

Development of Behaviors in a Male Spectacled Langur (*Presbytis obscurus*)

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ABSTRACT. An infant langur, *Presbytis obscurus*, was observed in a group setting, from birth until 1 year of age. Frequency or duration of 30 behaviors was recorded during 2 hour periods and plotted chronologically. Based on fluctuations and interrelations of these behaviors, age classes were designated. The Maternal Care Period (0-20 days) is characterized by close mother-infant contact, including a great deal of nipple contact and a high frequency of maternal behaviors. The Individuation Period (21-70 days) is typified by maternal restraint and retrieval, and independence and self-oriented behaviors like scratching, mouthing, and locomotory skills. The Socialization Period (71-240 days) is manifested by behavioral fluctuations, involving nipple contact, play, and care by other troop members and coincides with the molt from infant to juvenile pelage. Finally, during the Juvenile Period, the mother-infant distance increases and the mother interacts more with other troop members. Behavioral fluctuations observed in this infant langur are discussed with reference to other primates studied.

INTRODUCTION

Cyclical fluctuations characterize many biological processes. Daily and seasonal patterns linked to external cyclical stimuli are easiest seen. A definite function of fluctuation is indicated by its general occurrence in biological systems. This function is perhaps related to an activity budget; living things must rest during part of the time in order to renew themselves.

Similarly, behavioral development displays fluctuations related to underlying emotional states as observed in squirrels (HORWICH, 1972). These behavioral fluctuations also occur in other mammals as well as in primate behavioral ontogeny. For example, there are peaks of high mother-infant contact which are reminiscent of earlier developmental periods and thus regressive in nature (HORWICH, 1974). The contact is controlled by the infant and is dependent on his feelings of security within his environment.

This paper presents an integrated picture of early behavioral fluctuations and how the behaviors interrelate. The subject, a single male spectacled langur, *Presbytis obscurus*, was observed for over 100 hours in the first year of its life. This study is part of a comparative study of 13 species of Old World monkeys and four species of apes which will outline basic similarities in primate development. While the langur studied may represent an individual extreme of his species, he is not necessarily a modal representative of the species. Therefore, I supplemented my data with 50 hours of observation (during a 2 week period) on a 60-day-old infant female langur at the

Bronx Zoo caged with its mother, father, and brother. The observations from this individual are in agreement with those from the Brookfield individual.

Four growth periods were delineated based on the infant's and the mother's behavioral changes. However, many behaviors occur throughout the infant's first year and overlap periods. The initial period of Maternal Care is ended by a radical decrease of maternal behaviors. The second period of Individuation is bounded by the beginnings of independent behaviors and the endings of a high frequency of performance of them. The third, the Socialization Period, begins and ends with a relatively high level of nipple contact. This period includes fluctuations of other behaviors as well. The Juvenile Period marks the beginning of a base line of low nipple contact, an increase in distance the infant travels from its mother, and the resuming of the mother's normal interactions with the group.

MATERIALS AND METHODS

A male spectacled langur, *Presbytis obscurus*, was observed from birth until his death with a bloat syndrome at 1 year of age. He was caged with his mother, his father, and a juvenile sister who was 15 months of age at the time of the infant's birth. During the study, the infant and mother were isolated from father and daughter from day 9 to 65 and again for 2 weeks at 6 months of age because of injury to the mother.

The animals were kept in an exhibition cage (1.8 m \times 3.5 m \times 2.3 m) at Brookfield Zoo. A shelf ran the length of the cage at its rear and 2 stainless steel bars connected the front cage wire to the rear walls at a height of 1.1 m, 1 m from either side wall. Additionally, during some of the time two large concrete columns lay on the floor of the cage.

Notes were taken in longhand while sitting 1.5 m from the cage. Frequency or duration of behaviors was recorded for each 2 hour observation period. Observations were discontinued during periods of cage maintenance or other disturbances, but were continued again when the animals resumed normal activities. Observation periods occurred between 7-10 a.m. at 2 to 23 day intervals.

DESCRIPTION OF BEHAVIORS BY DEVELOPMENT PERIODS AND RELATIONSHIPS

I. MATERNAL CARE PERIOD (0-20 days)

The initial mother-infant relationship is characterized by a high level of six maternal behaviors. An abrupt reduction in frequency occurs in four of these behaviors after 20 days and in the remaining two after 45 days. The infant is very quiet, often sleeping, and on his mother's nipple most of the time.

Maternal back-scratching of the infant: The mother, while holding the infant against her ventrum, extends her hand and fingers in contact with the infant's back, flexes the fingers and rapidly draws her hand up again. She repeats the action three to eight times (Fig. 1). By 20 days, half-scratches or scratch intention movements are seen, in which she begins to scratch the infant's back but does not bring her hand up again. Maternal



Fig. 1. Mother scratches the infant's back.



Fig. 2. Mother kisses the infant.

back-scratching was not seen in the Bronx Zoo female whose infant was 60 days old, well after the behavior had disappeared in the Brookfield Zoo female. This stereotyped behavior was also seen in two other Colobines, *Colobus guereza* and *C. polykomos*.

Kiss: The mother leans her face over, laying her mouth and chin on the infant's back (Fig. 2). Her nostrils may contact the infant's fur and she may be sniffing it. Occasionally she mouths the infant's dorsal fur.

Kissing in a stereotyped form was also seen only in two species of *Colobus* monkeys. A patas monkey female infrequently showed similar gestures which were not as stereotyped.

Two-handed grasping: The mother, usually when kissing the infant (Fig. 2), tightly grips the infant's back fur on both sides and lifts it up toward her face. She often lifts the infant's feet off the ground as she grasps him. She grasps without the kiss infrequently.

Leg pull-out: The mother grasps the infant's foot with her hand and pulls the infant's leg out from her body and looks down at his urogenital region (Fig. 3a). She may then release the infant's leg, allowing it to regasp her ventral fur, or she may pull the infant's leg up and lower her face and mouth to the infant's penis or urogenital area, licking or mouthing it (Fig. 3b).

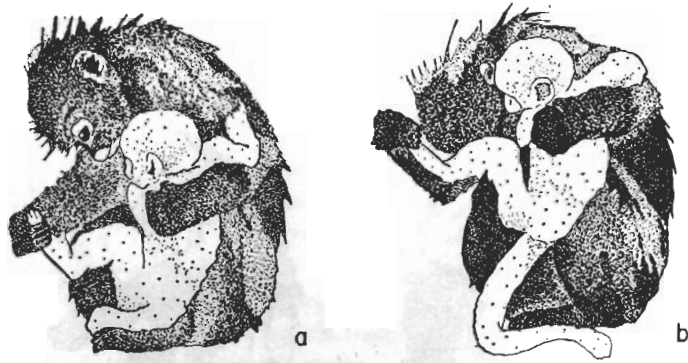


Fig. 3. Mother pulls the infant's leg out (a) and mouths his urogenital area (b).

Arm pull-out: The infant's hand or wrist, is grasped by the mother and pulled back away from her body. She looks at the infant's chest and may then mouth or groom his chest with her other hand. She may groom his arm or pick at the hand she is holding (Fig. 4).



Fig. 4. Mother pulls the infant's arm out.

Maternal grooming: Maternal grooming was defined as the mother manually manipulating the infant's fur with one or two hands, or mouthing its fur during any 1 minute period. Three types of grooming were observed in the langur: (1) the hand is used in a rake-like fashion, with the fingers bent at the second joint as the limb is retracted, (2) the palm with fingers extended is pushed across the infant's fur away from the

groomer, (3) the groomer grasps the recipients fur between thumb and index finger and rotates the hand to pull the fur back; the exposed fur and skin may then be mouthed. The langurs observed used the raking movement most often. The mother's grooming of the young infant showed more mouthing than did grooming between adults. An operational definition of maternal grooming included all these movements. If any of the movements occurred during any 1 minute of observation it was recorded as a minute of grooming though maternal grooming generally lasted less than a minute.

