

3 MATERIAL AND METHODS

3.1 Subjects

This study was conducted at three different zoos, observing 10 male gorillas between the ages of 6 to 26 years (see Table 1 and 2). The observations took place at Paignton Environmental Park (UK), in the following chapters referred to as “Paignton Zoo,” regarding the new group formation of an all-male group, and at Loro Park (Tenerife, Spain) where the only longtime established all-male group in Europe could be found. The formation of a new all-male group at Paignton Zoo involved two 15-year-old silverbacks (Claus and Pertinax) and two juveniles (Richard and Avahli). Additional observation took place at Cologne Zoo, where Claus and Pertinax were originally housed.

Prior to the group formation, these silverbacks were kept at Cologne Zoo as part of a multimale gorilla group. They both had been hand-reared and grew up together since they were approximately 6 month old (for further detailed information on their juvenile development see Meder, 1985b). Claus and Pertinax had a close relationship during this time with Pertinax being dominant over Claus. The author noted that when interacting with the other group members, Claus was the more social animal of the two. At the beginning of this study the group at Cologne Zoo consisted of a leading silverback, two adult females, two juveniles (male and female) and a 4-month-old infant. Claus and Pertinax lived clearly at the periphery of this group. Figure 2 denotes Pertinax at the age of about 16 years after he had settled down at Paignton Zoo. Claus (Fig. 3) was only at the initial stage part of this new all-male group.

Richard (Fig. 4), an 8-year-old mother-reared male, came from Frankfurt Zoo. He is the half-brother of Claus and joined this all-male group a few days later together with Avahli (Fig. 5), a 5-year-old hand-reared male that came from Stuttgart Zoo. As a final addition, Asato and Mambi joined this group one year later; the information on their integration is based on notes from the keepers.

The gorillas of the new all-male group at Paignton Zoo are shown in Figures 2 to 5.



Fig. 2: Pertinax at Paignton Zoo
(Courtesy of Paignton Zoo).



Fig. 3: Claus at Paignton Zoo.



Fig. 4: Richard at Paignton Zoo
(Courtesy of Paignton Zoo).



Fig. 5: Avahli at Paignton Zoo (Courtesy of
Paignton Zoo).

The gorilla group at Loro Park, Puerto de la Cruz, Tenerife, Spain consisted of six males since 1995 (Table 2). At the time of observation, Schorsch, (Fig. 6) was 26 years old and the leading silverback. His position was already being challenged by the two blackbacks, Noel (Fig. 7) and Ivo (Fig. 8). All members of the group, except for Maayabu (Fig. 9), a 10-year-old blackback, were hand-reared. This group was initially founded in 1992.

The first group members, who came to Loro Park as subadults in 1992, were Noel and Ivo. Ivo was born in Munich and had to be hand-reared because his mother died after his birth. Noel was born at La Palmyre. He was hand-reared as well and was raised initially with two orang-utans (*Pongo pygmaeus*) and one chimpanzee (*Pan troglodytes*). According to Downman (1998), this had some impact on his behavior. However, through time, Noel adjusted well once he became introduced to other gorillas.

Schorsch came to Loro Park in 1994, where he lived alone for two years (Downman, personal communication, 1998). He came from Nürnberg Zoo, where he had been hand-reared. Before he came to Loro Park, he was kept solitary (Kirchshofer, 1994) because when kept with other gorillas he proved not to be a very social animal (Downman, personal communication, 1998). Schorsch, as the only silverback at that time, joined the group as the final member after a slow integration process (see Downman, 1998 for detailed descriptions of the integration processes). Finally, Maayabu, Polepole (Fig. 10) and Rafiki (Fig. 11) arrived in 1995 at Loro Park. Although Polepole and Rafiki are brothers, they were raised at different places. Maayabu, the only group-reared animal within this group, was born in Stuttgart.

The gorillas from the all-male group at Loro Park, Tenerife, shown in Figures 6 to 11.



Fig. 6: Schorsch.



Fig. 7: Noel.



Fig. 8: Ivo.



