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Play Behavior in Infant Western Lowland Gorillas (*Gorilla gorilla gorilla*) at the Lincoln Park Zoo

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by

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ABSTRACT

An ethological investigation was made on a group of western lowland gorillas (*Gorilla gorilla gorilla*) at the Lincoln Park Zoo, Chicago. Focal animal sampling and all-occurrences sampling were used to collect data during the months of June and July 2000. Qualitative observations were made of the general behavioral patterns of the group, which included feeding and drinking behavior, resting, sleeping, nest construction, grooming behavior, group behavior, dominance hierarchies, zoo-keeper and public oriented behavior, and behavior in novel stimuli situations. Except for female dominance hierarchies, all behavioral patterns were found to be similar to those reported for feral gorillas.

The primary focus of this study was on play behavior in infant western lowland gorillas. Play was categorized into three types: solitary play, social play, and mother-infant play. In my study group, age, gender, and type of rearing had no influence on the percentage of time spent by each individual in these three play categories. All of the infants spent most of their time engaged in solitary play and social play. Mother-infant play was found to be almost non-existent by the time a gorilla infant reached two years of age. Social play peaked during the early afternoon and consisted mainly of contact play. Infants spent a greater amount of time engaged in object play, as compared to locomotor and self-directed play.

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INTRODUCTION

The gorilla (*Gorilla gorilla*) has been the subject of scientific study for many decades. From the time when humans first caught sight of a gorilla in the early 1800s to 1930 when Robert Yerkes began the first scientific study of apes, people have been trying to comprehend the nature of this gentle nonhuman primate. There are three subspecies of gorilla, all with some morphological variations owing to the different habitats in which they live. They are the mountain gorilla (*Gorilla gorilla beringei*), the eastern lowland gorilla (*Gorilla gorilla graueri*), and the western lowland gorilla (*Gorilla gorilla gorilla*). The lowland gorillas are relatively more arboreal, have shorter body hair, less expanded nostrils, a narrower chest, a less pronounced sagittal crest, longer arm limbs, and longer, narrower hands and feet (Fossey, 1983).

During the years 1959-1961, eminent American scientists, John Emlen and George Schaller, conducted the very first truly reliable field study of the mountain gorilla (*Gorilla gorilla berengei*) in the Virunga Volcanoes in Africa. Their research revealed a lot of information about the distribution of the mountain gorilla, the ecology of their habitat, their physical characteristics, population demographics, individual behavior and daily activities, social behavior and group structure, their response to the environment, and conservation needs and strategies (Schaller, 1963, 1965). In 1967, Dian Fossey established the Karisoke Research Center on the Virunga Mountains for the study and conservation of the mountain gorillas. She spent 15 years in the field, studying the

mountain gorillas of the Virunga Volcanoes, thus giving the scientific society tremendous insight into the animals that Fossey considered the "greatest of the great apes" (Fossey, 1983). Her book, "Gorillas in the Mist," reveals innumerable aspects of the anatomy, physiology, ecology, and behavior of the mountain gorilla (Fossey, 1983). After the pioneering work of Yerkes, Emlen, Schaller, and Fossey, interest in all three sub-species of gorillas continued to be strong and a natural history of the gorilla was compiled by Dixson (1981), which included their classification, distribution, behavior, ecology, reproduction, and infant development.

The native habitat of the western lowland gorilla is the equatorial jungles of western Africa, ranging from the Congo River basin to southeast Nigeria. It is the smallest and the most numerous of the three subspecies of gorilla. The male weighs around 300 pounds, and the female weighs about 150 pounds (Napier and Napier, 1985). Western lowland gorillas mostly feed on shoots, stems, leaves, and bulbs in their habitat of secondary forest. Fruits form about two percent of their diet. They occasionally eat a few grubs and slugs. If they need extra nutrients, they eat soil rich in calcium and potassium. Coprophagy has also been recorded both in the wild and in captivity, and this has been concluded to be the result of poor weather conditions and/or restricted movements (Stewart and Harcourt, 1987). Akers and Schildkraut (1985) found that coprophagy occurs at a higher frequency in captivity (to the point of it being considered as an aberrant behavior) owing to constraints on movement and foraging.

Gorillas in the wild spend a major portion of their day foraging and travel approximately one kilometer each day in search of food. Since they get the water they

need from their food, gorillas in the wild rarely drink. They are basically terrestrial quadrupeds and move about using a type of locomotion that has been termed as "knuckle-walking." Though they do not show much arboreal activity due to their body size, they sometimes climb trees to feed and nest. During aggressive displays, gorillas exhibit short bouts of bipedalism (Schaller, 1963).

Gorillas also spend a lot of time resting. They construct fresh nests made of leaves and branches to sleep in during the night and for mid-day naps (Dixson, 1981). Nests are not used more than once because the gorillas defecate in them before moving on. Gorillas communicate by a wide variety of vocalizations. Sixteen different vocalizations have been recorded, which include a variety of screams, grunts, cries, roars, and chuckles. Visual displays including gestures, body postures, and facial expressions have also been noted. Chest beating and a strutting walk are common threat displays (Fossey, 1983).

