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SOCIAL FACTORS AND MOTHER-INFANT RELATIONSHIPS IN CYNOMOLGUS MACAQUES

ABSTRACT: *It is established that in females primates mother–infant relationships are dependent on such factors as age and sex of the infant, as well as on the maternal style. The role of social factors in the development of mother–infant relationships in 3 corral groups of cynomolgus macaques is discussed in this paper. The observations showed that in all three groups the relations of group members to mothers depended on the age of the infants. The frequency of aggression towards the mothers was minimal for females with newborns of 0–8 weeks, attained its maximal level for the females with infants of 9–16 weeks and subsequently lowered to medium level. The higher frequency of grooming of the mothers has been noted when the infants were not older than 8 weeks and the mothers significantly were more often subjected to grooming than groomed. Social rank of mothers influenced on the relationships between mothers and other members of the groups. It has been established that high-ranking females were subjected to attacks less often than medium- or low-ranking ones, and they were less often groomed. Inter-group differences in the character of relationships between mothers and other group members have been noted. These differences correlated with the extent of maternal care in mothers. The highest level of maternal care has been noted in the group with the highest level of aggression towards the mothers. In such groups mothers spend more time with their infants. In another group with relatively "smooth microclimate" mothers have been more confident than in the first one.*

KEY WORDS: *Maternal behaviour – Aggression – Inter-group differences – Mother's rank – Cynomolgus macaques*

INTRODUCTION

A number of investigations concerning the dynamics of mother–infant relationships in primates (Altmann 1980, Altmann, Altmann 1970, de Vore 1964, Fragashy, Mitchell 1974, Ransom 1981, Ransom, Rowell 1972, Rowell 1969) and also maternal style (Berman 1983, 1990, Fairbairns 1989) have been published. In our investigation mother–infant relationships were studied in cynomolgus macaques as a part of a whole system of social relationships of the group. At least, three important aspects of the above mentioned problem could be distinguished. The first aspect was the characteristic of mother–infant relationships in respect to establishment of kin relations. The investigation in the same direction includes the study of dynamics of transformation of mother–infant relationships into kin

relations between mother and offspring. The 2nd aspect was to study the interactions of group's members with mothers, the character of relationships between different rank mothers and group members. The 3rd aspect was to study the influence of social conditions (social microclimate) on the maternal behaviour. The attention was paid to the factors determining the relations of the group of monkeys with mothers and with their infants on one hand and how these relations influence the mother–infant relations on the other hand.

MATERIAL AND METHODS

The investigation was carried out in the monkey colony of the Institute of Medical Primatology RAMS (Sochi –

Adler, Russia), between 1983 and 1996. The subjects for this analysis were mothers in three groups of cynomolgus macaques (*Macaca fascicularis*) which were observed 7, 13 and 14 years respectively. The groups of monkeys were kept in standard corrals with the area of 200 m² with adjoining feeding areas and heated accommodations for sleeping and sheltering. All three groups were of similar structure and consisted of one adult male, 8–15 females and a certain number of juveniles and infants. All the animals were tattooed with an individual number. We used focal animal sampling methods (Altmann 1974). Mothers served as focal subjects for observations. The observations were started after infant's birth and lasted for 120 weeks. As a whole the behaviour of 32 mothers was investigated and each of the mothers had from 1 to 5 infants in the sample. Each mother–infant pair was observed once every week. The observations consisted of 30-minutes or 60-minutes data collection sessions during which the behaviour of the focal female was registered every 5 seconds. All the mother's interactions with the infant and other members of the group were recorded.

To reveal the role of social rank the mothers were divided into 3 categories: low-ranking, middle-ranking and high-ranking. Their relative rank varied respectively between 0–0.33, 0.34–0.66, 0.67 and more. The relative rank of mothers was calculated according to the formula n/N , where n – is the number of the monkeys submissive to the focal mother and N – the total number of monkeys in the group (Bramblett, Coelho 1981).

Statistical analysis of the results obtained has been performed using the Student's t-test (Lakin 1990).

RESULTS AND DISCUSSION

The analysis of mother–infant relations in the process of the development of kin relations has convinced us in the necessity to subdivide the period of 120 weeks after infant's birth into the periods of 0–8 weeks, 9–16 weeks, 17–26 weeks, 27–52 weeks, 53–78 weeks, and 79–120 weeks. Such division of the observational period was necessary taking into account the variations in infant's behaviour in different stages of ontogenesis as well as the differences in mother's behaviour directed to the offspring in different periods of time. The differences were manifested both in the duration of interactions and in their quality. The main maternal functions, consisting of meeting the infant's need in food, warmth, defence and social partnership, are performed in a different way and degree in the different periods of the infant's development.

Emphasising on the social function of maternal behaviour of the females, we may discuss not only the dynamics of such behavioural patterns as grooming, which is mostly of social significance, but also the whole complex system of mother–infant relationships. All the forms of maternal behaviour which are oriented to meeting the infant's needs – the food, warmth and defence, serve also

to the enforcement of the relations between mother and infant.