Fig. 9: Maayabu.

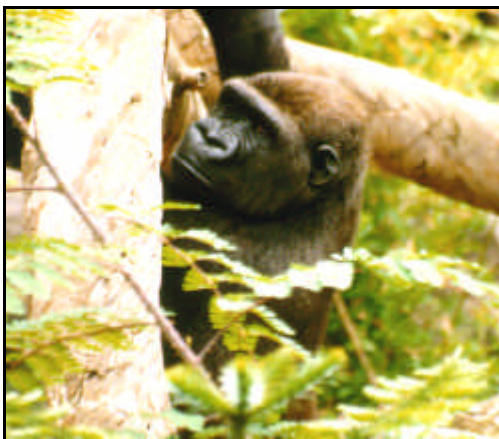


Fig. 10: Polepole.



Fig. 11: Rafiki.

Table 2: Individuals at Paignton Zoo ((hr) = hand-reared; (mr) = mother-reared).

Studbook-No.	Name	Date of Birth	Parents	Originated from	At Paignton Zoo since
802/259	Claus (hr)	06.07.1982	337 Matze 276 Dorette	Frankfurt am Main	April 1997 (from Cologne Zoo) Jan. 1998 Move to Bristol Zoo
792/250	Pertinax (hr)	13.04.1982	255 or 475 477 Dina	Stuttgart	April 1997 (from Cologne Zoo)
1169/586	Richard (mr)	09.11.1991	337 Matze 804/261 Rebecca	Frankfurt am Main	April 1997
1279/659	Avahli (hr)	24.04.1993	185 Tembo 972/402 Dafina	Amsterdam	April 1997 (from Stuttgart Zoo)
1166/583	Asato (mr)	20.10.1991	111/3 Jambo 90 N’Pongo	Jersey	May 1999
1162/579	Mambi (hr)	24.03.1991	497/75 Mamfe 635 Biddy	Twycross	May 1999

Table 3: Individuals at Loro Park, Tenerife, ((hr) = hand-reared; (mr) = mother-reared).

Studbook-No.	Name	Date of Birth	Parents	Originated from	At Loro Park since
435/54	Schorsch (hr)	03.03.72	253 Fritz 178 Liane	Nürnberg	Oct. 1994
942 / 379	Noel (hr)	28.12.86	183/6 Migger 565 Annette	Les Mathes / La Palmyre	Nov. 1992
1060 / 487	Ivo (hr)	29.01.88	519 Roututu 596/112 Wilma	München	Nov. 1992
1063/490	Maayabu (mr)	28.07.88	255 Banjo 241 Mimi	Stuttgart	July 1995
11067/527	Polepole (hr)	28.12.89	654/146 N’Gola 724/191 Inge	Zürich	July 1995
1177/592	Rafiki (hr)	29.05.91	654/146 N’Gola 724/191 Inge	Zürich	July 1995

3.2 Housing

3.2.1 Cologne

The inside enclosure consists of one smaller room with 52 m² area, which is connected to the larger exhibit through a 4 m long window and a sliding door (Nogge, 1985). The bigger show den (Fig. 12) covers 180 m², which can be viewed from various angles, and is separated from the public area by large windowpanes measuring up to 5 m in height. Figure 13 denotes the interior design consisting of various ropes, hammocks, and movable climbing structures, such as ropes, nets, climbing trees. Straw or other bedding materials are placed in hollows. Additional structures were created through the modeling of the floor space, leading to a difference in height up to 1.30 m, which can be used as vantage-points by individual animals. The enclosures were supplied with twigs and other materials of enrichment to ensure activity for the animals. The outside enclosure consists of 580 m² area, which is connected to the indoor exhibit through a glazed tunnel crossing the public pathways. The apehouse resembles a tropical rainforest with lush vegetation, contributing to the high humidity in the apehouse. Additionally, the vegetation prohibits the visitors from getting too close to the windowpane, thus, providing some distance between the gorillas and the public. At some points, it also facilitates a point of retreat for the animals.