Gorillas are extremely social animals and live in one male-multi female non-territorial groups, consisting of 10-15 animals. The family is led by the dominant silverback male. He is the oldest male in the group and is called a silverback because he has silvery gray hairs down his back and rump. He is responsible for the safety of the group, maintains group harmony, and leads the animals to good foraging sites. The silverback gets the first choice of mates and food. One or two immature males called blackbacks are also present in the group. They might be the sons or brothers of the silverback and help him during aggressive inter-group encounters. They usually stay at the periphery of the group. As they mature, they leave and travel in bachelor bands for sometime before forming families of their own (Schaller, 1963). The rest of the family consists of some adult

females and their offspring. Females that have been born in the family transfer out of their natal groups once they reach sexual maturity to avoid inbreeding (Stewart and Harcourt, 1987).

The gorilla is considered to be endangered throughout its range in the wild mainly due to habitat destruction, human population growth, and poaching (Fossey, 1983). Currently, there are fewer than 50, 000 lowland gorillas remaining in the wild. Fewer than 250 mountain gorillas remain in the Virunga mountains, Rwanda. Although several studies have been conducted on wild mountain gorillas, there are no mountain gorillas in captivity today. For the last few decades, captive lowland gorillas (in particular the western lowland gorillas) have been the subject of intense scientific study and several research papers have been published in the last two decades. A few of those relating to infants and infant development are briefly discussed below.

Non-social behavior of captive infant western lowland gorillas was studied by Kenneth Gold (1992). He found that the activity of infant gorillas peaked during the morning hours. Older infants were more active than younger ones, with higher average frequencies of locomotion. He also found that male infants showed a lesser degree of self-directed behavior than females. This may indicate that male infant gorillas engage in more social than non-social activities compared to females. Infants raised in a non-enriched environment were found to rest for a significantly large portion of their time. Infants raised by humans showed less exploration of the environment, less resting behaviors, and more self-directed and display behaviors than those infants raised by

natural mothers. One of the conclusions drawn from this study was that natural mother rearing of infants is essential for completely normal behavioral development.

Hoff, Nadler, and Maple (1981) studied the development of infant independence in captive western lowland gorillas. They found that as the infants grew older, mother-infant proximity and contact decreased. For the first few months after birth, the mothers showed a greater responsibility towards maintaining contact with the infant. As it grew older, the infant was responsible for any contact with the mother. An increase in the frequency of manipulation of objects also indicated that as the infant grew more independent, its attention was shifted away from the mother and towards the external environment.

Jendry (1996) found that using older female gorillas as surrogate mothers was effective while trying to integrate infants raised by humans into pre-established captive gorilla groups. Using a surrogate mother increases the chances that the infant will thrive well in a social group, and be accepted by other members of the group.

Enciso, Calcagno, and Gold (1997, 1999) studied social interactions between captive infant western lowland gorillas and the silverback male leader of the group. It was found that the infants were almost always initiating encounters with the silverback, and not the other way around. It was also found that the silverback showed greater tolerance towards his own offspring as compared to unrelated infants. Similarly, unrelated infants were the target of aggressive displays by the silverback, whereas no such agonistic behavior was ever seen to be displayed towards offspring. The data were, thus, supportive of the kin-selection hypothesis for male parental behavior. A male seems to have stronger bonds

with his own offspring, and this may indicate that the male indirectly wants to maintain a relationship with the infant's mother, to ensure future mating success.

Hoff, Forthman, and Maple (1994) studied interactions of captive infant western lowland gorillas in an indoor exhibit as compared to an outdoor display. Housing conditions were found to significantly affect behavior. They found that the infants indulged in more object play, solitary play, and environmental exploration in the outdoor exhibit. Mothers and infants spent a greater amount of time together in the indoor exhibit. A greater number of aggressive displays were found to occur indoors.

Apart from being places for scientific study, zoological parks have played an important role in ensuring the survival of the western lowland gorilla. To successfully maintain captive populations, zoos must make sure that the animals are physically healthy, exhibiting normal behavioral patterns, in order to mate and produce healthy offspring (Ogden et al., 1990). The well-being of captive gorillas depends not just on their physical and social environment. Research being conducted on how to better their physical and psychological state, gives us insight on whether gorillas are thriving in captivity or not. There are several ways to monitor "normal behavioral patterns." One such way is to look at the behavior and development of infants, in particular their play behavior. Since infant gorillas spend a major portion of their time playing, play behavior is a strong indicator of their normal development. Playing enables the individual to acquire strength, endurance, and coordination, and to explore the environment. It is important in developing social skills, and helps in maintaining social bonds. A common theory for the adaptive significance of play is that it gives an individual an opportunity to

gain skills essential for later survival, like agonistic (fight or flight responses), reproductive, epimeletic (care-giving) behaviors, and affiliative behaviors like grooming (Goodenough et al., 1993, Dolhinow, 1999). Finally, the very quality of the play behavior exhibited can be used to judge the adequacy of the environment provided to captive gorillas (Maple and Hoff, 1982).

The development of infant play in a captive group of western lowland gorillas was studied by Hoff, Nadler, and Maple (1981). They studied a pattern longitudinally over the first one and a half years of life of three infant gorillas and found that the developmental trend of play behavior showed the following order as age progressed: mother-infant play, solitary play, and social play. They also suggested that there might be some differences in social play with respect to gender, with more male involvement in rough and tumble play.

