

VI. EARLY LIFE AND DEVELOPMENTAL STUDIES

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EARLY BEHAVIOR PATTERNS OF SQUIRREL MONKEYS (*Saimiri sciureus*)

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Vital food nourishment and maintenance of contact with the mother are normally assured for infant primates by maternal support and assistance, and by reflex-like responses. These include head-turning and mouth-grasping, commonly called the rooting reflex, and hand and foot clasping and grasping reactions as well as auditory and visual orienting responses. Inasmuch as comparison of the neonatal rhesus monkey, chimpanzee, and human indicate a phyletic trend toward a lessening in the strength, persistence and consistency of these primitive infantile responses, MASON [1965] and others [PEIPER, 1963] have suggested that through evolution a complementary trend has occurred so that the degree to which maternal support and assistance is provided varies inversely with the overall efficiency of such early behavior patterns.

In view of this suggested phyletic trend on the ontogeny of infantile behavior patterns in Old-World primates it seems worthwhile to extend such studies to some New-World forms, such as the squirrel monkey. In addition, investigations concerning the normal postnatal development of a wide spectrum of reflexes and sensory motor skills have contributed to our understanding of the mother-infant interactional pattern in the social development of the macaque and the chimpanzee [MASON, 1965]. One of the more recent of these studies was that of MOWBRAY and CADELL [1962] on the early behavior patterns of rhesus monkeys. Moreover since the squirrel monkey has become increasingly important as the primate of choice for a large variety of biomedical research problems, a composite picture of its normal behavior development would seem necessary prior to any biomedical manipulations.

METHOD

Subjects. Three squirrel monkeys were observed daily from birth for at least 50 days, and a fourth animal was observed for the first twelve days of life. All the monkeys were of the Peruvian type (two males and two females) and were taken from the mothers each day for approximately one-half hour and then returned. Except for monkey 242, the infants received all their required sustenance from the mother. Although the mother of monkey 242 was multiparous, the previous parity of the other three mothers was unknown. Each mother became greatly excited when her infant was taken and immediately relaxed when the infant was returned and placed on her back. From birth until the conclusion of the study all mother-infant pairs were caged separately.

Procedure. The onset, acquisition and loss of early behavior patterns were recorded using rating scales similar to those used by MOWBRAY and CADELL [1962]. A three-point scale was used in which 2 indicated a full response, 1 indicated a partial response, and 0 indicated the absence of the behavioral pattern (fig. 1). No attempt was made to identify the neuromuscular units involved in these early behavior patterns.

1. *Rooting.* An eye-dropper was placed in contact with the infant's cheek. Immediate placement of the mouth on the object was scored as a full response. Slow movement and placement of the mouth was scored as a partial root.

2. *Vision.* The examiner held the infant so that it faced a black background at a distance of approximately 18 in, and a small earring containing several rhinestones was slowly moved back and forth through the visual field at a distance of approximately 4 in from the animal's eyes (fig. 1 a). A full response was scored if the animal followed the object with both head and eye movements; following with eye movements only or with only slight head movements was scored as a partial response.

3. *Audition.* A set of keys was jingled at approximately 135° azimuth from the front of the animal's head (fig. 1 b). On the first day that the infants were tested, 5 trials were given; thereafter only a single trial was given at each test session with intermittent tests of 5 trials. A full head turn in the direction of the sound source was scored as a full response; partial head turn was scored as a partial response.

4. *Head-up orientation.* This procedure consisted of placing the infant ventrally on a 45–60° inclined plane covered with terry cloth with the head oriented downward (fig. 1 h). The animal was given 2 min to reverse its orientation 180° so that its head and body oriented upward. A score of 2 was given if a full reversal was made; a score of 1 if the animal reoriented itself 90° but less than 180°; and a score of 0 if the animal failed to reorient itself at least 90°

5. *Climbing.* The infant was placed on an inclined plane of approximately 45–60° which was covered by a piece of terry cloth (fig. 1 i). Forward locomotion of 12 in was scored as a full response; a climb of 6 in but less than 12 in was scored as a partial response; and failure to climb at least 6 in was scored as a failure.

6. *Grasping.* In this test, hands and feet were scored separately. The infant was placed ventrally on a flat surface. One limb was raised and a normal-size pencil was thrust against the volar surface. If the infant clutched the pencil, held on, and was lifted clear off the table, a full response was scored; a partial response was scored if the animal grasped or clutched the pencil with the hand or foot but released as the pencil was brought up.



Fig. 1. Behavioral tests: *a* visual orientation; *b* auditory orientation; *c* tail-hang; *d* clasp; *e* partial release and right; *f* falling (note self grasp); *g* landing position after free fall during second week of life; *h* reorientation on terry cloth (note grasping of left foot on left arm; *i* climbing on terry cloth.