Mother-infant relationship: During the Maternal Care Period the infant spent most of the time on the nipple, often sleeping and rarely active except for searching movements when dislodged. The mother, in contrast, frequently manipulated the infant. After 20 days the infant engaged more often in activities not concerned with the mother. Figure 12a illustrates the abrupt change in nipple contact. Figure 5 exhibits the female's abrupt cessation of maternal behaviors at this same time. Kisses, two-hand grasps, and leg and arm pulling out decrease after 20 days. Maternal back-scratching resurges until 41 days and maternal grooming of the infant decreases markedly after

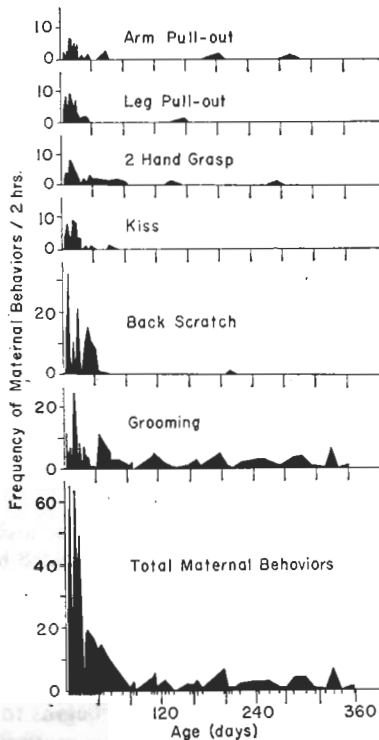


Fig. 5. The frequency of behaviors per 2 hours performed by the mother to her infant as a function of the infant's age: arm pull-outs, leg pull-outs, 2 hand grasps, kisses, back scratches, grooming, and their total. (Data points are indicated by short vertical lines below the abscissa).

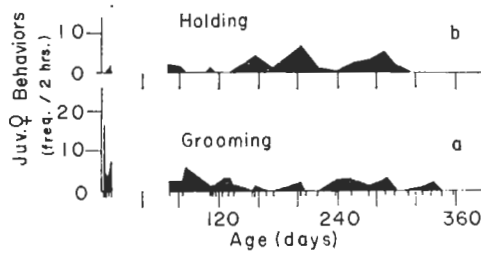


Fig. 6. The frequency of behaviors per 2 hours performed by the juvenile female to her brother as a function of his age, (a) grooming, (b) holding. (Data points are indicated by short vertical lines below the abscissa).

30 to 45 days. Only grooming persists with regularity throughout the infant's life; it is the only infant oriented behavior which occurs with regular frequency between adults.

During the first 9 days, when she was with the infant, the young daughter also groomed the infant frequently (Fig. 6a), but at 65 days, when she was reintroduced to the infant, grooming was at a low level. In contrast to the mother, she rarely held or carried the infant during the first days but after 5 months, she frequently did so (Fig. 6b).

Changes of the mother's behavior—During the first 20 days when the infant was always on her, the mother scratched herself infrequently but often scratched the infant's back (Fig. 7). During the period of infant independence (23 to 60 days), the mother's self-scratching was frequent. She again scratched herself at a high rate from 160–210 days.

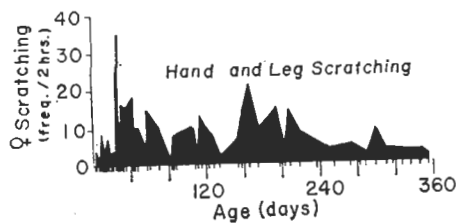


Fig. 7. The frequency per 2 hours with which the mother scratched herself with hands and legs as a function of the infant's age. (Data points are indicated by short vertical lines below abscissa).

II INDIVIDUATION PERIOD (21–70 DAYS)

Nipple contact diminishes greatly and the infant begins to explore his environment and himself. During this time a number of behaviors mature, in particular mouthing, scratching, and various locomotor skills.

Scratching: The development of hand and leg scratching from disoriented, unco-

ordinated behaviors to coordinated well oriented movements occurs from 10 to 60 days (Fig. 8). This peak may be a "practice" period during which the animal coordinates, orients, and integrates the components of the behavior.

Although scratching begins on day 1 it commonly occurs after day 10. Leg scratching matures and peaks later than hand scratching, after 20 days. Other fluctuations follow after 100 days but the frequency is never as high as the initial peak.

Hand scratching: This pattern begins day 1 as a jerky hooking motion of the flexed hand. It is an irregular vibration of the hand and arm which meanders over the infant's body often scratching the mother's arm or knee. By day 3 it is more coordinated but still arhythmic and random in orientation. On day 7 a slow uncoordinated, arhythmic scratching was first seen directed to the side. The same day he scratched his knee in a rapid regular manner. A day later he scratched his rump and back. On day 9 he scratched his hind leg. On day 12 he partially extended his leg out as he scratched it and fully extended it 2 days later. By day 25 he coordinated these components. By this time he also scratched his tail base and would pull his tail up, grasping it by the base. Although hand scratching has matured by day 25, long disoriented meandering scratches still occur.

Leg scratching: A single scratch reflex was noted on day 1 and not seen again until day 15. The next day a leg scratch landed on his side although it is not directed to a specific area until day 20. Between days 22 and 25 he directed scratches to his neck,

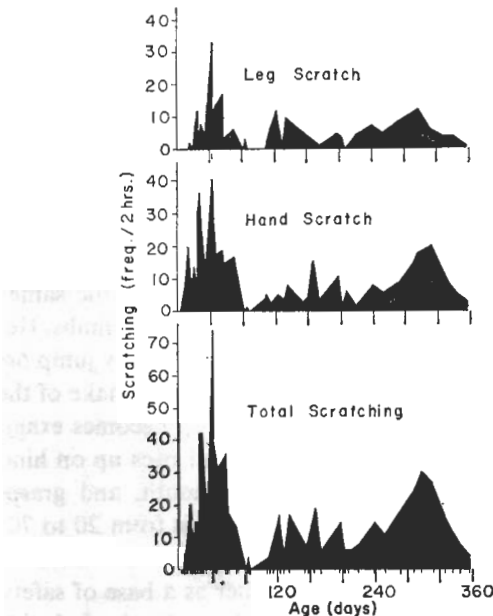


Fig. 8. The frequency per 2 hours that the infant scratched himself as a function of his age: hand scratches, leg scratches, and total scratches. (Data points are indicated by short vertical lines below the abscissa).

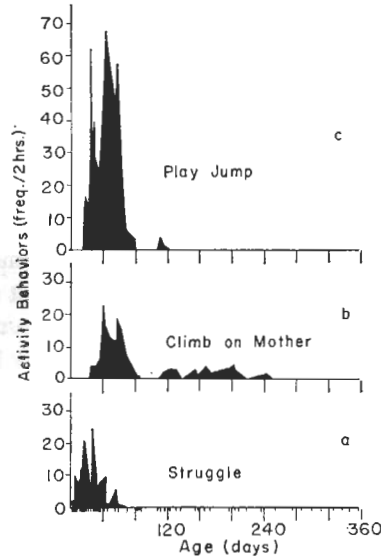


Fig. 9. The frequency per 2 hours of locomotory activities performed by the infant as a function of his age: (a) struggling while on his mother, (b) climbing on his mother, (c) play jumping. (Data points are indicated by short vertical lines below the abscissa).

upper arm, and chest. When scratching his chest he did not extend his arm but did turn his head away when scratching his head or neck. The leg scratch becomes well coordinated and directed to specific body areas by day 41 but forearm extension during chest scratching was still not seen.

Infant struggling while on mother's ventrum: The infant, at a few days, makes quick sporadic jumps on the substrate between the mother's legs. He pushes off the shelf or the mother simultaneously with both legs or seems to try to pull himself away from his mother. Figure 9a shows the main period of struggling when on the mother, from 5–45 days.