The zoo opens for the public from 9:00 am until 6:00 pm, with the gorillas being on show from about 10:30 am (after cleaning) until 4:30 pm. On-show feeding occurs at 10:30 am, 2:00 pm and 4:30 pm, whereas early morning and evening feedings are off-show, mainly inside the night quarters. Various vegetables and plant species are fed throughout the day, which include for instance, broccoli, various kinds of green salads, carrots, celeriac, onions, leeks, bell peppers, various kinds of herbs, etc. The availability depends on the respective season. There were no fixed feeding schedules, thus, the animals did not get used to a predictable schedule but enough food was available at all times. Each individual received approximately 16 kg of food per day. A more detailed list of what was being fed can be found by Ruempler (1990) concerning the change of diet for the gorillas at the Cologne Zoo.

Camera position of Fig.13

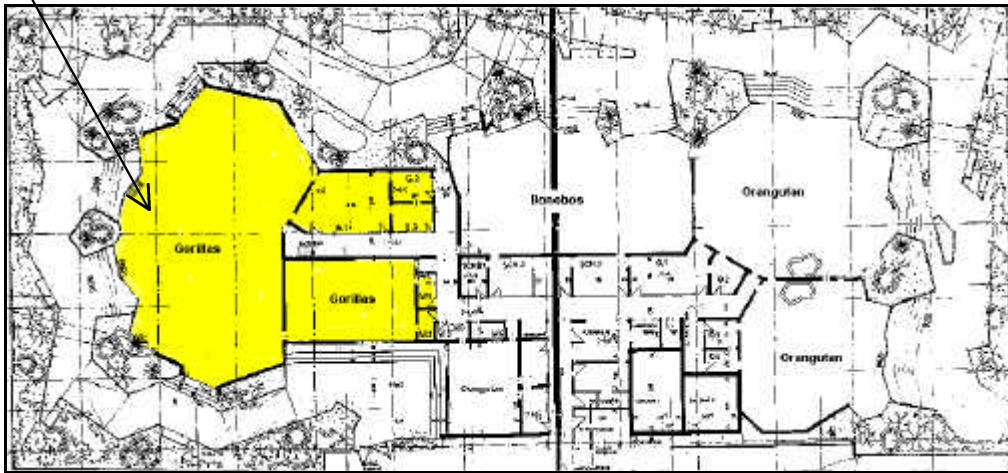


Fig. 12: Enclosure Layout, Cologne Zoo (modified after Nogge, 1985).

Highlighted areas denote inside exhibit, available to the gorillas.



Fig. 13: Cologne Zoo, Indoor Enclosure.

3.2.2 Paignton, Great Britain

Figure 14 denotes the blueprint overview of the indoor show den. It consists of approximately 150 m² in total, distributed over three levels, with the top level (L1) covering 50 m². The different levels (L1 to L3) are noted accordingly. The interior design consists of the following features: various wooden posts (horizontal and vertical, see Fig. 15); two hammocks, a big cargo net covers the largest area above the lower level (L3). The main purpose of this net is for security reasons, but it was also used frequently by the juveniles for climbing. The animals used the various ropes for swinging and climbing throughout the enclosure. The adult gorillas made use of these ropes also during display sequences. The six night dens are located underneath the top level. Three dens have access to the show den and measure 9 m² each. The other three dens are located on the opposite side and measure between 6 m² and 15 m². The island covers approximately 4000 m² and is designed like a hillside area with various wooden climbing structures, a big cargo net (see Fig. 16) and a shelter area, which can be used by the animals for shelter during rainy weather or to retreat from each other's view.