7. *Clasping*. The clasping test was conducted with a 5 1/2-in cylinder of approximately 5/8-in diameter, which was pushed against the ventral surface of an infant lying on its back (fig. 1 d). If arms and legs encircled the cylinder and the animal could be lifted off the table, a full response was scored; a partial response was one in which the animal clasped using the legs only and could still be lifted off the table.

8. *Righting and releasing*. As the infant clasped the cylinder it was lowered until the dorsal side of the infant rested on the table surface. A full response consisted of releasing a clasp with both hands and feet and turning to a position of ventral contact with the table. Releasing hands with feet still clasping on (often feet grasped the tail – see fig. 1 e) without full righting was scored 1; failure to release and right within 1 min was scored 0. In another test infants were placed on their backs without anything to clasp and were given 1 min to return to a position of ventral contact with the table.

9. *Tail-hang*. When a finger was placed near the base of the ventral surface of the tail, all infants could be suspended by the tail for varying periods of time. The animal curled its tail around the finger and the examiner lifted his hand up so that the animal hung head down (fig. 1 c).

10. *Free-fall and landing*. The animal was dropped onto a pillow from a height of approximately 12 in and landing postures were observed (fig. 1 f, g).

RESULTS

The day of onset and disappearance of the behavior patterns for each of the monkeys is listed in table I.

1. *Rooting*. Although all infants showed a full rooting response within 8 days of birth, the response was inconsistent both between and within individuals. This was not unexpected since rooting is known to vary inversely with food satiation (among other variables) and no attempt was made to control the level of food intake by the infants prior to testing.

2. *Vision*. Consistent visual orientation occurred between 9 and 13 days. Development of visual following in squirrel monkeys appears similar to that of rhesus monkeys (fig. 2 b). ROSENBLUM [in press] noted that at the end of the first week the squirrel monkey infant repeatedly raises and turns its head with the eyes opened widely while clinging to the mother's back.

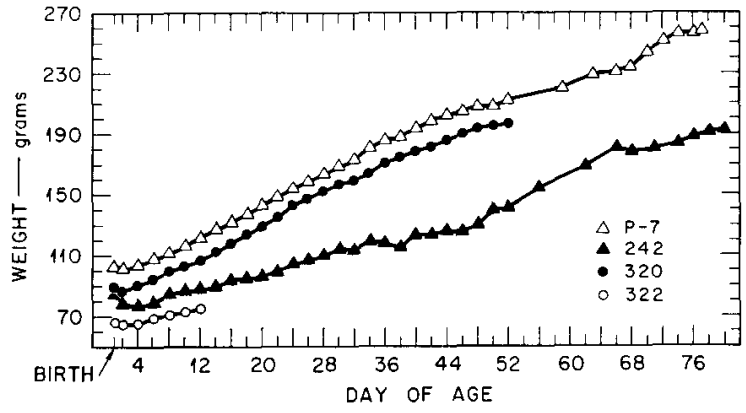
3. *Audition*. All infants showed immediate and persistent sound localization on the first day tested. Unfortunately three of the four animals were not tested until the sixth day of life; however, one which was tested within 24 hours of birth showed perfect sound localization (fig. 2 b). JAMES and PRISCILLA KING (personal communication) used a metallic clicker to test sound localization in four squirrel monkey infants and found excellent localization within the first four days of life. MOWBRAY and CADELL [1962] showed that infant rhesus monkeys respond to lip smacking sounds within 24 h of birth.