Play jumps: Later the infant shows a series of 2–3 jumps in the same place, pushing his hind limbs off the ground while remaining affixed by fore limbs. He does this while holding onto his mother or the bars with his hands or he may jump on all 4 feet. This jump is self play and may be preceded by a quick twist or shake of the head which is used later as a social play initiation signal. The jump becomes exaggerated when it grades into social play. In that movement the animal rises up on hind legs with fore legs bowed and then jumps forward with open mouth, and grasps and bites its partner. The major occurrence of self play behavior is from 20 to 70 days (Fig. 9c).

Climbing on the mother: The infant uses its mother as a base of safety from which it can practice locomotory skills. It frequently climbs on her back, head, and shoulders from 30 to 70 days. This behavior is common in all 13 species of Old World monkeys studied and defines the nature of the Individuation Period. The infant, although

active, still does not wander from his mother, and often chooses to climb on her rather than something else (Fig. 9b).

Maternal restraint and retrieval: During the initial period of infant independence the first conflict of interests develops. Although the infant, through his actions, is achieving a limited independence, it is clear to the observer that he is not capable of taking proper care in these actions. It seems that the mother realizes this and she constantly watches and performs protective actions during this period. At first the mother reacts to the struggling infant by holding its body tightly. As the strugglings become more strenuous she may also restrain the infant by holding his arms (Fig. 10) or tail. When the infant pulls away from her, she goes to it, pulls it to her ventrum and carries it (retrieval).

Struggling and restraining occurred during transition from Maternal Care Period to Individuation Period (Fig. 11a). Retrieval, however, showed its main peak from 20 to 60 days, during the Individuation Period (Fig. 11b).



Fig. 10. Mother restrains the infant by holding his arm.

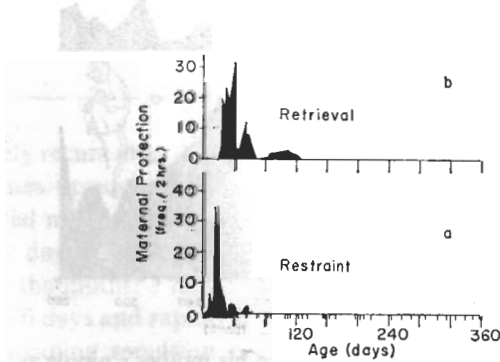


Fig. 11. The frequency per 2 hours that the mother restrains (a) and retrieves (b) the infant as a function of his age. (Data points are indicated by short vertical lines below the abscissa).

Nipple contact: A minute of nipple contact was recorded each time the infant was on the mother's nipple at the beginning of the minute.

Object mouthing: A minute of object mouthing was recorded each time the infant mouthed: (1) each of *infant's own limbs* (hand, arm, foot, tail) (2) each of *mother's limbs* (hand, arm, foot, leg, tail) (3) each of *cage objects* (bar, shelf, wall), at any time during the minute.

Maternal repulsions: These were recorded any time the mother (1) pushed or pulled the infant from her nipple, (2) bit the infant, or (3) stared at the infant while moving her tongue slowly in and out over her bottom lip and jaw. The mother may also cup her hand under the infant's chin as she tongues at him. Most repulsions consisted of pushing the infant away from her nipple or pulling his head off her.

Interrelationship of nipple contact, object mouthing, and repulsion from the nipple: Figure 12 shows the relationship of nipple contact to total object mouthing (including cage objects, mother's limbs, infant's limbs) during the infant's first year. Initially, the infant spends most of the time on his mother's nipple. After 20 days, there is a period of relative independence from the nipple and a high level of object mouthing, followed again by a period of high nipple contact and little object mouthing. At 100 days, the periods become less distinct. A comparison of these 2 variables by SPEARMAN Rank correlation for successive 120 day periods indicates a significant inverse correlation for the first period only. However, correlation values decrease with age (Table 1).

Two mouthing patterns are noticeable. First, mouthing the mother's limbs peaks

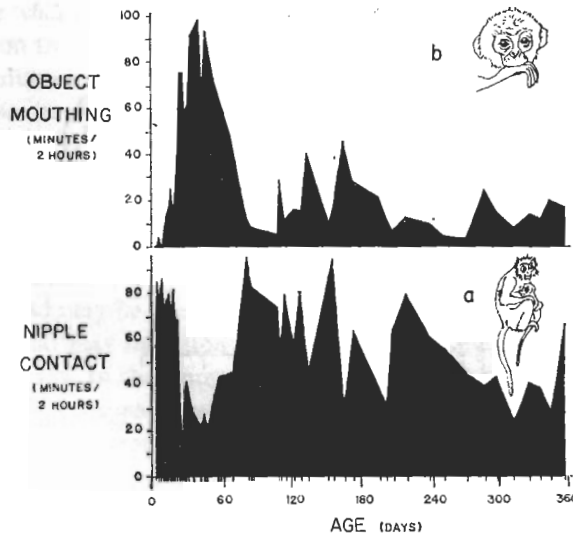


Fig. 12. (a) Time spent per 2 hours by the infant on his mother's nipple as a function of his age, (b) Time spent per 2 hours by the infant mouthing objects other than his mother's nipple as a function of his age. (Data points are indicated by short vertical lines below the abscissa).

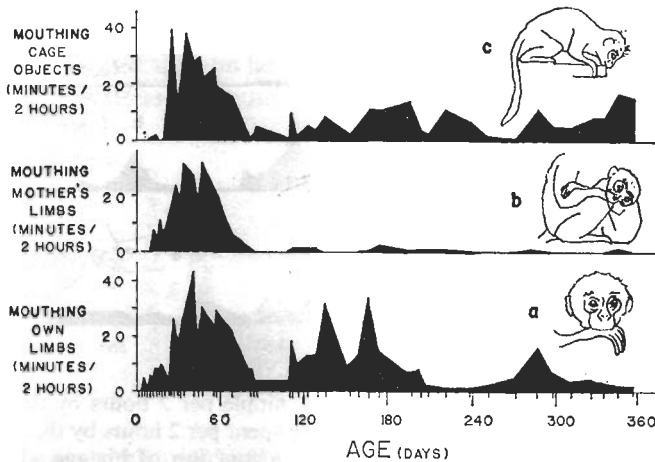


Fig. 13. Time spent per 2 hours by the infant mouthing the following objects as a function of his age: (a) his own limbs, (b) his mother's limbs, (c) cage objects. (Data points are indicated by short vertical lines below the abscissa).

Table 1. SPEARMAN rank correlation coefficients for tests of correlations between various mouthing behaviors.

| Mouthing | 0-120 days | 31-115 days, high repulsions | 120-240 days | 240-360 days |
|-----------------------------|------------|------------------------------|--------------|--------------|
| Nipple/Total other mouthing | -.88 | -.87 | -.41 | -.19 |
| | p .001 | p .001 | NS | NS |
| Nipple/cage | -.82 | -.87 | p .20 | p > .20 |
| | p .001 | p .001 | -.37 | -.21 |
| | | | NS | NS |
| Nipple/own limbs | -.76 | -.83 | p > .20 | p > .20 |
| | p .001 | p .001 | -.15 | -.08 |
| | | | NS | NS |
| Nipple/mother's limbs | -.82 | -.70 | p > .20 | p > .20 |
| | p .001 | p .05 | | |
| Nipple/own hands | -.65 | -.56 | -.22 | -.00 |
| | p .001 | p .05 | NS | NS |
| Nipple/mother's hands | -.62 | -.40 | p > .20 | p > .20 |
| | p .01 | NS | — | — |
| | | p > .20 | | |

early, and rarely recurs after 70 days (Fig. 13b). In contrast, mouthing itself and cage objects fluctuates through the first year (Figs. 13a & 13c). Another pattern exists within the initial mouthing peak. Cage object mouthing (Fig. 13c) rises rapidly to a peak at 25-35 days and gradually declines. In contrast, mouthing its own hands (Fig. 14b) and the mother's hands (Fig. 14c) or limbs (Fig. 13b) gradually increases to peak at 55-70 days and rapidly declines.

Maximum weaning repulsion occurs from 40-70 days (Fig. 14a) when nipple contact is low but increasing (Fig. 12a). Maximum frequency of repulsions (days 56 and 57) corresponds to the beginning of a steep increase in nipple contact time.

