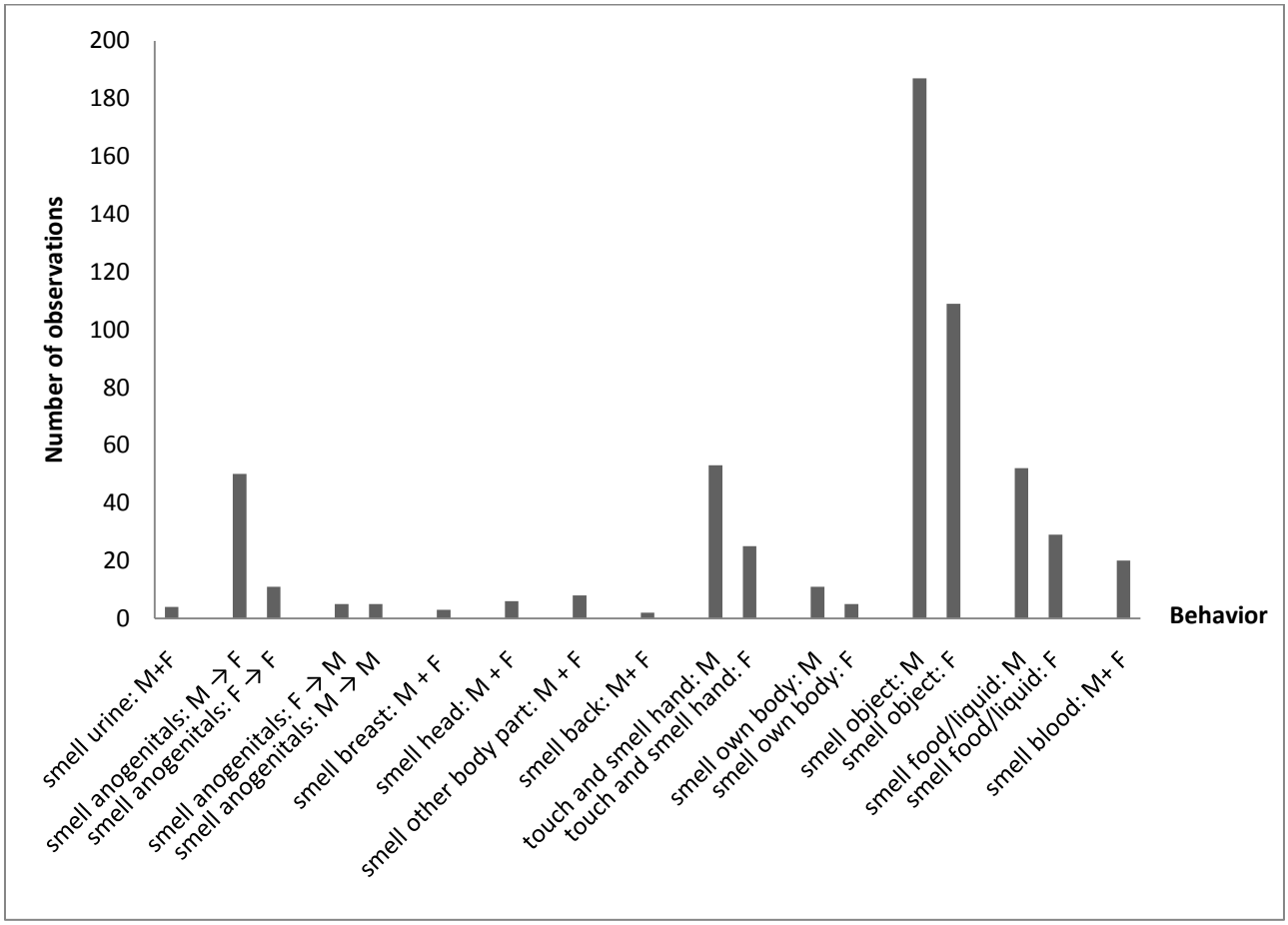

Figure 2. The number of observations for each of the olfactory-related behaviors observed. M is for male chimpanzees and F is for female chimpanzees.

When comparing male and female anogenital smelling, statistical analysis shows a significant difference between male to female smelling of the anogenitals and male to male smelling of the anogenitals (Chi = 30.6, p = 0.0001). There was no significant difference between females smelling at the anogenital region of males and males smelling at the anogenital region of other males (Chi = 2.44, p = 0.1479). There was a significant difference between the occurrences of males and females touching an object with the hand and then smelling at the hand (Chi = 11.51, p = 0. 0007). A significant difference between male and female frequency of smelling at an object was found (Chi = 29.39, p = 0.001), but there was no significant difference between males and females smelling at their own body (Chi = 2.44, p = 0.1479).