Table I. Day of appearance or disappearance of early behavior patterns

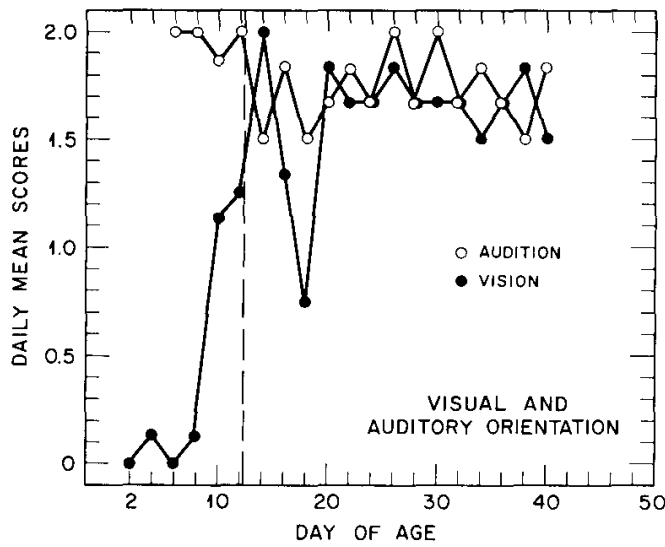
Pattern	Animal			
	242	320	P-7	322
Rooting				
First day of full root	7	8	8	2
Vision				
First day of visual following	13	10	9	12
Audition				
First day of turning head to locate sound source . .	6 ¹	6 ¹	6 ¹	1
Releasing and righting				
First day of righting	2	3	1	2
First day of hands releasing	2	2	2	4
First day of complete releasing and righting	6	3	4	5
Head-up orientation				
First day of 180° orientation	2 ²	3	1	1
Locomote				
First day of 6 in forward movement	6	7	11	5
Climb				
First day of 12 in climb	2 ²	3	8	5
Tail hang				
First day of tail hang < 5 sec	32	3	11	—
Day of last tail hang	37	5	30	—
Clasp				
First day of clasp and lift with feet only	27	7	8	—
Last day of full clasp	26	27	35	—
Last day of any clasp	45	30	36	—
Grasp				
First day of grasp and release of either hand	25	26	24	—
First day of grasp and release of either foot	61	42	28	—
Last day of full grasp of either hand	48	45	39	—
Last day of full grasp of either foot	69	—	65	—
Free Fall and landing				
First day of limb extension	6	5	11	6
First day of hind limb flexion	33	39	32	—
First day of full flexion	66	—	52	—

1 First tested on the sixth day of life.

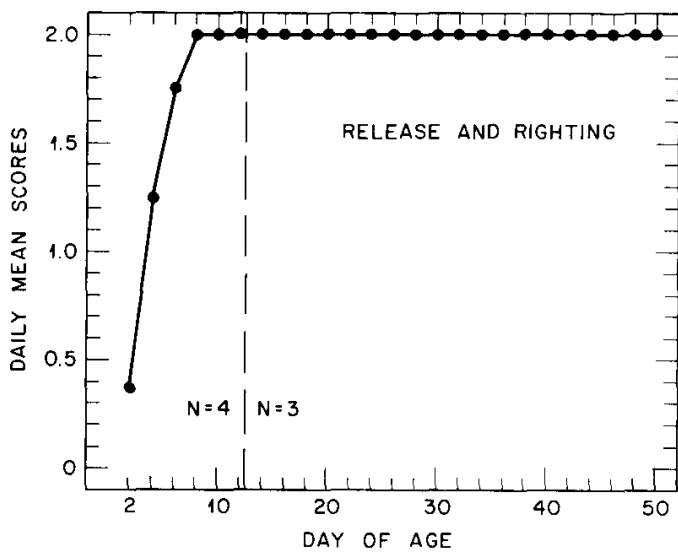
2 First tested on the second day of life.



2 a



2 b



2 c

Fig. 2a, b, c. Development and loss of infant squirrel monkey behavior patterns.