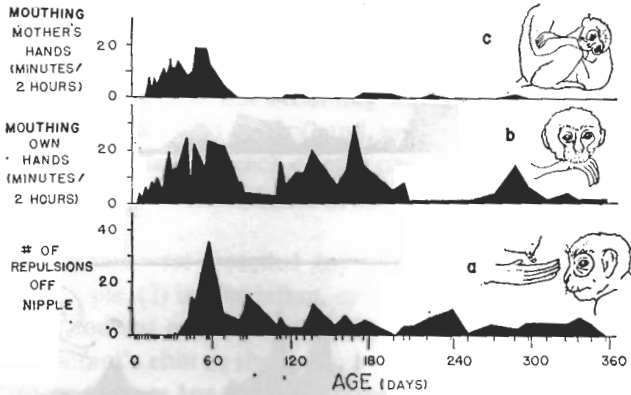


Fig. 14. (a) The frequency of repulsions from the nipple per 2 hours by the mother to the infant as a function of the infant's age; (b), (c) time spent per 2 hours by the infant mouthing its own hands (b), and its mother's hands (c) as a function of his age. (Data points are indicated by short vertical lines below the abscissa).

Additionally, the high level of infant's mouthing its mother's hands and its own hands is extended, following the period of maximum weaning (Figs. 14b & 14c). In contrast, mouthing of cage objects (Fig. 13c) decreases despite the mother's repulsions (Table 1 & Fig. 14).

Correlation values between nipple contact and mouthing its own hands and the female's limbs show decreased significance levels during the period of high repulsions (Table 1 & Fig. 14), indicating a smaller probability of correlation. The inverse correlation of nipple contact to mouthing the mother's hand during this period is not significant. In contrast, the inverse correlation between nipple contact and total mouthing or mouthing cage objects maintains high significance at $P < .001$

III SOCIALIZATION PERIOD (71-240 DAYS)

This period is characterized by the onset and development of the infant's interest in social play and in other troop members, interest in the infant. Most of the mother's intense interest in the infant has waned though she does respond to the nipple contact by holding him closer. As his behavior is changing from that of an infant to that of a juvenile, so his physical appearance is also changing. During this period the major pelage change occurs.

Maternal clasping contact: Maternal clasping was recorded as the average number of hands and feet with which she embraced the infant at the beginning of each minute of observation (Fig. 15). During the Socialization Period the infant showed fluctuations from high to low frequencies of nipple contact (Fig. 12a), indicating his anxiety level. The mother reacted to the infant's insecurity, clasping it with her hands and feet. Peaks of infant clasping coincide with periods of high nipple contact at 0-20 days, 55-90 days, 150 days, and 220-240 days, after which a base level of two hands is maintained. During the second peak and the final base line, she was less attentive and generally used only her hands, whereas in the first and third peaks she used her feet as well, folded over the infant's tail (Fig. 4). Perhaps her behavior during the second

peak was influenced by the high frequency with which she repulsed the infant's advances to her nipple (Fig. 14a). After 200 days the mother rested only her two hands on the infant's back as it slept on her nipple. This contact was the only nipple contact it had except during stress situations.

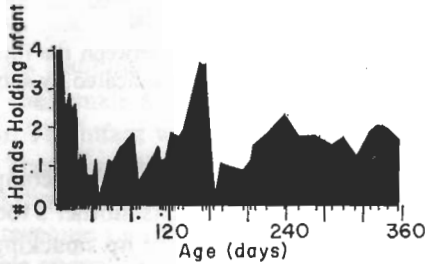


Fig. 15. The average numbers of hands and feet with which the mother clasps her infant at the beginning of each observation minute as a function of the infant's age. (Data points are indicated by short vertical lines below the abscissa).

Nipple preference: After 80 days the infant spent most of its time on the mother's left nipple. However, during feeding it alternated between nipples. Data on nipple preference were not taken during the first 9 days, but data from days 10 and 12 seem to indicate the infant was consistently contacting the left nipple. From then until 70 days, he used the right nipple (Fig. 16). With a return to high nipple contact he consistently readopted and maintained use of the left nipple (Fig. 16).

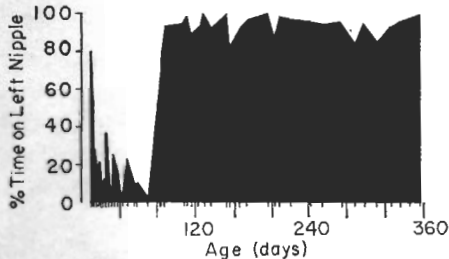


Fig. 16. The percentage of time the infant spends on the left nipple in preference to the right nipple as a function of his age. (Data points are indicated by short vertical lines below the abscissa).

Social play: An operational definition of play between the infant and his sister consisted of the infant grasping, wrestling, and mouthing of his sister's fur. Play was not as active or as prolonged as in such species as *Colobus guereza* or *Papio hamadryas*. Play fluctuated with time spent on the nipple (Figs. 12 & 17). Play peaks occurred during periods of low nipple contact at 115 to 135 days, 165 to 205 days, and 325 to 425 days.

Social grooming: The first indication of grooming-like behavior was noted at 6 days. The infant directed its gaze at a portion of its mother's fur and pawed or picked at it

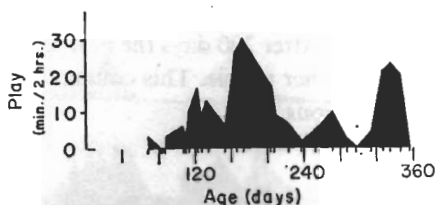


Fig. 17. The frequency per 2 hours of social play between the infant and his juvenile sister as a function of the infant's age. (Data points are indicated by short vertical lines below the abscissa).

in an uncoordinated manner. On day 41 I first saw an incomplete precursory grooming. The infant directed its attention to fur on its mother's toes and alternately pulled its hands with fingers bent through her fur. The lip smacking component (extension of the tongue between the lips) which is common to all Old World monkeys observed, was seen in the 70-day-old Bronx Zoo infant. Gradually the grooming components were integrated but even as late as 200 days the behavior did not appear as concise as in adults and grooming was neither frequent nor long during the first year.

Paternal care: Both adult male langurs observed showed a great deal of interest in the infants. The Brookfield male carried another infant born to the mother. However, the mother was in poor condition with an extruded rectum following the birth and



Fig. 18. The adult male (right) and adult female (left) clasp, grin, and vocalize.

showed little interest in the infant. The male did not always hold the newborn upright and there were occasions when it almost fell. The male's handling of the infant, showed behavioral similarities to female handling including the two-handed grasping and kissing of the infant's back. This behavior was also directed to a 15-month-old juvenile when it was reintroduced to the male. The male pulled the juvenile to his belly with both hands, grinned with his mouth open and vocalized. This, was similar to the clasp greeting in which two animals clasp each other about the waist, expose the teeth in a grin and vocalize with rapid expulsions and inhalations which sound like human

laughter (Fig. 18). The male slept with this juvenile at 16 months, clasping her. The adult male also clasped the infant male at 314 days.

By 2 months of age the Bronx Zoo infant was already establishing a relationship with his father. The male sought to carry the infant who often approached and climbed on the male's ventrum. Due to the Brookfield male's separation from the female and infant until the infant was 65 days old, there was a later development of this relationship from 70–120 days (Fig. 19). It began to peak during the infant's first insecurity peak, often resulting in the male inserting his arm across the infant's face pulling him off of the female as he whimpered softly, and carrying the infant clinging on his ventrum. The infant would quickly climb off and proceed hastily to his mother's nipple. On occasion the male also picked the infant up when it was alone and crying. At 110 days the male retrieved the infant as the female pushed it off her. He also retrieved it in response to a keeper's presence until 318 days at which time the infant ran to the male crying.