Although several studies have been conducted on wild and captive infant gorillas, very little research has been done on infant play behavior, and the few studies that have been conducted in the past do not provide much quantitative data (Hoff et al., 1981). My research was intended to supplement the limited data available on this topic. The focus of my research was on play behavior in captive infant western lowland gorillas at the Lincoln Park Zoo, Chicago. The objectives of my study were to:

1. Make qualitative observations of general behavioral patterns of the gorilla group, including feeding and drinking behavior, resting, sleeping, nest construction, grooming behavior, dominance hierarchies, zoo-keeper and public oriented behaviors, and behavior in novel stimuli situations.

2. Identify main forms and aspects of play behavior in captive infant western lowland gorillas, like solitary play, social play, and mother-infant play.
3. Determine variations in infant play behavior with respect to differences in age, sex, time of day, and type of rearing (natural versus surrogate mother).
4. Delineate future lines of research on this topic of play behavior in captive infant western lowland gorillas.

METHODS

My research was conducted at the Lincoln Park Zoological Gardens, Chicago, Illinois. The Lincoln Park Zoo has been a significant participant in the Western Lowland Gorilla Species Survival Plan since 1970. It is called the "Gorilla Capital of the World" because more than 40 gorillas have been born in captivity at the Lincoln Park Zoo, and the zoo has also transferred individual gorillas and entire groups to other accredited zoos across the country. The 15 gorillas at Lincoln Park Zoo live in the Great Ape House and are divided into two groups. One group consists of four adult gorillas. The other group, my study group, consisted of five infants, five adult females, and one silverback male. The infants in this latter group were the primary focus of my study. Observations were conducted in the months of June and July 2000.

STUDY GROUP

The leader of the group under study was a 36-year-old silverback male called Frank. A heavyweight of over 300 pounds, Frank was born in Africa and arrived at Lincoln Park Zoo when he was two years old.

Debbie was a 34-year-old female who was also born in Africa and was brought to the Lincoln Park Zoo when she was six months old. She has been unable to reproduce, but has successfully foster reared many infants. During my study, she was acting as a surrogate mother to siblings Rollie and Mumbali.

Except for Frank and Debbie, the rest of the gorillas in the study group were born in captivity at the Lincoln Park Zoo. Table 1 shows the name of each animal with its sex, date of birth, age at time of study, and parentage (if either parent was a member of the group at the time of this study).

STUDY SITE

The Great Ape House at Lincoln Park Zoo consisted of four indoor displays, two for the gorillas and two for chimpanzees. The group studied was housed in Indoor Display 1, which consisted of two huge glass-walled enclosures, that were interconnected so that the gorillas could freely move about. Apart from incandescent lighting, the ceiling was made of frosted glass to let in some natural sunlight. Sometimes part of the roof was opened to let in some fresh air. The floor was covered with straw. Food was hidden under the straw to enable foraging. The following accessories were provided: one cloth hammock, four green metal "trees," four metal platforms and two large plastic bins hanging from the ceiling at different levels, several ropes and rope grids, and several large yellow concrete platforms on the ground. A few hidden platforms were also provided, where the gorillas retreated during cleaning and feeding. The gorillas were also provided with thick telephone directories, burlap sacks, cardboard boxes, and other items as play objects.

During nice weather, the gorillas had access to an outdoor enclosure. The outdoor enclosure was planted with suitable greenery and had a hammock, two metal "trees," and several logs and rocks.

Table 1. Western lowland gorillas observed at the Lincoln Park Zoo showing name, sex, date of birth, age at time of study, and parentage (if either parent was part of the group during time of study).

Name	Sex	Date of birth	Age at time of study (years)	Parentage
Frank	Male	1964	36	Feral born
Debbie	Female	1966	34	Feral born
Makari	Female	July 12, 1987	~13	-
Bulera	Female	Jan. 22, 1989	~11	-
Bahati	Female	Sept. 20, 1990	~10	-
Tabibu	Female	April 30, 1992	~8	-
Madini	Female	June 20, 1996	4	Mother: Bulera Father: Frank
Rollie	Female	Oct. 3, 1996	3.7	Fostermother: Debbie
Jelani	Male	Jan. 6, 1997	2.4	Mother: Makari
Mumbali	Female	Dec. 7, 1997	2.5	Foster mother: Debbie
Bengati	Male	June 1, 1998	2	Mother: Bahati Father: Frank

Like all other accredited institutions, the Lincoln Park Zoo followed a daily feeding schedule as is found exhibited by the gorillas in the wild. In the mornings, the animals were moved off exhibit to enable zoo-keepers to clean the displays and spread food around and under fresh straw. Various kinds of fruits and vegetables including apples, carrots, sweet potatoes, and celery stalks were hidden underneath the straw to enable the animals to forage for their food. Fresh leaves and shoots were also scattered about. Certain biscuits, called leaf-eater biscuits, were also provided daily for protein and extra nutrients. Food was spread out for a second time during the early afternoon, too, and the gorillas were taken off exhibit while this was being done. Vitamin pills were supplied daily. Water was provided by a small faucet on the floor of the exhibit.

SAMPLING METHODS

Two sampling methods were used to observe individual animals, as well as groups of animals and dyads. They were focal animal sampling and all-occurrences sampling (Altmann 1974). In focal animal sampling, one individual was the focus of all observations of all behaviors during a particular sample period. I used this method to gain information about percentage of time spent on a particular activity and durations of certain activities. The sample period I used was 15 minutes for each focal-animal each day.

In all-occurrences sampling, the focus was on one or a limited number of behaviors. All occurrences of the play behavior of one animal were recorded during a particular sample period. The type of information provided by this method included frequencies of

occurrence of particular behaviors. The sample period selected was 15 minutes for each animal each day.