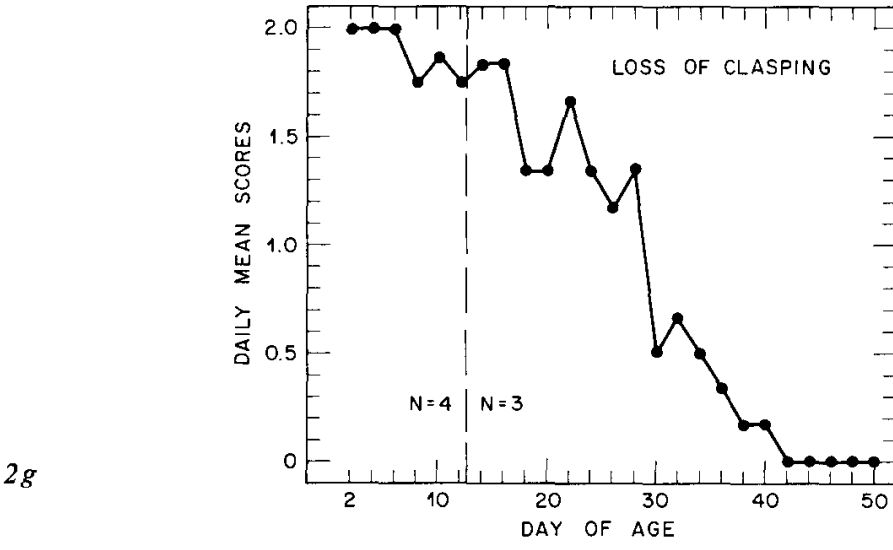
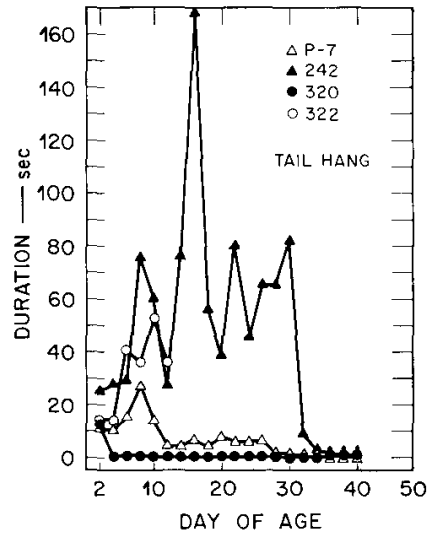
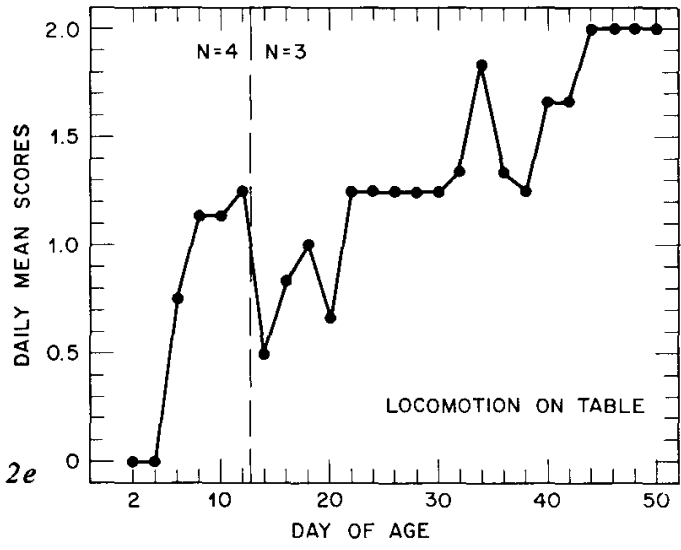
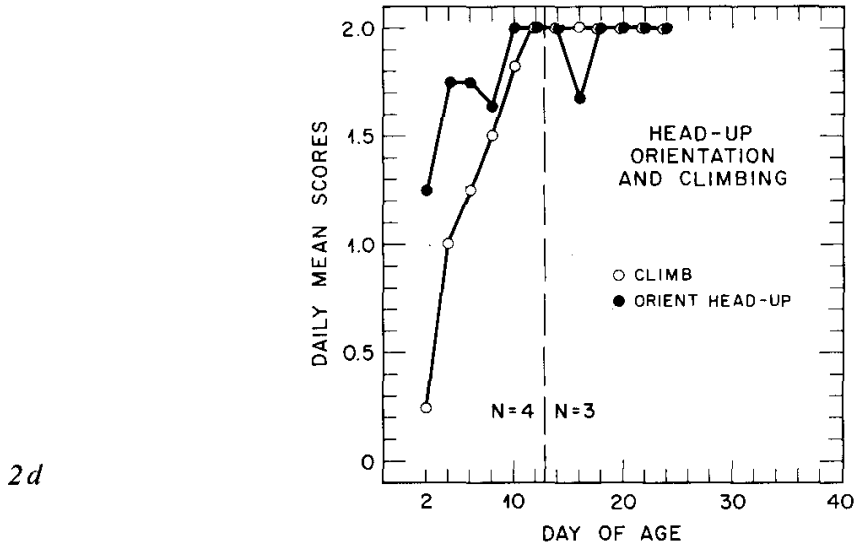
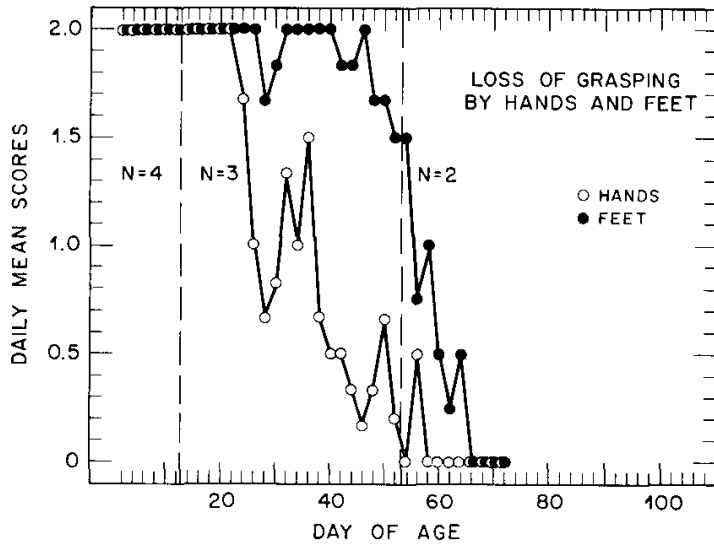


Fig. 2d,e,f,g. Development and loss of infant squirrel monkey behavior patterns.