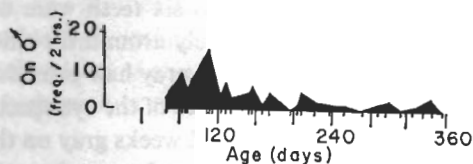


Fig. 19. The frequency per 2 hours that the infant was carried on the male's ventrum as a function of the infant's age. (Data points are indicated by short vertical lines below the abscissa).

Both infants also climbed on the male's back, sucked his hand, hung on and mouthed his tail, and manually manipulated his face and lips as they also did to their mother. The male tolerated this behavior as early as 70 days.

Another paternal behavior was noted at 60 days in the Bronx Zoo group. The male pulled the infant with his hands while pushing it away with his feet (Fig. 20) often as the infant was attempting to get away. This was first noted at Brookfield at 135 days and increased in frequency after 270 days. With increasing frequency it terminates with the male holding the young male by his waist or rump with his hands while it faced away and the male's feet pushing the young by the arms and shoulders (Fig. 20). On day 318 the male's feet were noted on the infant's calves and it appeared as though the young male was being pushed into a present posture by the adult male. On occasion, the infant remained in that posture for a few seconds after the male stopped holding it, before moving away. The infant was first seen to present on its own to the adult male at 273 days of age when the male then mounted and afterward displaced the young by pushing him away with his hind feet. Based on observation in *Colobus* I feel the potential to present might occur much earlier but because of the amicable relation between male and infant it was not seen earlier. The young male also groomed the adult male although he rarely groomed anybody else. The adult male first groomed the young male at 273 days.

Pelage color change (Fig. 21): The infant is born bright orange-yellow with pink skin

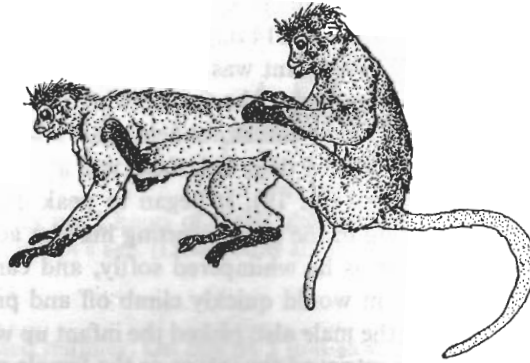


Fig. 20. Posture by which the adult male arranges the juvenile male into a present posture.

showing through the hair. The bare skin on its ears, face, hands, and feet are also light pink. The face has sparse short white fur, especially on the upper and lower lip, and chin. The eye rings are bare. At 20 days four to six teeth were noticed on the upper jaw. By 7 weeks long black hairs appear sparsely around the side and above the eyes and on the muzzle. By 9 weeks a wedge of dark gray hair extends back an inch on the head; a week later it has extended along the sides of the eye spectacles. Black pigment in the hand skin has emerged by week 11. By 12 weeks gray on the head has extended along the sides to the ear although it is sparser than on top. Additionally, a small white beard has grown in and the whole back of the head has grayish hair coming in

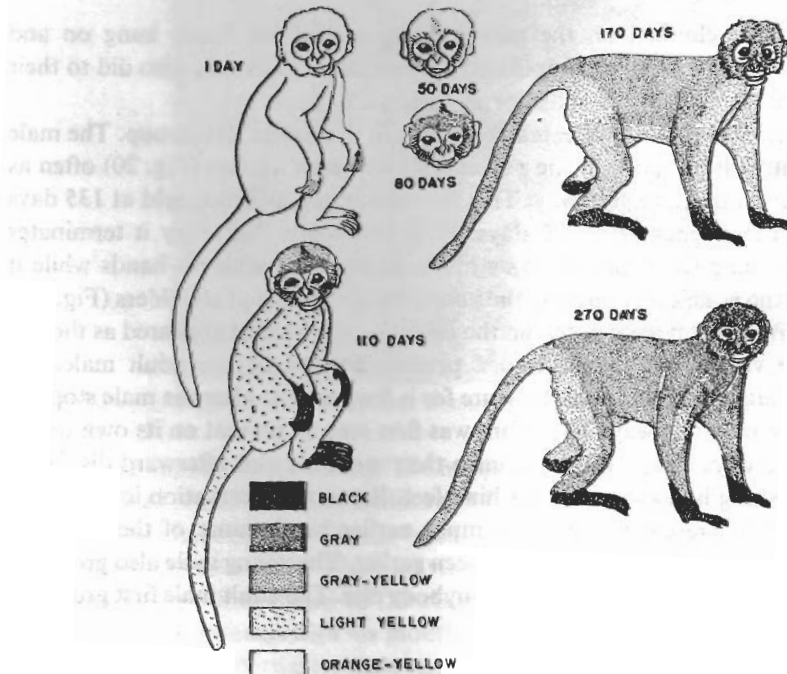


Fig. 21. Pelage change in the infant langur as a function of age.

on it. By 14 weeks most of the head is gray except for yellowish areas in front of the ears and the back is becoming darker gray. The hands are grayish black up to the wrist. By 20 weeks most of the back and head is gray and only the belly, tail, and upper arms show slight traces of yellow hair. By 31 weeks a few yellow hairs remain on the lower back and tail but by 9 months the pelage is mostly gray with only vestiges of yellow on the lower back, hind legs, and shoulder. Its face is light gray and the white spectacles and mouth patches are distinct although the latter are still pinkish white. At 10 months the complete gray coat has grown in although it is lighter than in adults.

IV JUVENILE PERIOD (AFTER 241 DAYS)

During this period no new behavior patterns emerge, and mother-infant contact is not as frequent. The distance the infant stays from its mother and her greater interest in other troop members as exhibited by her grooming and being groomed by them are important features of this period.

Mother's grooming interactions with other troop members: A minute of grooming interaction was when the mother groomed or was groomed during any minute of observation. The mother's grooming interactions with the troop (measured in minutes of grooming) show a low level of sociality until 240 days (Fig. 22). This coincides with the end of the final high peak in nipple contact.

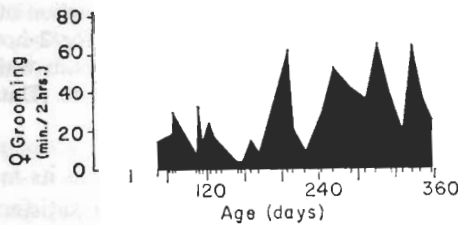


Fig. 22. The time spent per 2 hours by the mother in grooming or being groomed by the adult male and her juvenile daughter as a function of age of her male infant. (Data points are indicated by short vertical lines below the abscissa).

Distance from its mother: At 240 days there is an increase in two related measures of mother-infant distance. Figure 23a shows the total number of feet from the mother at the beginning of each minute per 2 hours. Figure 23b shows the number of times the infant was over 1 foot from its mother at the beginning of each minute. Before 240 days a pattern fluctuating with nipple contact is seen with increased independence from 40–80, 110–140, and 160–200 days, all periods of low nipple contact.

DISCUSSION

AGE CLASSIFICATION PERIODS

Although development proceeds gradually, there are distinct changes. Age classifications based on these changes are essential for species comparisons. Few attempts at primate age classification have been made. In the field, workers have classified animals for working purposes based on a few gross changes such as coat color or

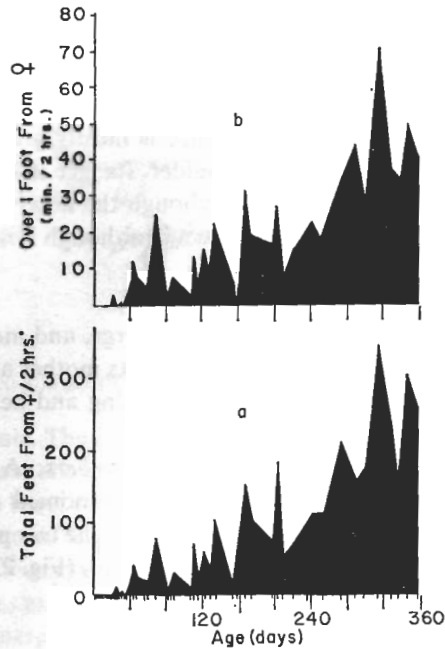


Fig. 23. Related measures of mother-infant distance as a function of the infant's age: (a) the number of feet at the beginning of each minute totaled for 2 hours which separates the mother and infant, (b) the frequency of minutes per 2 hours in which the infant is farther than one foot from the mother at the beginning of each minute. (Data points are indicated by short vertical lines below the abscissa).

other physical aspects, distance the infant wanders from its mother, time spent near its mother, or weaning (HINDE, 1971). These are not satisfactory because the field studies have not obtained much data on continuous behavioral development profiles. Based on quantified behavioral profiles, the langur ontogeny exhibits four periods (Fig. 24). The Maternal Care Period (0–20 days) is a period of close attachment to the mother including a high level of nipple contact with her. The mother exhibits a high frequency of maternal behaviors and a low level of self-maintenance.