There was also a significant difference between the occurrences of male and female smelling at foods and liquids (Chi = 8.8, p = 0.003).

Other behaviors observed, but not compared between male and female chimpanzees, were the smelling at urine, smelling at the head, neck and breast of a conspecific, as well as the smelling at blood due to injuries among the chimpanzees.

5. Discussion

A range of olfactory-related behaviors were observed in the captive chimpanzees, and some were more frequent than others. The chimpanzees spent a lot of their time grooming each other with their hands and mouth which made it difficult for the observer to tell whether or not they smelled at each other during the time of the grooming. Therefore, not much can be said about olfaction as means of recognizing a conspecific in a group of chimpanzees. The difficulty in observing the smelling of another chimpanzee may explain the low frequency of observations for smelling at other individuals' body parts. Frequent, however, was the smelling at the anogenital area of another chimpanzee, which often occurred during the active parts of the chimpanzees' day, and not so much during resting and grooming.

The chimpanzees had developed a habit of drinking urine from both themselves and the urine of other individuals, which made it difficult to assess if the chimpanzees actually smelled at the urine or just moving their face close to drink it. Therefore, no data was collected on the smelling on urine, although most individuals were in contact with conspecific urine on a daily basis. There was no record of chimpanzees smelling at faeces from another individual, suggesting that the faeces may not contain any important information to other chimpanzees. The chimpanzees did not scent mark with their body parts, urine, faeces or anogenital rubbing, which differs from some New World primates which use scent marking for different purposes, like communicating information about gender, social status and sexual status (Epple 1973; Epple 1986; Epple 1974[2]; Heymann 1998). Based on this, there is a difference in the olfactory-related behaviors of chimpanzees compared to some New World primates, like the marmoset monkeys (*Callithricidae*).

Comparing results with Heymanns (1998) scent marking study in tamarins, similarities can be detected between the tamarins and the captive chimpanzees. Although no scent marking was observed in the chimpanzees, the results of this study did show that male chimpanzees smelled significantly more often at the anogenitals of female chimpanzees than the anogenitals of other male chimpanzees. Both male and female chimpanzees smelled more frequently at female anogenitals than male anogenitals. There was a significant difference between male and female smelling at an object, at food and liquids, at anogenitals and the touching an object and then smelling at the hand, where males used their sense of smell more frequently than females. The smelling at the female anogenitals suggests that females may produce pheromones when they are receptive to mating (Epple 1974[2]). Considering that chimpanzees are promiscuous animals, male chimpanzees might be able to detect precisely when a female chimpanzee is receptive to mating, depending on her odor, which may explain the frequent smelling of the female anogetials.

The lack of scent- marking behavior among the chimpanzees suggests that chimpanzees may use other means to communicate information to each other. This could be the direct smelling at each other, if it is olfactory-related, or perhaps by visual or vocal means. However, these are just speculations that require further research.

When it comes to olfactory-related behaviors that include food and water, there was a difficulty with the placement of the water-outlet, which was located in the corner of the ditch

of the enclosure. This made it nearly impossible to observe the chimpanzees' drinking behaviors. The frequency of smelling at a food or a liquid was relatively low compared to the smelling at an object, which might be explained by the fact that the chimpanzees received the same food every day, indicating that they might recognize these based on vision. This can be compared to week two of observations, where the chimpanzees rarely smelled at an object, probably due to the fact that no new objects, besides from the caramel sauce, were placed in the enclosure as they were during week one. This indicates that the chimpanzees recognize all old items within the enclosure through vision. The chimpanzees did, however, smell at some of the food and then either rejecting it or eating it, suggesting that chimpanzees may also possess an olfactory memory (Laska & Hübener 1998; Hepper et al. 2008) when it comes to edible and inedible food.

A distraction during the observations was the visits from school classes. Some of the visitors made the chimpanzees hide behind their mountain in the enclosure, out of sight for the observations. Another difficulty with the observations was the large number of chimpanzees to be studied by one observer. There would most likely be more observations of olfactory-related behaviors in the chimpanzees if there was more than one observer.

To conclude, it is clear from these results that chimpanzees use their sense of smell, from investigating new objects to the inspection of food and other chimpanzees. There is also a significant difference in smelling at anogenitals, food and objects between male and female chimpanzees, which is an observation that would be interesting to investigate further.

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