The observations were made at different times each day. The order of the sampling methods used and the order in which the individuals were observed were varied each day to ensure as much randomness in the samplings as possible. The stopwatch feature of a digital wrist watch was used to record the time.

ETHOGRAM

For use in data collecting, an ethogram was compiled based upon reconnaissance observations and literature reviews (Bowen, 1980, Brown, 1988). Play behavior was divided into three main categories of solitary play, social play and mother-infant play. To make observations more complete, three other categories of public and zoo-keeper oriented behavior and a "not visible" category were included. Finally, all remaining behavioral patterns were grouped into an "other" category. Table 2 shows a condensed version of the ethogram used during the study.

STATISTICAL TESTS USED DURING DATA ANALYSIS

The statistical tests performed on the data were the Kruskal-Wallis ANOVA by ranks test, the Wilcoxon matched pairs test, and the Mann-Whitney U test. The type of data on which these tests were performed is discussed later in the Results section of this thesis.

Table 2. Behavioral categories and their definitions

Behavioral category	Definition
Solitary play	All play behaviors which are not directed towards other group members.
Rotational or locomotor play	Twirl--spinning around bipedally. Somersault--turning the body one full or partial rotation head over heels. Roll--turning the body from side to side while supine. Run--loose limbed gait, usually bipedal.
Object play	Playing with and manipulating external objects using hands, feet, and/or mouth.
Self-directed or self play	Includes patting or pulling of body parts like arms, legs, toes, fingers, face, and chest; clapping hands.
Social play	All play behaviors directed toward other members of the group (except the mother). This includes wrestling, chasing, playing at trains (two or more individuals walking one behind the other while holding onto the shoulders or waist of the preceding animal), and piggyback-riding.
Mother-infant play	Play between mother and infant.
Public oriented	Gazing at the public, pounding on the glass walls.
Zoo-keeper oriented	Putting fingers through the enclosure to touch keepers; soliciting grooming from the keepers.
Not Visible	Animal was out of the observer's sight.
Other	Behavior patterns not included in the defined behavior categories.

RESULTS

GENERAL BEHAVIORAL PATTERNS OF THE GROUP

Feeding and Drinking Behavior

Each day, after the zoo-keepers cleaned the displays and distributed fresh straw and food, the gorillas were let back into the exhibit. They started feeding intensively at once. They foraged in a leisurely fashion, sometimes sitting, and sometimes walking about. Usually, the gorillas sat and reached for food in all directions. Some gorillas would take food to a platform or to the top of a "tree" to eat. Sometimes a gorilla would take food away from another animal (though never from the silverback), but usually the "thievery" went unnoticed, without any aggressive displays. The feeding activity slowed as the morning progressed, though one infant, Rollie, was seen to eat and forage for a longer period of time, compared to the rest of the group. In the early afternoon, the gorillas were taken off exhibit so that the zoo-keepers could enrich their environment. When they were let back in, the same intense feeding activity ensued. The silverback male always had the first choice of any food item. On three or four occasions, whole branches of leaves were provided, and the gorillas would strip the leaves off by hand, before consuming them. Whenever paper bags and cardboard boxes were provided, those were eaten too. Apples and sweet potatoes seemed to be the preferred food items.

As mentioned before, the gorillas were provided with a small water faucet on the floor of the exhibit. The gorillas would either put their mouths directly over the water source

and suck, or they would lick water from the runoff, or they would scoop water up with one cupped hand and drink from the palm.

The two and three year olds nursed two or three times each day. Nursing was always initiated by the infant and lasted for three to five minutes each time. Nursing was always terminated by the mother.

Resting, Sleeping, and Nest Construction

The gorillas rested or took naps during the early afternoon. Nests were made with the straw. Some of the gorillas just padded straw under themselves and slept on the floor. More commonly, huge armfuls of straw were carried up into the "trees" or onto platforms, where the straw was spread out before the animal lay down. Infants almost always slept/rested near their mothers.

Grooming Behavior

All animals were observed to frequently groom themselves. Arms and legs were the main areas that were groomed. Fingers, and sometimes the mouth, were used to part hair while picking out any debris or ectoparasites from the skin. Sometimes, the debris were examined and eaten. Only in a couple of instances did one adult female groom another. The silverback neither groomed others nor was groomed himself. Mostly, the mothers were seen grooming their infants and occasionally other unrelated infants, too. Debbie and Bulera were never observed groom their infants. Grooming was always initiated by the mother and terminated when the infant moved away. On some occasions the infants

would groom their mothers for three to four minutes. Infants were never observed to groom one another.

Group Behavior and Dominance Hierarchies

The dominant male was Frank, the silverback leader of the group. It was very apparent that he controlled the group. Whenever a fight erupted among the females, Frank was seen to charge at them and break up the quarrel. On one instance, he made an aggressive charge towards two squabbling females, Makari and Bahati. Bahati escaped up a tree, but Frank charged at Makari and pushed her to the ground, where she lay submissively for 15 minutes, even after Frank had retreated. Frank was fairly tolerant towards the youngsters. On two or three occasions, Bengati was observed to ride on Frank dorsally for one or two minutes, before jumping down.