The following period, Individuation (21–70 days) includes high frequencies of behaviors in which the infant is concerned with himself and his environment. These include scratching and mouthing objects. The mother shows high frequency of scratching her own body. During this time the infant begins a period of activity as displayed by a peak of strugglings on the mother, play jumps, and climbing on the mother. She frequently responds by restraining and retrieving the infant during this time. The infant additionally shows little nipple contact, and an increase in distance from his mother.

The Socialization Period includes three phases of high nipple contact, which are regressive in nature (HORWICH, 1974), and enclose two phases of low nipple contact. The initial division (Socialization I) has two regressive phases. During the first progressive phase, there is an increase in infant object mouthing and distance from its mother. The infant also shows a moderate amount of play and is often carried by the

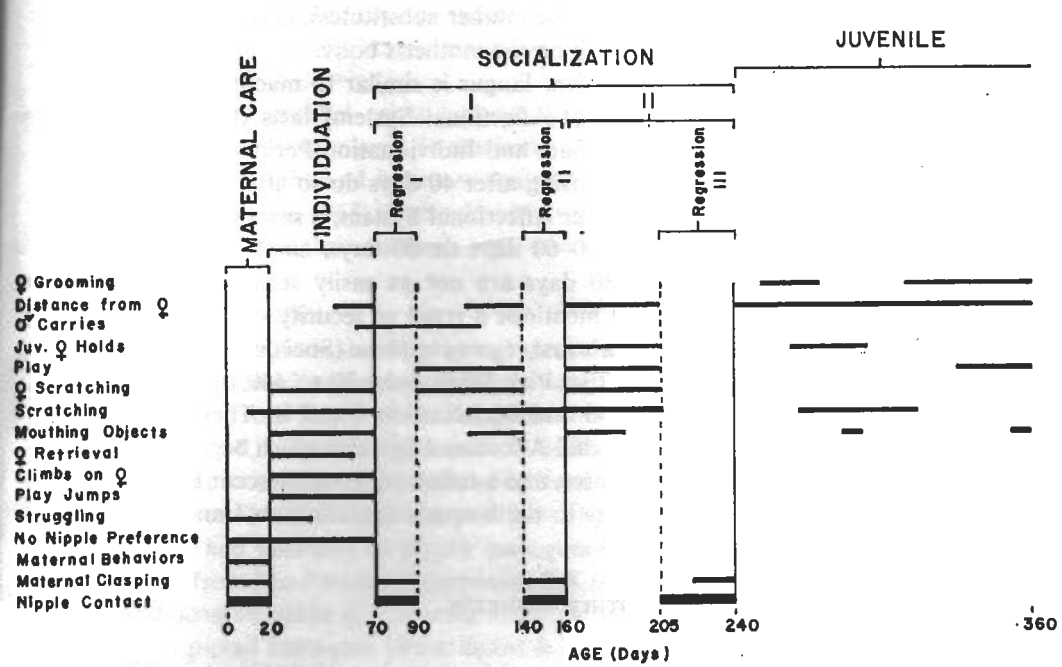


Fig. 24. Age periods in the infant langur and the relationship of high frequencies of behaviors to these periods and to each other. (Dark bars represent peaks of high frequencies of behaviors estimated from the data).

male. The mother displays a high level of self-scratching. During the first regressive phase the infant is carried often by the male despite the infant's objections. During the second regression the infant continues to scratch at a high level. In both of these phases, the mother responds to the infant with a high level of claspings of it.

In the progressive phase of Socialization II the infant mouths objects and scratches more than in the preceding phase, and moves greater distances from its mother. It also plays a great deal and is carried often by its sister. The mother scratches more than in the preceding phase. The regressive phase is mainly concerned with infant nipple contact and the mother's claspings of the infant.

The Juvenile Period showed a low frequency of nipple contact, greater distances between mother and infant, phases of object mouthing, scratching, play, and being carried by its sister. The mother responds to this extra freedom by resuming her normal grooming activities with other troop members.

In rhesus macaques HARLOW and HARLOW (1965) have named some age classes but because they deal with maturation in five affectional systems the developmental age classification is complicated. However, some of the age classes which I have determined for the langur are similar to certain of their categories. Their Reflex Stages (Infant-mother and Peer Affectional Systems) are equivalent to my Maternal Care Period. In the langur and macaques, for about the first month, infants are totally concerned with close physical contact with the mother (or peers, which, in the experi-

mental absence of the mother, seem to be mother substitutes), and the behaviors of rooting, sucking, clinging, and sleeping on the mother's body.

The Individuation Period in the infant langur is similar to macaques. HARLOW'S Maternal Attachment Stage (Maternal Affectional System) lasts from 0-60 days, encompassing the langur's Maternal Care and Individuation Periods. Restraint and retrieval which they mention as decreasing after 40 days do so after 50 or 60 in the langur. In the HARLOWS' Infant-mother Affectional System, a second phase of comfort and attachment extends from 20-60 days or 80 days, similar to the langur. Patterns in periods following 60-80 days are not as easily seen. The HARLOWS' (Infant-mother Affectional System) mentions a stage of security beginning after 80 days, which coincides with the langur's first regressive phase (Socialization I) (Fig. 24). The HARLOWS' speak of an Interactive Play Stage from 30 to 140 days, which encompasses the langur's Individuation and Socialization I and II. They mention an Infant Heterosexual Stage (Heterosexual Affectional System) which begins at 60 days judging from certain "threat" responses, and a following Preadolescent Heterosexual Stage at 180 days which corresponds to the langur's Socialization I and II Periods respectively.

DEVELOPMENTAL SIMILARITIES IN OTHER MONKEYS

Maternal Care

Maternal care behaviors in other primates studied is most intense during early ontogeny. In rhesus macaques, maternal grooming of the infant was less in the second 6 weeks than in the first 6 weeks (HINDE & SPENCER-BOOTH, 1967). An additional peak at 17-22 weeks was never seen in the langur (HINDE et al., 1964). Rhesus studied by HARLOW et al. (1963) showed an increase of maternal grooming until 30 days and a decrease following a peak at 2 months. HANSEN'S (1966) studies of rhesus macaques, also show a high rate of cradling for the first 2 months followed by a sharp decrease. His data on mother's reacting to strange infants, by cradling, clasping, and manipulating the infant showed similar results. Cradling was high during the first month while clasping and manipulating remained high an additional month. An overall index of maternal responses compiled by subtracting the index of negative behaviors from positive behaviors, was positive only during the first month.

One difference noted in rhesus macaques is that most females don't allow other females to groom their infant for the first 5 weeks and maternal grooming thereafter increases slightly and remains at a steady low level (HINDE & SPENCER-BOOTH, 1967). Infant baboons, in contrast, are similar to the langur, and show a high period of interaction with other females during the first 3 weeks (ROWELL et al., 1968).

Mouthing

HANSEN'S (1966) "orality" data in infant macaques showed some similarities to the langur. In a category of mouthing its mother, both mother-reared and surrogate-reared infants showed a peak at 1 month as in the langur. The second peak at 5-7 months in the rhesus never reappears in the langur. Self orality in surrogate-raised infant macaques shows the same 4-6 month peak as the langur. SEAY (1966) also found this increase from 2 to 6 months for surrogate raised infant macaques. Orality

directed at apparatus and toys by macaques (HANSEN, 1966) increased slowly from 1 to 15 months. In contrast langur mouthing of cage objects follows its general profile of self-mouthing.