The first 8 weeks of the infant's life are a very important period for the enforcement of mother–infant relationships as well as for the normal dynamics of the infant's socialisation. During this period the mother is the single and the most important social partner for the infant. At the end of this period the time of mother–infant interactions decreased to 70% of the observational time, but the time of the infant's interactions with other members of the group increased. The decreasing of time of mother–infant interactions which was recorded with increasing of the infant's independence from mother was linked with the decreasing of time when the mother was occupied with meeting the infant's needs in food and defence.

The dynamics of interactions having mostly a social function only is very small. The time which the mother was occupied by grooming the infant remained 4% of the observing time during all the time of the infant's first year of life. The decreasing of this time to a level of 2% of the observing time was observed in the third half-year. The infants begin to groom their mothers at the age of 33 weeks in average. The beginning of the infant's second year of life is a period when mothers and infants exhibit elements of adult kin relationships. The infant does not need breast feeding any more. Mother–infant interactions in that period consist of mutual grooming, spatial proximity and the mother supporting the infant in conflicts with other non-kin-related monkeys. No significant changes in mother–infant interactions could be detected till the end of the infant's second year of life. We have therefore suggested that the main type of mother–infant relations characteristic of kin relations is established during the second year of life.

Infant's age and mother's interactions with other members of the group

In our investigation all the mothers were members of stable groups of monkeys, where the mothers occupied some positions that developed during the female's life. The development of mother–infant relationships took place in a definite social environment whose influence depended on the infant's sex, age and the mother's social position. We detected that in cynomolgus macaques the age of the infant influences not only the mother–infant relationships, but also the relations and interactions between the mother and other members of the group. Table 1 shows the tendencies of changes in aggressive and friendly mother's interactions conditioned by the age of the infants.

The frequency of aggression directed towards the 9–16-week-old infants' mothers was the highest in comparison with the mothers of differently aged infants. Aggression initiated by the 9–16-week-old infants' mothers towards other members of the group was also most frequently observed. The mothers with the youngest infants (0–8-week-old) received grooming more frequently than mothers of differently aged infants. All the mothers performed aggression more frequently than they received attacks from

TABLE 1. Mean values of interactions of the mothers with group's members (frequency per hour).

Age of the infant (weeks)	Aggression received by the mothers	Aggression performed by the mothers	Grooming received by the mothers	Grooming performed by the mothers
0–8	0.76*	1.03*	6.94*	1.62*
9–16	1.58*	2.56	4.57*	4.00
17–26	0.59	1.90	5.74*	4.82
27–52	0.75	1.53	4.40	3.98

*the differences between the age cohorts are statistically significant (t-Student test, $P < 0.05$).

TABLE 2. Mother's rank and the interactions with other members of the group (frequency per hour).

Type of interaction	Low-ranking mothers	Middle-ranking mothers	High-ranking mothers
Received aggression	0.60	1.57	0.07
Performed aggression	0.60	1.31	1.01
Received grooming	7.92	6.84	6.50
Performed grooming	2.00	2.18	0.87

TABLE 3. Interactions between the mothers and the infants of different age in 3 groups of macaques (observational time in %).

Interactions	Group	0–8 week	9–16 week	17–26 week	27–52 week	53–78 week	79–120 week
Total time	A	92	70	36	11	10	10
	B	91	46	33	13	10	7
	C	94	62	33	24	17	11
Ventre-ventral	A	78	44	21	1	0	0
	B	79	33	21	4	0	0
	C	86	41	24	17	1	0

the others. This tendency is much weaker in the mothers with the youngest infants (0–8-week-old), it increases in dyads with 9–16-week-old infants and reaches a significant level in the mothers with infants of 17 weeks and older ($t=2.94$, $P < 0.01$). We suppose that it happens because the necessity to protect the infants increases with the increasing of the infant's independence. The fact that mothers with the youngest infants received grooming three times more frequently ($t=6.59$, $P < 0.001$) than they initiated it, reflects the mothers' preferable position as grooming partners.

Infant's sex and mother's interactions with other members of the group

The sex of the infant exerts some influence on the relationships of the pair mother and infant with other members of the group. It was revealed that the mothers with female infants received and performed less aggression than those with male infants. The mean frequency of aggression addressed to the mothers with 0–8-week-old female infants and male infants of the same age was 0.14 and 0.70 per hour respectively. The mean frequency of aggression performed by such mothers was 0.14 and 1.14 per hour, but the differences were not statistically significant. The frequency of grooming received by the mothers with 0–8-week-old female and male infants from other members of the group did not differ and was 7.00 and 6.94 per hour respectively.

Mother's social rank and interactions with other members of the group

The mother's social rank is another factor influencing the relationships and interactions between the mothers and other members of the group. Table 2 shows the differences in interactions between the 0–8-week-old infants' mothers and other monkeys depending on the mother's rank. All the data presented in Table 2 can be easily explained by the mothers' social rank. Thus, high-ranking mothers receive minimum aggressive attacks. The level of aggression received by low-ranking mothers corresponded to the average level typical for all the observed females, and the low frequency of aggression performed by low-ranking females, reflects their real abilities to defend themselves and their infants. The cause for the high level of received and performed aggression observed in middle-ranking mothers is their and their infants' high attraction as a social partner for other members of the group, along with the high ability of defence.