Among the females, Debbie, the oldest, was the dominant one. On two occasions she was observed to rise and stare at Tabibu and Bahati, who had been squabbling, upon which, the two females stopped being aggressive. Fighting among females was not very common and was usually instigated when a female ran past and "whacked" an unrelated infant. Then, the mother would charge to protect her young. On four or five occasions a longer chase was observed. At the beginning of the study, Tabibu was observed to start most occasions of conflict, mainly by teasing an infant, but this behavior seemed to reduce towards the later part of the study. No discernible dominance hierarchy was observed among the infants.

Keeper-Oriented Behavior

The gorillas were observed to be friendly towards their keepers. Whenever a keeper appeared near their exhibit, most of them would run to him/her. Sometimes, the adults presented their backs to the keepers for a scratch. Frank was observed to present his back the keepers for a scratch almost everyday. Sometimes, the animals would want their fingers to be touched. The vitamin pills were supplied in the order of the dominance hierarchy, Frank first, and then the females and infants. They either took the pills by hand, or directly by mouth.

Public Oriented Behavior

Frank was observed to charge towards the glass once or twice when visitor numbers were high. On several occasions, Bahati, Makari, and all the infants were observed to run towards the glass and pound on it with their hands. On the whole, the animals did not seem too disturbed by the public and carried out their normal daily routine. Tabibu and some of the infants were observed to put their hands upon the glass if a visitor's palm was on the glass too.

Behavior in Novel Stimuli Situations

During my observation period, the zoo-keepers introduced some novel stimuli situations to see how the animals reacted. On one occasion, loud "jungle" sounds were simulated, with noises of thunder, the chattering of monkey, roars of wild beasts, and the loud cries of birds. Three or four minutes of this noise was followed by three or four

minutes of some peaceful classical music. The gorillas were observed to be initially very disturbed by the jungle simulation. The infants ran to their mothers, who tried to get as close to Frank as possible. Frank exhibited some amount of chest-beating, but mostly stayed at the far end of the display, where the keepers usually appeared. When the classical music pieces were played, the animals visibly clamed down, and went about their normal routine. This went on for a half hour, after which the animals, including the infants, did not seem to be disturbed by the recording of the jungle simulation.

On one occasion, the keepers spread ice-cubes around the exhibit. The gorillas seemed puzzled at first. They tried to get hold of the slippery ice-cubes, which just slid away. The infants tried licking them. The adults seemed to lose interest in the ice-cubes in two or three minutes and started feeding. The infants continued to play with the ice-cubes until the ice melted.

Towards the end of my observation period, the gorillas were presented with a mirror outside their exhibit for an hour or so each day. All the animals seemed to take a keen interest in the mirror initially. They would stand in front of the mirror and stare at their reflections. They would push each other out of the way to get in front of the mirror. Frank was observed to charge at it once, but after sometime, the adults' interest in the mirror waned. Tabibu and the infants, however, continued to show a strong interest in the mirror. Tabibu started to throw straw around while looking into the mirror. The infants pushed each other away and seemed to like to stare at their reflections.

On one occasion, some people visited the non-public portion of the gorilla exhibit. When they approached the display from where the keepers usually approached, some of

the adults, including Frank, were observed to charge at the visitors, with some chest-beating.

PLAY BEHAVIOR

Individual Differences in the Amount of Time Spent in Different Types of Play Behavior

Solitary Play

A Kruskal-Wallis ANOVA by ranks test was used with the individual infants as the independent variables, and the time spent in solitary play as the dependent variable (Table 3). There was no significant difference in the amount of time spent in solitary play by each individual at the $\alpha = 0.05$ level of significance.

Social Play

A Kruskal-Wallis ANOVA by ranks test was used with the individual infants as the independent variables and the time spent in social play as the dependent variable (Table 3). There was no significant difference in the amount of time spent in social play by each individual at the $\alpha = 0.05$ level of significance.

Mother-Infant Play

A Kruskal-Wallis ANOVA by ranks test was used with the individual infants as the independent variables and the time spent in mother-infant play as the dependent variable (Table 3). There was no significant difference in the amount of time spent in mother-infant play by each individual at the $\alpha = 0.05$ level of significance.

Table 3. Statistical analysis of solitary, social, and mother-infant play behavior with the five individuals as the independent variables.

Variable	Mean	H*	df	p-value
Solitary Play		1.46	4, 105	> 0.05
Individual				
Bengati	2.65			
Jelani	2.13			
Mumbali	1.74			
Rollie	1.25			
Madini	1.79			
Social Play		7.96	4, 105	> 0.05
Individual				
Bengati	3.64			
Jelani	2.77			
Mumbali	1.90			
Rollie	1.75			
Madini	1.04			
Mother-infant Play		14.53	4, 105	> 0.05
Individual				
Bengati	0.29			
Jelani	0.39			
Mumbli	0.00			
Rollie	0.00			
Madini	0.00			

* Kruskal-Wallis ANOVA by ranks test

Time spent in each type of play behavior by the entire group of infants as a percentage of the total number of hours observed for play was calculated. The percentage of time spent in solitary play was found to be 43.31%; in social play, 53.49%; and in mother-infant play, 3.20%.

A Kruskal-Wallis ANOVA by ranks test was made with the three types of play behavior as the independent variables and the number of minutes spent in each play category as the dependent variable (Table 4). There was a significant difference in the amount of time spent by all five individuals in solitary, social, and mother-infant play at the $\alpha = 0.05$ level of significance.