The early morning feeding of animals took place inside the night dens. After cleaning, the food was spread out throughout the indoor show den and, weather permitting, on the island. Additional feedings of the gorillas occurred around midday and in the late afternoon. The zoo opens from 9:00 am until 6:00 pm, and the gorilla buildings are closed around 5:00 pm. The gorillas have access to water through various drinking fountains throughout the inside and outside enclosures. Furthermore, once a day, in the afternoon, tea and some vegetables were provided in addition to the regular feeding schedule. Gorillas received various vegetables and plant species, consisting of the following: 10-12 carrots, 8 bell peppers, 8 tomatoes, 3 celeriac roots, 4 leeks, several dozen of onions, 1/2 loaf of bread, 3 heads of lettuce, several cabbages, 2 white turnips, 1 swede, 4 cucumbers, 2 broccoli or 1 cauliflower. Every other day the gorillas receive one boiled egg, 2-3 celeries, browse, and sunflower seeds. The seeds were scattered throughout the enclosure to encourage foraging. Occasional dog biscuits or scattered feed is provided in addition to various kinds of herbs throughout the week.

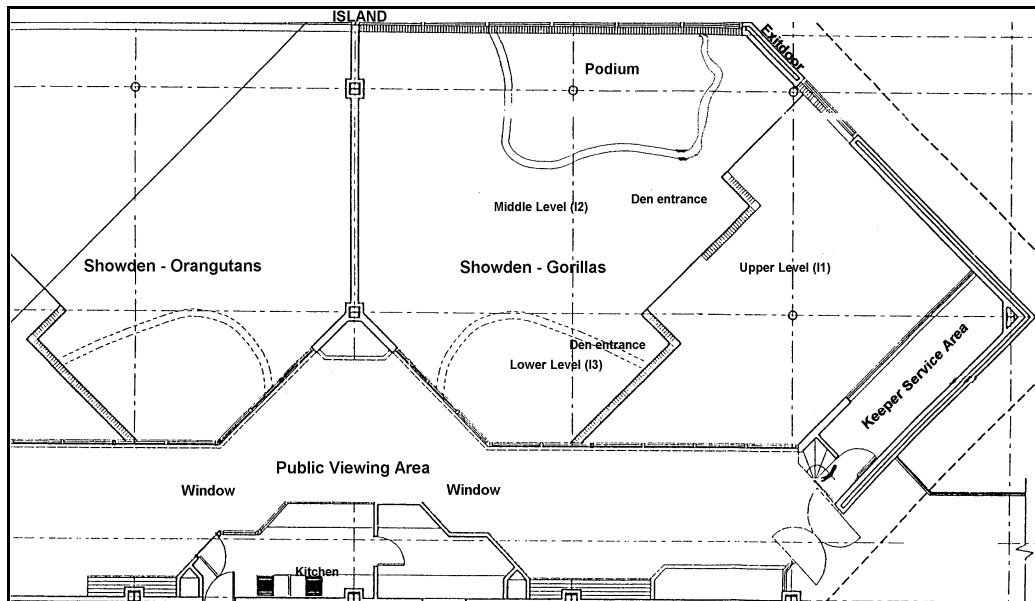


Fig. 14: Enclosure Layout, Paignton Zoo (courtesy of Paignton Zoo).



Fig. 15: Paignton Indoor Show Den.



Fig. 16: Paignton Gorilla Island.

3.2.3 Loro Park, Tenerife

The gorilla enclosure consists of two outdoor multi-level exhibits (a 60/40 split) with a total area of 3700 m², a larger one (also further referred to as west terrace, see Fig. 18) and a smaller one, also further referred to as the east terrace (see Fig. 19). Figure 17 denotes an overview of the outdoor enclosure design. The four public viewing points are: two open public view points on either end of the exhibit and two view points which are separated from the public by two large window-panes, which are in the center area of the enclosure. The behavioral observations took place from all four view points (open and window, see also Fig. 17). The exhibit is planted with various tree and shrub species. The boulders in various sizes for climbing serve as vantage points and for hiding from one another or from the public's view. The west terrace has two waterfalls, one cascading over a field of boulders. Additionally, a cave is built into the concrete wall structure.