2 h

Fig. 2h. Development and loss of infant squirrel monkey behavior patterns.

4. *Head-up orientation.* All infants showed complete 180° reorientation from 1 to 3 days of life (fig. 2d). It may be concluded that this negative geotactic response is present at birth in the infant squirrel monkey. This behavior pattern develops more slowly in rhesus monkeys.

5. *Climbing.* All infants demonstrated a 12-inch climb between 2 and 8 days of age (fig. 2d).

6. *Grasping.* On the first day of life, all squirrel monkey infants showed grasping which was firm enough so that the animal could hang by one of its limbs. Grasping by hands remained strong during the first 3 weeks and then declined sharply. Grasping by feet remained strong during the first 7 weeks and then dropped precipitously (fig. 2h). This differential loss of grasping has also been found in macaque monkeys, and in the squirrel monkey it is probably related to ROSENBLUM's observation that the onset of manual exploration of the infant while still clinging to the mother with the feet begins during the third week. In contrast to the much slower disappearance of the grasping patterns in the squirrel monkey, the rhesus monkey completely loses reflexive grasping between 20 and 25 days of age. The slower decline of grasping by the squirrel monkey may be an adaptation to the lack of any extensive support offered by the mother in normal circumstances.

7. *Clasping.* The clasping pattern was demonstrated in all infants within 24 hours of birth and declined gradually thereafter (fig. 2g).

8. *Righting and releasing.* In contrast to the rhesus monkey infant in which a full righting and release pattern occurs after about 8 days, this pattern emerged on the

average as early as 4 to 5 days in the infant squirrel monkey (fig. 2c). Partial righting and release, that is release of the hands and turning the trunk while still clasping with the feet appeared as it does in the rhesus as an intermediate stage between no release and full release. During this intermediate stage, an infant would frequently cry and try to release its feet but to no avail (fig. 1e).

9. *Tail-hang*. The infant's tail appears to play an important role as a support mechanism in the early attachment to the mother. Tail-hanging disappeared at differential rates for each of the individual infants, and persisted for as long as 37 days in the most immature of the infants (fig. 2f).

10. *Free-fall and landing*. Four distinct response patterns were observed when the infant landed. The sequence of these patterns was as follows. During the first week, the infant would grasp itself as it was dropped and fell curled up in a ball. From the second week through the fourth week, the infants began extending their limbs upon falling with the ventral surface of the body touching the pillow at impact. From the fifth to the seventh or eighth week, the animals landed with the hind limbs fully flexed a moment after impact and the ventral surface no longer touched the pillow; however, the arms were not as yet fully flexed and were slightly extended. At the end of the second month and beginning of the third month of life, the infants landed on the soles of all four limbs which were fully flexed at impact.

DISCUSSION

When this study began in July, 1967, the only information we had on the normal developmental behavior of infant squirrel monkeys was that supplied by our own observations and those of R. W. COOPER [personal communication] and VANDENBERG [1966]. All such observations were consistent in indicating that the normal infant maintains relatively close contact with the mother from birth to at least two months by clasping onto her back and occasionally clinging to her lateral and ventral surface while nursing. Combining the present observations with ROSENBLUM's recently completed and extensive study of mother-infant relationships in squirrel monkeys [ROSENBLUM, in press] we now have a better understanding of the relationship between early behavior patterns of the infant and mother-infant interactions in this New-World primate species.

Detailed observations of the interactions of mother and infant monkeys [ROSENBLUM, in press] suggest that in contrast to Bonnet and Pigtail macaques support is never provided by the mother squirrel monkey to its infant unless the infant is debilitated in some way [PLOOG *et al.*, 1967; RUMBAUGH, 1965]. The squirrel monkey infant appears better suited for maintaining contact and for moving about on the body of the mother than these Old-World species.

SUMMARY

Three *Saimiri sciureus* were observed daily from birth to at least 50 days and a fourth for the first 12 days of life. The onset, development, and loss of early behavior patterns were recorded using rating scales. Many of these behavioral patterns showed consistent changes with growth.

The present results showing the early onset of a head-up orientation, climbing skills, strong and persistent grasping and clasping patterns and the early use of a prehensile tail as a support mechanism suggest that the squirrel monkey's repertoire of early behavior may be better suited for maintaining contact with the mother than that of Old-World species.

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