Since the time spent in mother-infant play represented only 3.20% of the total time observed for play behavior, whereas times spent in solitary and social play were of similar order of magnitude, it was decided to conduct a Mann-Whitney U test with solitary and social play behaviors as the independent variables and the number of minutes spent in those two play categories as the dependent variables (Table 5). There was no significant difference in the amount of time spent in solitary and social play by all five individuals at the $\alpha = 0.05$ level of significance.

Differences in Play Behavior at Different Times of the Day

The day was divided into three blocks of time: morning (1100 to 1300 hours); early afternoon (1300 to 1500 hours); and late afternoon (1500 to 1700 hours). To determine whether there were any differences in play behavior at varying times of day, a Kruskal-Wallis ANOVA by ranks test was used with the different time blocks as the independent

Table 4. Statistical analysis of time spent in each of the three categories of play behavior (solitary, social, and mother-infant play) with the five individuals as the independent variables.

Variable	Mean	H*	df	p-value
Behavior Category		73.05	2, 315	< 0.05
Solitary Play	1.29			
Social Play	2.21			
Mother-infant Play	0.13			

*Kruskal-Wallis ANOVA by ranks test

Table 5. Statistical analysis of time spent in solitary and social play behaviors with the five individuals as the independent variables.

Variable	Mean	N	U *	Z	p-value
Behavior Category			5102.00	0.97	> 0.05
Solitary Play	1.79	105			
Social Play	2,21	105			

* Mann-Whitney U test

variables, and the time spent in each of the three main play categories (solitary, social and mother-infant) by all five infants as the dependent variables. The following results were obtained (Table 6).

There was no significant difference in the amounts of time spent in solitary play at the different time periods at the $\alpha = 0.05$ level. There was a significant difference in the amounts of time spent in social play at the different time periods at the $\alpha = 0.05$ level of significance. There was no significant difference in the amounts of time spent in mother-infant play at the different time periods at the $\alpha = 0.05$ level of significance.

Solitary Play

There were three main categories of solitary play behavior: rotational/locomotor play, object play, and self-directed play. To determine whether there was a significant difference in the frequencies of occurrence of these three types of solitary play in all five infants combined, a Wilcoxon matched pairs test was used with pairs of play behaviors as the independent variables and the frequencies of their occurrence as the dependent variables (Table 7). The following results were obtained.

There was a significant difference in the frequencies of occurrence of rotational play and object play at the $\alpha = 0.01$ level of significance. There was no significant difference in the frequencies of occurrence of rotational play and self play at the $\alpha = 0.01$ level. There was a significant difference in the frequencies of occurrence of object play and self play at the $\alpha = 0.01$ level of significance.

Percentage of time spent in each of the three sub-categories of solitary play for all five

Table 6. Statistical analysis of time spent in solitary, social, and mother-infant play behaviors during morning, early afternoon, and late afternoon.

Variable	Mean	H*	df	p-value
Solitary Play		0.78	2, 105	> 0.05
Time of Day				
Morning	2.09			
Early afternoon	1.75			
Late afternoon	2.06			
Social Play		7.44	2, 105	< 0.05
Time of Day				
Morning	2.68			
Early afternoon	2.53			
Late afternoon	0.60			
Mother-infant play		0.23	2, 105	> 0.05
Time of day				
Morning	0.23			
Early afternoon	0.10			
Late afternoon	0.02			

* Kruskal-Wallis ANOVA by ranks test

Table 7. Statistical analysis of the frequencies of occurrence of rotational and object play (set # 1); rotational and self-directed play (set # 2); and object and self-directed play (set # 3).

Variable sets	Mean	N	T *	Z	p-value
Set # 1		21	5.50	3.71	< 0.01
Rotational play	1.24				
Object play	6.62				
Set # 2		21	51.0	0.09	> 0.01
Rotational play	1.24				
Self-directed play	1.10				
Set # 3		21	0.00	4.01	< 0.01
Object play	6.62				
Self-directed play	1.10				

* Wilcoxon matched pairs test

infants was found to be as follows: rotational play-- 4.01%; object play-- 91.94%: self play-- 4.05%.

Social Play

There were two main types of social play behavior (contact and non-contact play). To determine whether there was any significant difference between the frequencies of occurrence of contact play and non-contact play in all five individuals combined, a Wilcoxon matched pairs test was used (Table 8).

There was a significant difference in the frequencies of occurrence of contact play and non-contact play at the $\alpha = 0.01$ level of significance. Percentage of time spent in contact play was found to be 90.62%.

Contact play occurred mainly in the form of wrestling To determine whether there was any difference in the duration of a wrestling bout between the two age groups (group A-- 2 to 2.5 years; group B-- 3.5 to 4 years), a Mann-Whitney U test was used. The dependent variable was the duration of a wrestling bout and the independent variables were the two groups. There was no significant difference in the average duration of a wrestling bout for the two age groups at the $\alpha = 0.05$ level of significance (Table 9). The average duration of a wrestling bout was found to be 2.08 minutes.

Table 8. Statistical analysis of the frequencies of occurrence of contact play and non-contact play.

Variables	Mean	N	T*	Z	p-value
		21	14.0	3.40	< 0.01
Contact play	6.05				
Non-contact play	1.48				

* Wilcoxon matched pairs test

Table 9. Statistical analysis of the duration of a wrestling bout for two different age groups (group A--2 to 2.5 years; group B-- 3.5 to 4 years).