Wooden climbing structures are supplied in both sections. Fishing boards are supplied as enrichment items were yogurt and various other foods are secured inside the tree trunks on a daily basis. Water fountains are found throughout the exhibit as drinking spots for the gorillas. Further enrichment items include palm fronds, banana leaves and bamboo. The banana leaves were preferably manipulated by the gorillas to serve as fishing tools (see Fig. 42 on page 117, Maayabu fishing for yogurt). Until April 1997, the all-male group occupied only the west terrace, while a male and a female gorilla occupied the east terrace until this pair was sent to the Nürnberg Zoo. In 1997, both terraces were newly planted, and the male gorillas gained access to both parts (see Downman, 1999; Neubauer and Heckner-Bisping, 1999 for details).

The gorillas stood outside all day and during the night they were kept in the inside dens (see Fig. 20), where the main feeding in the morning and evening took place. The inside area consists of nine sleeping dens. Each den consists of sleeping bench, ropes, automatic water dispenser; plenty of palm fronds are supplied as bedding material. An additional holding and quarantine area contains climbing structures and suspended tires for climbing and play activities. This area is usually used when animals are ill and therefore kept off-show, or for off-show introductions.

The gorillas were on show between 9:00 am and 4:30 pm. The main feedings occurred in the morning and evening. Throughout the day the animals were fed every hour, by which the keepers called each individual (by starting with Schorsch, the silverback) and threw fruits and vegetables to the animals upon which they either caught or picked up the food.

Before the animals had to go outside, they were being fed with Gofio, which is a Canarian specialty, made from roasted wheat with milk. In the meantime, the staff spread out various kinds of fruit and vegetable as well as nuts and monkey chew. Palm fronds and banana leaves were supplied as enrichment items. In the evening, when the gorillas were inside the building, they received their main meal consisting of fruits, vegetables, and yogurt. As nesting material and enrichment, palm fronds, banana leaves, paper, burlap, and cardboard boxes were provided. For a change, the fruit and vegetable share was varied on a daily basis.

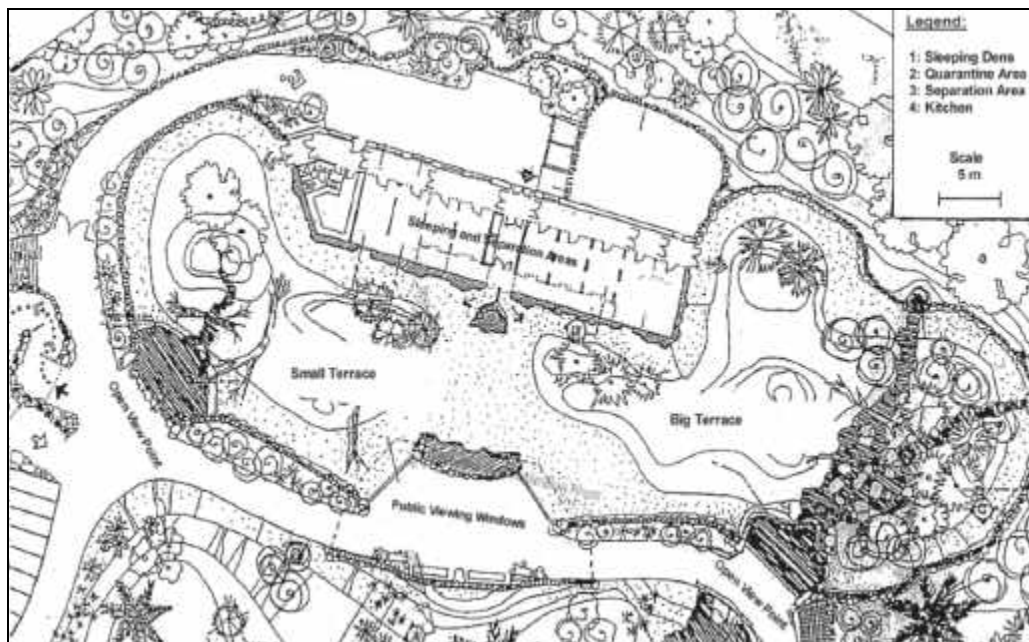


Fig. 17: Loro Park Outline (modified after Neuwald, 1998).