The different frequency of grooming received and performed by mothers of different social positions, also show the same tendency. Low-ranking mothers were mainly more preferable to be groomed because the infants guarantee their attractiveness as partners for grooming and they cannot avoid the same interactions due to their low rank.

Mother's rank and differences in maternal behaviour

We studied the relationships between the style of maternal behaviour and the mothers' social rank and also inter-group differences in maternal behaviour for the establishment of the influence of social factors on mother-infant relationships. The influence of the mother's rank position on mother-infant relationships is minimal in the mothers with 0-8-week-old infants. The time spent with infants for high-, middle and low-ranking females is of 96%, 93% and 91% respectively of the total observational time.

The time of ventro-ventral contact between the infant and high-, middle and low-ranking mothers is of 76%, 86% and 87% respectively, but the differences were not statistically significant. The same tendency was detected in the time of ventro-ventral contact of mothers with 9-16-week-old infants (34%, 43% and 41% respectively for the high-, middle- and low-ranking mothers). The middle-ranking females with the infants aged 27-56 weeks (the second half-year of the infant's life) spent statistically significantly more time in ventro-ventral contact with the infants than the high- ($t=2.66$, $P<0.01$), or low-ranking ($t=1.99$, $P<0.05$) mothers (10%, 2% and 4% respectively).

The middle-ranking females with infants older than 1 year also exhibited a relatively high level of ventro-ventral contact (2% of the observational time) while ventro-ventral contact in high-ranking and low-ranking mothers was almost absent (0.2% and 0.1% respectively). The cause of the tendency to higher level of care in the mothers of middle rank can be the different level of aggression received by mothers of different rank. The mothers that received the highest level of aggression from other members of the group demonstrated the longest time spent in the contact with infants and the highest level of care.

Inter-group differences in maternal confidence

The occurrence of some interdependence between the level of aggression towards the mothers from other group's members and the characteristics of maternal behaviour suggests the possibility of the influence of each group's social microclimate on mother-infant relations. To determine the occurrence of such influence we examined the maternal behaviour of the females in 3 corral groups of macaques with a comparable structure.

The groups were conventionally designated as group A, group B and group C. And it was found that the mothers in those groups were different according to the level of care devoted to the infants. The relationships between the mothers and infants were in a complex way related with the frequency of aggressive and friendly relations between the mothers and other group members. Thus, in the group conventionally designated as group C, the maximum level of physical contact between mothers and infants has been noted in most observational periods. In that group the mothers spent more time with the infants than the mothers in the other two groups and more than others they were involved in ventro-ventral contact with their infants (Table 3).

A high frequency of infant following and infant retaining by the female has been noted, and a minimum level of maternal aggression towards the infants. All the characteristics are in agreement with our view of the situation concerning the mothers of the group, which were the less confident of their infant's security comparing to the females of other groups.

Such mother-infant relationships in group C have been observed along with stricter mother-infant relationships of the mothers with other group members than in groups A and B. In group C mothers were subjected to a significantly higher frequency of aggression during the whole first 26 weeks of their infant's life (1.64 per hour in group C; 0.37 and 0.58 in groups A and B respectively), and they were more often aggressive towards the other animals (2.20 per hour in group C; 1.83 and 1.34 in groups A and B respectively). In group C the highest frequency of grooming directed to the mothers from other members of the group was also observed (6.95 per hour in the first 26 weeks).

In group B the females were more confident than those in the other two groups. Different periods of the infant's development are characterised by minimum or mean levels of maternal care (Table 3).

Such level of maternal care allows to consider the mothers of group B as the ones which are not afraid of unexpected danger for their infants. The level of aggression toward the mothers during the first year of the infant's life in this group was 0.58 per hour, which corresponded to a mean value of the levels shown in the other two groups. The lowest frequency of grooming directed to the mothers from other members of this group was noted (4.43 per hour in the first 26 weeks of the infant's life).

In group A during the different periods of mother-infant relations the mothers showed relatively variable indices of occurrence of the maternal behaviour patterns which could be characterised as mean values comparing to the indices in the other two groups. Such indices occurred along with the lowest level of aggression towards the mothers and a mean frequency of grooming by other group members (6.34 per hour in the first 26 weeks).

CONCLUSIONS

The study of mother-infant relationships in captive cynomolgus macaques showed that beginning with the second year of the infant's life adult kin relationships are established between mother and offspring.

It was detected that the infant's age influences not only the mother-infant relationships, but also the relations and interactions between the mother and the other members of the group. The frequency of aggression directed to the mothers with 9-16-week-old infants was the highest in comparison with the differently aged infants' mothers. The mothers of the youngest infants (0-8 weeks) received grooming more frequently than other mothers.

The mother's social rank influences the relationships

and interactions between the mothers and other members of the group. The middle-ranking mothers show the highest level of received and performed aggression.

The mother's rank exerts some influence on the mother-infant relationships. A tendency to higher level of maternal care in the mothers of middle rank position was observed.

The group's social microclimate influences the mother-infant relationships. The mothers were most confident in groups where the level of aggression directed to mothers was not high.

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