Depression in Infant Monkeys Separated from Their Mothers

Abstract. *The mothers of four pigtail* (Macaca nemestrina) *infants living in a group were removed for 4 weeks. All infants reacted initially with agitation. Three of the four infants then became severely depressed. The depression lasted about a week and was strikingly similar to the "anaclitic depression" of human infants who lost their mothers. When they were reunited, all four dyads showed a marked and prolonged intensification of the mother-infant relationship.*

In children severe and serious effects are known to follow separation from mother for more than a brief period (*1, 2*). Higher organisms, who are not precocial, require parental care to develop normally. The relationship between infant and mother is thus crucial and the consequences of its disruption are momentous (*3*).

In our study of infant pigtail monkeys (*Macaca nemestrina*) we found two striking effects of a 1-month separation: (i) three of four infants developed a severe depression, and (ii) in all four there was a marked and long-lasting intensification of the mother-infant relationship after the mother and infant were reunited.

The subjects were four infant monkeys, 4.8 to 6.1 months of age at separation, who were born in the laboratory and raised from birth by their feral mothers in a group which also included their sire and an infantless adult female. The group, which had been together for over 2 years at the start of the study, was housed in a pen 2.4 m wide, 4 m deep, and 2.1 m high (*4*). Observations, made through one-way vision windows, began 1 to 2 months before separation and continued for 3 months after reunion. They were spread over 3 to 5 days per week, for a total of about 2 hours per week for each dyad in the month before and after separation, and for each infant alone during separation. Observation time was reduced by half in the second and third months after reunion. With a keyboard-clock-counter device the observer recorded the total duration and frequency of a wide variety of behaviors by the mother and the infant; they included, for the infant, both filial and nonfilial behaviors and, for the mother, both maternal and nonmaternal behaviors (*5*).

The physical separation of mother and infant was done outside the pen with a minimum of handling and trauma. The mother was placed in a separate location, and the infant was returned to the group. After 4 weeks the mother was returned to the group. There was a 3-week overlap in the separations of the first two infants, and again in the separations of the second two, approximately 10 weeks later.

The reaction during separation, in three infants, fell into three phases: agitation, depression, and recovery (*6*). The fourth infant showed only the first and third phases. During the first phase pacing, searching head movements, frequent trips to the door and windows, sporadic and short-lived bursts of erratic play, and brief movements towards other members of the group seemed constant. Cooing, the rather plaintive distress call of the young macaque, was frequent. There was an increased amount of self-directed behavior, such as sucking of digits, and mouthing and handling of other parts of the body, including the genitals (Fig. 1). This reaction persisted throughout the first day, during which time the infant did not sleep.

After 24 to 36 hours the pattern in three infants changed strikingly. Each infant sat hunched over, almost rolled into a ball, with his head often down between his legs. Movement was rare except when the infant was actively displaced. The movement that did occur appeared to be in slow motion, except at feeding time or in response to aggression. The infant rarely responded to social invitation or made a social gesture, and play behavior virtually ceased (Fig. 1). The infant appeared disinterested in and disengaged from the environment (Fig. 2). Occasionally he would look up and coo (*7*).

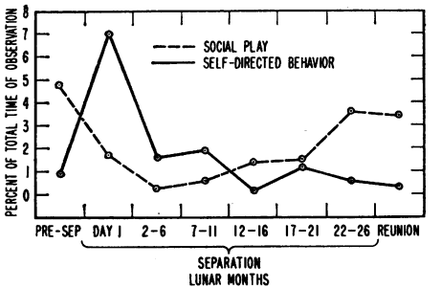

Fig. 1. Mean duration of self-directed behaviors and of social play for all four infants during the month before separation, successive periods of the month of separation, and the month after reunion.

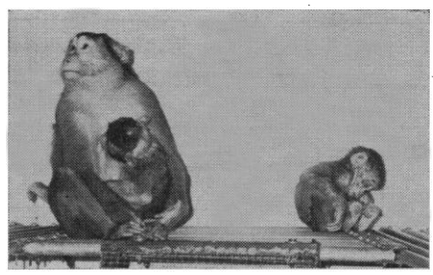

Fig. 2. A depressed motherless pigtail infant showing the characteristic posture. He is completely disengaged from the mother (not his) and her infant sitting nearby in close ventral-ventral contact.

After persisting unchanged for 5 or 6 days the depression gradually began to lift. The recovery started with a resumption of a more upright posture and a resurgence of interest in the inanimate environment. Slow tentative exploration appeared with increasing frequency. Gradually, the motherless infant also began to interact with his social environment, primarily with his peers, and then he began to play once again. The depression continued, but in an abated form. Periods of depression alternated with periods of inanimate-object exploration and play. Movement increased in amount and tempo. Toward the end of the month the infant appeared alert and active a great deal of the time; yet he still did not behave like a typical infant of that age.

The fourth infant, the offspring of

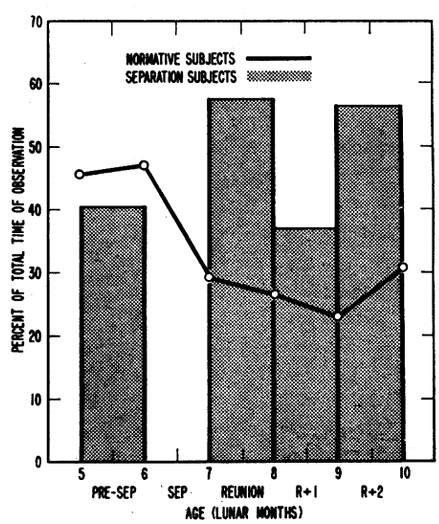

Fig. 3. Mean duration of ventral-ventral contact between mother and infant for four pigtail dyads over the course of the separation study (represented by the columns) and for nine pigtail dyads that were not separated over the same age period (represented by the line of points).

the dominant female, did not show the phase of depression. During the agitation phase, unlike the other infants, she spent a great deal of her time with the adult females in the group. As she recovered she became actively involved in exercise play and in exploration of the inanimate environment, followed later in the month by social play. However, the nondepressed infant showed many of the same behavioral changes as the other infants.