Fig. 18 Loro Park, West Terrace, view from open view point.



Fig. 19: Loro Park, East Terrace from open view point.



Fig. 20: Loro Park, view of one of the sleeping dens.

3.3 Method

This project was twofold, with the observation of the formation of a new bachelor group at Paignton Zoo (UK) in their early stages and the acquisition of behavioral data on selected social behaviors of the established group at Loro Park, Tenerife (Spain). The following paragraphs describe the applied methods at both locations.

All observations were made from the public viewing areas. The times of observations in all three zoological gardens add up to about 260 hours. The order of observation and time of the day was chosen, at random under constraints posed by zoo management. “To avoid observer bias, the order in which focal subjects or locations are sampled during each observation period should be randomized (Crockett, 1996).” However, this was not always possible, since the time when the animals had access to the enclosures varied for management reasons, such as cleaning procedures or when there were problems with the animals during a previous night.

The project started in April 1997 with the observation of the two silverbacks, Claus and Pertinax at the Cologne Zoo, while they were still part of a social group. This was done to become familiar with the animals as well as to obtain information on their behavioral patterns prior to their move to Paignton Zoo. During this time (08.04.1997 – 13.04.1997), *ad libitum* sampling (Altmann, 1974; Lehner, 1996; Martin & Bateson, 1993) was used to record the whereabouts of Claus and Pertinax and to develop an ethogram for this study to determine the various behavioral categories. A summary concerning the behavioral categories used during this research is denoted in Table 4. The descriptions of these behavioral categories are presented in more detail in the result section.

During the actual phase when the animals arrived at Paignton Zoo, *ad libitum* notes were taken on the reactions of the animals towards the new enclosure (22.04.1997 until 05.05.1997). A total of 65 hours was recorded using this method. Throughout this study, this method was applied to record seldom occurring events.

Data were also supplemented through additional information obtained from conversations with the staff.

Behavioral data were collected prior to and subsequent to the group formation. Data collection prior to the group formation took place from September - October 1997, by this time the animals had settled down. However, the silverbacks had been separated, only the juveniles stayed together all the time. Data collection post of the group formation took place in March – April 1998 after the introduction of the juveniles with one of the silverbacks. A behavioral check sheet was developed to record the behavioral categories as well the location of the individuals within the enclosure. Focal animal sampling was applied (Martin & Bateson, 1993) as the sampling method. During the recording sessions, the behavior of the focal animal was noted on a check sheet at predetermined sample points, every 30 seconds. Each focal animal was observed for 20 minutes during one session. A multi-function stopwatch with memory-timer and a headphone was used as the timing device. Martin & Bateson (1993) describe this recording method as “time sampling.” Lehner (1996) refers to this method as “instantaneous sampling.” A total of 110 hours, corresponding to 13120 scans, was collected using the above method at Paignton Zoo.

The all-male group at Loro Park, Puerto de la Cruz, Tenerife, was observed from June 1998 until September 1998. Continuous focal animal sampling (Altmann, 1974) was used to record all affiliative and agonistic interactions between the members of this group. Thus, all occurrence sampling for selected social behaviors was applied as sampling method; sampling rule was focal animal sampling (Martin and Bateson, 1993). For each individual, 84 sessions were recorded. Each session lasted for 10 minutes and an observation session for all six gorillas lasted for 1½ hour, including seven scan samples of the whole group. Hence, the whole group was observed for a total of 84 hours, 14 hours for each focal animal. For each individual, the rate per hour was calculated on with whom the individual was involved with, based on the total time each dyad was visible. Between samples, scan sampling was applied for the whole group to record the location of each gorilla. From June to September a total of 109

scan sessions for each animal was recorded. For the whole group 4578 scans were obtained.

As previously noted, *ad libitum* sampling was applied to record seldom occurring behaviors, such as the support of one male during agonistic encounters, to obtain information on whether individual males form coalitions. Additionally, eventual occurring aberrant or stereotypic behaviors were also recorded with this method. The group was observed 2-3 times a day; times were randomly determined to cover all times of the day while the animals were on display, usually from 9:00 am until 5:00 pm. As mentioned before, within each session, the order of observation of the focal individual had been determined before each recording session to reduce observer bias.