Variable	Mean	N	U*	Z	p-value
			95.00	1.91	> 0.05
Group A	2.59	18			
Group B	1.53	17			

*Mann-Whitney U test

DISCUSSION

Most of the general behavioral patterns of my study group at Lincoln Park Zoo were similar to the behavior exhibited by wild gorillas. Food was made available to the group in the morning and early afternoon, so that the gorillas could follow a schedule of feeding that was similar to that followed in the wild. Schaller (1963) observed that the main feeding bouts in wild gorillas occurred during the morning hours (0700 to 1000) and the afternoon hours (1400 to 1700). The way my study group foraged was also similar to foraging activities in the wild (Schaller, 1963). The gorillas foraged in a relaxed fashion, sitting and reaching out for food in all directions, and moving when all the food material within reach was eaten. Feral gorillas have never been observed to drink water, presumably because the water they need comes from the food they eat. Captive animals have been observed to drink water in several ways, either by sucking water directly from the source, or by scooping up water in a cupped hand and drinking from it (Schaller, 1963). The gorillas in my study group drank water in a similar fashion. The two-year-old and three-year-old infants were observed to nurse two or three times each day. Nursing was always initiated by the infant and terminated by the mother. Studies in the wild have shown that infants continue to nurse this way until the mother gives birth again (Fossey, 1983).

It has been demonstrated that nesting behavior in gorillas is an innate activity (Fossey,

1983). From my observations, it seemed that nesting behavior was instinctive, rather than learned, because even though most of the subjects were born in captivity, all of them tried to construct nests of some sort from the straw provided for sleeping and resting purposes.

My observations of grooming behavior were consistent with what Schaller (1963) found among feral gorillas. In my study, only one adult female was observed to groom another; she did so twice. None of the females were ever observed to groom the silverback. Most of the grooming sessions involved the mother grooming her infant. Grooming was always initiated by the mother and terminated by the infant.

As in wild situations, the silverback was the leader of my study group. Dominance hierarchies among females, however, differed from those in the wild. Rank order in feral female gorillas depends on the order in which the females are acquired by the silverback (Fossey, 1983). In my study group, the dominant female was Debbie, the surrogate mother. Her dominant status might have been due to the fact that she was substantially larger in size and older than the other females. Among the other females, the ones with the youngest offspring were the most dominant. This might have been so because in the captive environment, the females were not "acquired" by the silverback male. Secondly, because the youngest infant in my study group was sired by the silverback, its mother might have gained a higher dominance position.

In my research, different types of play behavior were studied to compare possible differences between the five infants of varying ages. It was found that there were no significant differences in the times spent in the three main forms of play (solitary, social,

and mother-infant) by all five infants. From this it is clear that there was no significant variation in the times spent in the three main forms of play, not only with respect to age but also with respect to gender and type of rearing. The earlier study of play behavior by Hoff, Nadler, and Maple (1981) showed a variation in times spent in the three main forms of play behavior as age progressed up to 1.5 years; with the youngest infants spending most of their time playing with their mothers, older infants spending more time in solitary play, and still older infants spending more time in social play. From my results, it can be suggested that after two years of age, the amount of time spent in each of the three forms of play does not depend on age. My results for social play were consistent with Schaller (1963) who observed that equal proportions of infants (aged 0-3) and juveniles (aged 3-6) engaged in social play.

Since there was no significant difference in the amount of time spent in the three main types of play by different individuals, I calculated the percentage of time spent in each type of play behavior by the entire group of infants. The percentage of time spent in solitary play was found to be 43.31%; in social play, 53.49%; and in mother-infant play, 3.20%. These results agree with what Schaller (1963) observed. He found that infants engaged in solitary play 43.4% of the time. He also found that by the time infants are 21 months old, mother-infant interactions are restricted to sleeping in the same nest, nursing, and grooming. Therefore, it can be assumed that mother-infant play is almost non-existent after the infants progress beyond two years of age.

Play behavior at varying times of the day was studied to see if there were any differences. There was no significant difference in the amounts of time spent in solitary

play and mother-infant play at the different time blocks of morning, early afternoon, and late afternoon. There was a significant difference in the amount of time spent in social play at the different times of the day by all five individuals. It can be inferred that since the gorillas were feeding during the morning and late afternoons, early afternoon was the time when social play between infants peaked. These results are consistent with what Schaller (1963) observed. He found that after the morning feeding activity, the adults rested or slept, while the infants and juveniles played.

I categorized solitary play into three categories of locomotor play, object play, and self-directed play to determine if there were any differences in the amounts of time spent in each category by all five infants combined. There was no significant difference in the frequencies of occurrence of locomotor play and self-directed play. But there was a significant difference in the frequencies of occurrence of object play when compared to self-directed play and locomotor play. I calculated the percentage of time spent in these categories of play behavior by the entire group of infants. Since object play accounted for 91.9% of the observations of solitary play, it is clear that as wide a variety of objects as possible has to be made available to captive gorilla groups. Frequent changes can be made in the type of object provided, since the gorillas were observed to spend more time and be more interested in manipulating novel objects. It has been shown that play items have to be changed periodically, in order to prevent boredom and maintain good health in captive gorilla infants (Maple and Hoff, 1982). Manipulation of novel objects has been found to be crucial in the development of sensorimotor intelligence, coordination, and insightful problem-solving in infant gorillas (Gomez et al., 1999).