An interesting parallel exists between langur oral exploration and manual exploration in squirrel monkeys. In the latter, manual exploration peaks at 2 months, decreases at 4 months and increases again at 6 to 7 months to finally decrease at 8 months (ROSENBLUM, 1968). It should be noted that squirrel monkeys and other New World monkeys ride their mother's back and do not show much nipple contact.

Mother-Infant Conflict

As in the langur, baboons display a clash in mother-infant interests (ROWELL et al., 1968). Restriction of infants by captive baboons which did not occur in the wild was most frequent from 3 to 8 weeks when the mother tries to prevent interaction with other females. Rhesus macaques show a similar pattern with restraint and retrieval increasing for the first 40 days, decreasing thereafter (HARLOW et al., 1963). This peak may extend until 2 months (HANSEN, 1966; HINDE & SPENCER-BOOTH, 1967).

Restraint and guarding in pigtail macaques follows a similar pattern, with main occurrence from 3 to 5 weeks (ROSENBLUM & KAUFMAN, 1967). Retrieval in pigtail and bonnet macaques peaks at 2 months and remains high to 3 months in bonnet and 4 months in pigtail macaques (ROSENBLUM & KAUFMAN, 1967). Similar data on pigtail macaque retrieval show high levels of retrieval from 1 to 6 months (KAUFMAN & ROSENBLUM, 1969).

Squirrel monkey mothers prevent departure most frequently from 6 to 8 weeks and retrieve the infant at greatest frequency at 6 weeks (ROSENBLUM, 1968).

Maternal Weaning

Nipple withdrawal and punitive deterrence is very different between the langur and macaques. In rhesus macaques, although occasional rejections were seen in the first week, they became common after the first 2 months and a peak occurred at 23-24 weeks and a higher one at the end of the first year (HINDE & SPENCER-BOOTH, 1967). Similar peaks at 5 and 11 months were noted by HANSEN (1966).

In pigtail macaques nipple withdrawal peaked during the first, fourth, and eighth months. Punitive deterrence increased to a high level from 4 to 9 months (KAUFMAN & ROSENBLUM, 1969). Bonnet macaques were more like the langur with a peak in nipple withdrawal and punitive deterrence at 4 months and another increase in punitive deterrence from 7-13 months (KAUFMAN & ROSENBLUM, 1969).

Paternal Care

In both the langur and baboons male interest is delayed. In baboons (ROWELL et al., 1968), the male's interactions are generally brief examinations of genitals, brief grooming, and lip smacking. In the wild they cuddle and carry the infant as do male langurs. In baboons there was little interaction in the first month followed by an increase in the second month. The Bronx Zoo male langur was already frequently carrying the infant by 2 months.

Play

A comparison of social play development in squirrels and macaques revealed similar frequency fluctuations (HORWICH, 1972). In general, information on monkey development indicates similar fluctuations. As in the langur there is an increase in play after 3 months, extending to about 6 months and another period occurs at about 1 year.

Squirrel monkey activity play develops rapidly after 2 to 3 months, peaking at 5 to 7 months, falling afterward and reappearing at 10 months (ROSENBLUM, 1968). Social play shows a peak at 3 to 6 months followed by a slight decrease, another peak at 8 months, and a low at 10 months.

In mother-raised rhesus macaque infants, rough-and-tumble play peaks between 2 and 5 months, again at 10–12 months, and once more at 22 months (HANSEN, 1966; HARLOW, 1965; HINDE & SPENCER-BOOTH, 1967). Approach-withdrawal play follows a similar pattern (HINDE & SPENCER-BOOTH, 1967).

Pigtail and bonnet macaques show similar fluctuations in play (KAUFMAN & ROSENBLUM, 1969). In social play, peaks in bonnet macaques were present at 5, 9, and 12 months. In pigtail macaques it was slightly earlier at 4 to 5, 8, and 11 months. Exercise play in pigtail macaques shows a bimodality peaking at 4 to 9 and 11 months. In bonnet macaques a high frequency of exercise play at 4 to 5 months slowly decreased.

Sexual Behavior

The absence of any sexual behaviors is notable when comparing the infant male langur with other male primates. Personal observations on primates have shown that sexual behaviors do commonly occur in infant males and in some females. In species such as mandrills, macaques, and baboons the behaviors are very frequent. I have even seen a complete male copulatory sequence performed by a two-month-old female Hamadryas baboon. In contrast, I never saw even an erection or anything resembling a mount in the infant langur.

Relationship of Nipple Contact to Finger and Object Mouthing

Motivations in object mouthing must be considered in at least two stages, during early and late development. During early ontogeny it is clear that a deprivation situation leads to increased finger sucking (LEVY, 1928, 1934; ROSS, 1951; DAVIS et al., 1948; KLACKENBERG, 1949). It is also clear that an initial period of finger mouthing is quite normal in infrahuman primates (personal observations on 17 species of monkeys and apes) and in man (KLACKENBERG, 1949; BRAZELTON, 1956; GESELL & ILG, 1937; KUNST, 1948).

Sucking in humans (HALVERSON, 1938) and nipple contact in the langur are not functions of hunger alone. Nipple contact aids young monkeys in maintaining an equilibrium of psychological security in their environment. It appears as though the relationship between nipple contact and mouth contact with other objects follows the same pattern as non-nutritive sucking and thumbsucking in humans. Following the initial period of high nipple contact, the infant langur still showed a propensity for oral contact with all kinds of objects. Much of this oral contact was directed at

inanimate cage objects and appeared to be exploratory in nature, as in humans (GESELL & ILG, 1937; KUNST, 1948; LANGFORD, 1939).

When the young langur appeared most insecure, it stayed closest to the female and exhibited a great amount of nipple contact. When it was in a more secure period it utilized its high oral motivation to explore its environment.

A direct comparison of period changes in the young langur with human babies reveals some basic similarities in motivational states (compare Fig. 12a (langur) with Fig. 25 (humans) taken from KUNST (1948) on non-nutritive sucking, WHITING (1954) on anxiety level, and ROSS et al. (1957), on preferential weaning ages i.e., optimal with regard to some measures of physical, social, and intellectual development). In humans there is an increase in the degree to which infants give indications of disturbance due to weaning from 0–2 weeks until a peak at 13–18 months, after which the amount of emotional disturbance decreases (Fig. 25, right side), reconstructed from WHITING, (1954). This curve of emotionality agrees with other data on fear at the sight of or of handling by strangers, which seem to be most evident at about 6–14 months and which decreases during the second year (SCARR & SALAPATEK, 1970; SCHAFFER, 1966; KESSEN & MANDLER, 1961; BAYLEY, 1932; FREEDMAN, 1971). Thumbsucking in humans initially inversely follows this anxiety curve with a rapid increase during the first 3 months and a subsequent decrease after 4 months (KUNST, 1948) when the anxiety level is just beginning to increase (Fig. 25, left side). However, the second increase in thumbsucking no longer inversely follows the anxiety peak, but seems to be an increase correlated with increased anxiety and regression back to infant behavior (HORWICH, 1974). BRAZELTON (1956) noted the increase of thumbsucking until 7 months of age and the virtual disappearance of it by 12 months except during stress