During the separation month all four showed a significant increase in self-directed behavior ($P < .05$) and exploration of inanimate objects ($P < .01$), and a significant decrease in play ($P < .01$), both social and nonsocial. The early reaction to separation included a drastic fall in social play and a great rise in self-directed behavior, whereas recovery was accompanied by a gradual rise in social play and normal levels of self-directed behavior (Fig. 1).

When the mother was reintroduced to the group another dramatic change occurred. There was a tremendous reassertion of the dyadic relationship with marked increases in various measures of closeness in all four pairs. Clinging by the infant (Fig. 3), protective enclosure by the mother, and nipple contact all rose significantly ($P < .01$) in the month after the reunion as compared to the frequency of these actions in the month before separation. Even in the third month after the reunion this trend was evident. This significant rise in measures of dyadic closeness is particularly striking in view of the fact that ordinarily for the age periods involved (*8*) these particular behaviors fall considerably.

The increased closeness was manifest in other ways as well. A measure of mother-infant physical separation that we have found valuable in our normative studies concerns departures (usually by the infant) to another level of the pen. The frequency of such departures during the month after the reunion fell to 20 percent of the departures in the month before the separation. Furthermore, the mean duration of these departures fell from 60.5 seconds to 34.4 seconds. Finally, maternal behavior which normally discourages dyadic cohesiveness at this age, such as punitive deterrence and nipple withdrawal, appeared very rarely (*9*).

The individual differences in the reaction to separation may in part be explained in terms of the ontogenetic influence of the regulation of monkey behavior by the dominance hierarchy (*10*). The offspring of dominant females may develop greater coping ability and thus have a greater likelihood of survival if the mother is lost. This is consistent with selective advantage of dominance.

The stages of the reaction appear to be successive efforts at adaptation. The first two stages are comparable to the two basic response systems proposed by Engel (*11*) as available to the organism for dealing with mounting stress. The agitated phase, which appears to coincide with Engel's "flight-fight" response pattern, is likely to effect reunion with mother, if she is available. The second stage is strikingly similar to the syndrome of "anaclitic depression," reported by Spitz (*2*), in human infants separated from their mothers, an example of the response pattern described by Engel as "conservation-withdrawal, [which] involves inactivity . . . and withdrawal from the environment," and which appears to conserve energy and avoid injury. The striking similarity between the early stages of the reaction to separation of pigtail infants and children suggests that the mediating central nervous response systems may be common to both species. The third stage, recovery in the continued absence of the mother, which was not reported in the human infants, may in the monkey infant be attributed to his greater locomotor ability, which enables him to reengage the environment actively on his own.

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4. The characteristics of the pen are detailed in L. A. Rosenblum, I. C. Kaufman, A. J. Stynes, *Animal Behav.* **12**, 338 (1964).
5. I. C. Kaufman and L. A. Rosenblum, *Primates* **7**, 205 (1966). All scores were transformed into percentages of total time of observation to equate for variations in the length of observation. Repeated measures analyses of variance were utilized throughout to assess the statistical significance of the data.
6. Seay and Harlow (*3*) have described an initial "violent protest" in separated rhesus infants followed by a stage "characterized by low activity, little or no play, and occasional crying." Hinde *et al.* (*3*) in their study of separated rhesus infants also noted increased crying and a reduction in play and locomotor behavior, and described "a characteristic hunched posture."
7. The facial expression had an appearance similar to that which Darwin [*The Expression of the Emotions in Man and Animals* (1872) (Philosophical Library, New York, 1955)] described and believed "to be universally and instantly recognized as that of grief."
8. L. A. Rosenblum and I. C. Kaufman, in *Social Interaction Among Primates* (Univ. of Chicago Press, Chicago, in press); I. C. Kaufman and L. A. Rosenblum, in *Determinants of Infant Behavior IV* (Methuen, London, in press).
9. Hinde *et al.* (*3*) reported that after reunion only one pair showed a long-lasting increase in closeness. Seay and Harlow (*3*) found that despite an increase of mother-infant contact on the first reunion day the increase disappeared within 2 weeks. They concluded that "the result of mother-infant separation on the mother-infant relationship of these animals was transient and apparently unimportant." In this regard our results differ dramatically from theirs, since we found a marked and long-lasting intensification of the relationship in all our dyads.
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12. We thank W. Barnett for assistance. Research supported by USPHS grant MH-04670; authors supported by USPHS grants 1-F3-MH-31,925 and K3-MH-23,685.
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Disruption of Hibernation Caused by Hypothalamic Lesions

Abstract. *Lesions were made in the preoptic-anterior hypothalamic area or ventromedial nucleus of ground squirrels* (Citellus tridecemlineatus). *Four squirrels, two with preoptic damage and two obese hyperphagics, entered hibernation within 1 to 3 days. They all died after 11 to 12 days, shortly after all normal hibernating squirrels had awakened. Seven squirrels with preoptic damage, rendered hypothermic before being placed in the cold, died within 2 to 6 days.*

In hibernators, as in homeotherms, appropriate hypothalamic lesions cause disturbances in three important regulatory systems—temperature, food intake, and sleep and wakefulness. For instance, when ground squirrels were rendered hypothermic and allowed to return to normal body temperature in an environment of 10°C, animals with lesions in the preoptic-anterior hypo-