No gender differences were found with regards to the amount of time spent in self-directed play among the infants. This is in contrast to the observations of higher levels of self-directed behavior in female infants in a captive study conducted by Gold (1992).

I categorized social play into two main categories of contact play and non-contact play to determine if there was any difference in their frequencies of occurrence. There was a significant difference in their frequencies of occurrence, with the infants spending a greater amount of time engaged in contact play (mainly wrestling). Contact play accounted for 90.6% of the observations of social play by all five individuals combined. On average, the duration of a wrestling bout was found to be 2.08 minutes. There were no differences in the durations of a wrestling bout when two different age groups (group A-- 2 to 2.5 years; group B-- 3.5 to 4 years) were compared. Since there was a greater amount of social play and, in particular, contact play, it is very important to rear captive infants in the company of other infants and juveniles, as opposed to rearing an infant in a group consisting of the mother and other adults only. Fossey (1983) found that the absence of playmates deprived infants of many learning and socializing opportunities, resulting in delayed development of motor and social skills, growth retardation, atypical behavioral patterns, and a longer weaning period.

In conclusion, the study of infant gorilla play behavior with a view to understand and provide the optimum conditions required for their normal development in captivity is a worthy subject for continued research. Studies comparing feral and captive infant gorilla behavior will help in identifying any aberrant patterns of behavior in captivity. Studies involving the provision of a variety of play items to captive infant gorillas will be useful

in determining the type of play object necessary at each stage of infant development. Similarly, research involving the presence of peers can be used to monitor the degree of socializing seen in infants. The survival, physical, and mental health of future groups of captive gorillas will depend on such studies.

LITERATURE CITED

Akers, J.S. and D.S. Schildkraut. 1985. Regurgitation/reingestion and coprophagy in captive gorillas. Zoo Biology 4:99-109.

Altmann, J. 1974. Observational study of behavior: sampling methods. Behaviour 49: 227-267.

Bowen, R.A. 1980. The behaviour of three hand-reared lowland gorillas (*Gorilla gorilla gorilla*) with emphasis on the response to a change in accommodation. DODO 17:63-79.

Brown, S.G. 1988. Play behaviour in lowland gorillas: Age differences, sex differences, and possible functions. Primates 29(2):219-228.

Dolhinow, P. 1999. Play: a critical process in the developmental system. In: The nonhuman primates. (Ed. by Dolhinow, P. and A. Fuentes), pp. 231-236. California: Mayfield Publishing.

Dixson, A.F. 1981. The natural history of the gorilla. New York: Columbia Univ. Press.

Enciso, E.A., Calcagno, J.M., and K.C. Gold. 1999. Social interactions between captive adult male and infant lowland gorillas: implications regarding kin selection and zoo management. Zoo Biology 18:53-62.

------ 1997. Kinship and social interactions between captive adult male and infant lowland gorillas (*Gorilla gorilla gorilla*). American Journal of Physical Anthropology Supplement 24:107.

Fossey, D. 1983. Gorillas in the mist. Boston: Houghton Mifflin Company.

Gold, K.C. 1992. Nonsocial behavior of captive infant gorillas. Am. J. Primatol. 26: 65-72.

Gomez, J.C. 1999. Development of sensorimotor intelligence in infant gorillas: the manipulation of objects in problem-solving and exploration. In: The mentalities of gorillas and orangutans: Comparative perspectives. (Ed. by Parker, S.T.; Mitchell, R.W.; & H.L. Miles), pp. 160-178. Cambridge: Cambridge Univ. Press.

Goodenough, J.E., Mcguire, B., and R.A. Wallace. 1993. Perspectives on animal behavior. New York: John Wiley and Sons, Inc.

Hoff, M.P., Forthman, D.L., and T.L. Maple. 1994. Dyadic interactions of infant lowland gorillas in an outdoor exhibit compared to an indoor holding area. Zoo Biology 13:245-256.

Hoff, M.P., Nadler, R.D., and T.L. Maple. 1981. Development of infant independence in a captive group of lowland gorillas. Developmental Psychobiology 14(3):251-265.

----- 1981. The development of infant play in a captive group of lowland gorillas (*Gorilla gorilla gorilla*). Am. J. Primatol. 1(1):65-72.

Jendry, C. 1996. Utilization of surrogates to integrate hand-reared infant gorillas into an age/sex diversified group of conspecifics. Applied Animal Behavior Science 48:. 173-186.

Maple, T. L. and M.P. Hoff. 1982. Gorilla Behavior. New York: Van Nostrand Reinhold Company.

Napier, J.R. and P.H. Napier. 1985. The natural history of the primates. Cambridge: MIT Press.

Ogden, J.J., Finlay, T.W., and T.L. Maple. 1990. Gorilla adaptations to naturalistic environments. Zoo Biology 9:107-121.

Schaller, G.B. 1963. The mountain gorilla: ecology and behavior. Chicago: Univ. of Chicago Press.

------ 1965. The behavior of the mountain gorilla. In: Primate Behavior. (Ed. by DeVore, I.), pp. 324-367. New York: Holt, Rinehart, and Winston, Inc.

Stewart, K.J. and A.H. Harcourt. 1987. Gorillas: variation in female relationships. In: Primate Societies. (Ed. by Smuts, B.F.; Chaney, D.L.; Seyfarth, R.M.; Wrangham, R.W.; & T.T. Struhsaker), pp. 154-164. Chicago: Univ. of Chicago Press.