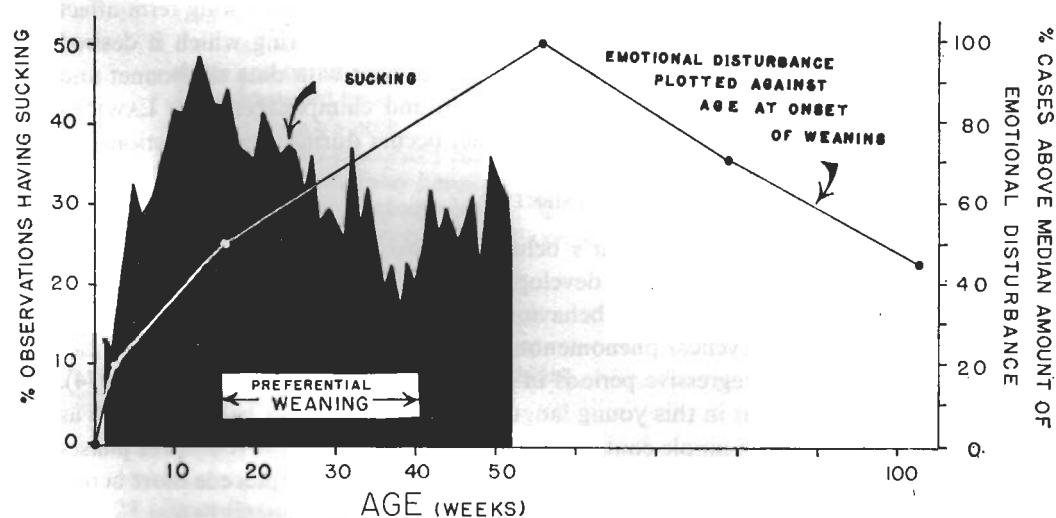


Fig. 25. The relationship of finger-sucking and emotional disturbance in humans. On the left is the percent of observations of infants sucking their hands while awake as a function of age (reconstructed from KUNST, 1948). On the right is the percent of children observed above the median amount of emotional disturbance (reconstructed from WHITING, 1954). Preferential weaning age range is taken from ROSS et al. (1957).

situations. Thus, in humans as in the langur, the initial "normal" peak of finger mouthing is related to some kind of oral gratification and exploration during a period of low anxiety and is thus not associated at this time with anxiety. However, in later periods after 1 year in humans and 4 months in the langur, it appears to be more related and used in situations of high tension or as in the langur and other primates observed following repulsion from the nipple. In both humans (KUNST, 1948), and the langur, a second peak in finger mouthing occurs. In the langur, this peak is no longer inversely correlated to the nipple contact, perhaps indicating a closer relationship to situational tensions.

It is during the early period of thumbsucking and of low anxiety that weaning of children seems to be easier to accomplish relative to maladjustment in school, timidity, and abnormal behavior. The coincident weaning ages recommended (ROSS et al., 1957) are 4-9 months (HOEFER & HARDY, 1929), 6-10 months (REARSON, 1931), and over 5 months (CHILDERS & HAMIL, 1932). Similarly, the female langur initiated the strongest weaning behavior toward her young at this same relative age when in conjunction with its exploratory sucking the infant stayed off her nipple most of the time (Fig. 12a). Additional anxiety was produced by the mother's initial and highest level of weaning attempts in which the young then seemed to get a tranquilizing effect by displacing its oral behaviors from the mother's nipple to her hands and to its own hands as a substitution for the nipple. Finger sucking as a tranquilizing release from frustration or fear has been noted in man and other animals (MCKEE & HONZIK, 1962; LANGFORD, 1939). The nipple has also been seen to serve as a pacifier in goats and man (ADLER, LINN, & MOORE, 1958), in a young gorilla (JACOBSON et al., 1932), in baboons (GILLMAN, 1941), and in 13 other species of Old World monkeys and four species of apes (personal observations).

It is also possible that repulsions from the nipple may have had a long term affect of causing the young to proceed into an insecurity period during which it desired more nipple contact for pacification. This is in agreement with data on bonnet and pigtail macaques (KAUFMAN & ROSENBLUM, 1969) and chimpanzees (VAN LAWICK-GOODALL, 1968) in which closer maternal contact occurs during weaning actions.

FLUCTUATION IN BEHAVIORAL DEVELOPMENT

Development of the infant langur's behaviors clearly points out the fluctuating nature of development. Behavioral development, rather than gradually proceeding unidirectionally from one level of behavior frequency to a higher or lower level, instead shows a crude cyclical phenomenon. This is common in primates and other mammals which show regressive periods in mother-infant contact (HORWICH, 1974). Behavioral interrelations in this young langur point out that other behaviors such as play form a pattern with nipple contact fluctuations (Fig. 24). These regressive phases seem to function as physical and psychological rest periods which precede more active periods of growth in the infant.

APPENDIX

Initiation of behaviors (first noticed)

- Day 1 – nipple searching, nursing, switches nipples with nipple searching between sucking, licks tongue out.
 – pushes up on feet.
 – extends hand to ground without probing or manipulation, leans body back and looks around.
 – leg scratch reflex, precursory hand scratching.
- Day 2 – flails arms out vigorously.
- 3 – better feet gripping ability.
 – clenches fist after extending hand, reaches toward bars without grasping.
 – yawns.
 – coordinated arhythmic hand scratching.
- 5 – more deliberate flailing of arms.
 – directs gaze and projects hand toward object.
- 6 – mouths hand.
 – looks around with nipple in mouth.
 – paws at female's chest and picks at own hair uncoordinatedly.
 – uncoordinated hand scratch directed at own body and knee, shakes head and shoulders.
- 8 – hand scratches back.
- 9 – sucks female's thumb.
- 10 – set on floor alone as he holds female.
 – coordinatedly hand scratches female's knee.
 – sucks female's knee.
- Day 12 – switches nipples when nursing without searching.
 – head falls off nipple while sleeping.
 – stretches hands out in jerky uncoordinated motions, watching them intently.
 – hand scratches rump.
- 14 – tries to climb bars.
 – flails tail side to side.
 – sniffs and mouths food.
 – fully developed hand scratching of extended leg.
 – mouths female's neck.
- 15 – uncoordinated precursory hind leg reflex scratch.
 – jumping in place (play jump).
- 16 – hind leg scratch contacts side.
 – very conscious of external stimuli (keepers, objects, public, etc.).
- 20 – rubs eye with closed fist.
 – 4-6 teeth on upper jaw.
 – grasps food to bring it in.
- 22 – hind leg scratches neck.
 – female consistently leaves infant alone.
- 22 – uncoordinated jumping.
- 25 – sucks foot (toe).
 – manipulates and mouths female's tail.
- 27 – holds and scratches tail.
- 29 – coordinated climbing.
- 31 – jumps 2 feet onto female's lap, female first directs a bite in punishment toward female, cups infant under chin as beginning of tonguing punishment.
- Day 34 – climbs on female's back, play shakes.
- 38 – bites female's hands in play.
- 41 – precursory grooming of female's toes.

- oriented hind leg scratch to head.
- 42 - initiates play with juvenile.
 - walks on ground by self.
- 44 - runs (gallops).
- 50 - chews and swallows food.
- 56 - tail carried in air, sniffs female's rear.
 - picks and mouths own knee hair.
- 57 - walks across 5' large bore, smooth bar and back alone.
 - female tongue punishes infant after pulling him off of her.
- 68 - walks on hind legs only.
 - hangs on male's tail.
- 84 - walks with tail looped over back.
 - jumps to ground alone.
- 123 - picks at male's face.
- 136 - eyes closed in play.
- 167 - young didn't cry when left far behind.
- 175 - plays with male.
- 205 - clasps with juvenile (precursor?).
- 210 - precursory combing alternately with two hands, mouthing of fur and lip smacking.
- 241 - aggressive biting.
- Day 254 - brachiation.
- 273 - presents to male.
- 328 - male pushes infant to present consistently.
- 347 - presents to juvenile.
 - stays in present posture when male arranges it.

Acknowledgements. I would like to extend my thanks to the keepers, TONY BLUEMAN, WALLY HAHN, JIM ROWELL, and especially JOHN O'CONNOR for their help and cooperation in this study. Thanks also go to Drs. BEN BECK, GEORGE RABB, and CHRIS WEMMER for their critical reading of the manuscript and to MARY NICHOLS and DOLORES FISERA for the typing of it. Credit for the photograph goes to LELAND LAFRANCE and for photographs of the figures to PAT BOROWCZYK. I am also grateful for the help extended to me from the staff and keepers of the Bronx Zoo.

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—Received July 10, 1973; Accepted December 24, 1973.

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