Table 4: Summary of the behavioral categories used during this study.

Note: All occurrences of social behaviors were recorded also at Loro Park.

Idle	Includes all behaviors and body postures in which the animals are inactive, such as sitting, squatting, lying down, sleeping.
Locomotion	Summarizes all forms of locomotion, such as quadrupedal or bipedal locomotion and climbing, if not part of any other social or non-social behavior.
Ingestion	Involves all food gathering and food intake activities.
Self-directed behavior	Includes behaviors directed to oneself such as scratching oneself, cleaning wounds, eliminating urin and feces, or autogrooming, when not expressed excessively.
Stereotypic and aberrant behaviors	Includes repetitive movements and undesirables behaviors, such as regurgitation and reinstion of food or other ingested goods, hair plucking, rocking and coprophagy.
Solitary Play	All playful activities expressed by one individual alone, such as summersaults, swinging, jumping, usually accompanied with a playface.
Object Play	Includes using objects as part of solitary play as well as object handling and manipulation.
Social Affiliative Behaviors	Playful and friendly activities involving two or more individuals, such as rough and tumble play, chasing each other, grooming other or being in body contact to each other.
Agonistic Behaviors	Includes display and apprehensive behaviors directed towards another gorilla in an aggressive context, such as hitting surfaces, bluff charge, chest beating displays.

3.3.1 Data Analysis

The *ad libitum* notes of the behaviors of the silverbacks before and subsequent to their move to Paignton Zoo were analyzed by dividing the total occurrences of social behaviors (e.g. agonistic behaviors) by the total observation time for each interacting pair, resulting in a rate per hour. The data obtained by scan sampling were analyzed by calculating the proportions of each behavioral category for each of both phases. Every time a focal animal was not visible or not clearly seen by the observer, it was scored as “out of sight.” The proportions for each behavioral category were then calculated by dividing the number of scans for a particular behavior by the total number of scans taken. Before this calculation, the number of scans for the “out of sight” category were subtracted from the total number of scans, resulting in the total number of scans when the animals were visible. These scans were then used to calculate the proportions each animal spent in the various behavioral categories. The final proportions were then transformed into percentages of time of observation. The data presented from the gorillas at Paignton Zoo, post group formation, denotes the sessions when all three gorillas were kept together. When applicable, time spent with certain behaviors when the juveniles were by themselves is shown.

Statistical analysis for the recorded behaviors at Paignton Zoo prior and post group formation was not conducted since both observation periods were separated by approximately five months. Any changes, which can be seen after the group formation (the actual introduction happened four weeks prior to the data collection) might be related to the ontogenetic development of the juvenile gorillas, independent changes in their daily routine during data collection and the new situation for Avahli.

For analysis of the all occurrence data of selected social behaviors of the all-male group at Loro Park, mean occurrences per hour were calculated by dividing the total number of occurrences of a particular behavior by the total number of hours that both members of an interacting pair were in sight. The time spent “out of sight” was subtracted from the observed time and the remaining time visible was used as the basis for the analysis.

For the analysis of the enclosure utilization at Loro Park, sessions where the individuals were not visible for all of the scans were excluded from the analysis, as mentioned previously. The calculated percentage of time visible is based on the actual visible scans. Thus, the total numbers of scans minus the scans for being “out of sight” were used for calculation.

For statistical analysis, non-parametric tests were applied to social affiliative and agonistic behaviors as well as enclosure utilization of the group at Loro Park. Mann-Whitney U test was utilized to test whether an individual’s overall score was significantly different from other group members, regardless of any partner involved, or to compare the interacting dyads with one another. This test compares the medians to test for significant differences. The Mann-Whitney U test is two-tailed and the level of confidence was set to 95% ($p < 0.05$) (Snedecor and Cochran, 1981). The statistical analysis was done with the statistical software SPSS 10.0 for Windows.