Love in Infant Monkeys

Affection in infants was long thought to be generated by the satisfactions of feeding. Studies of young rhesus monkeys now indicate that love derives mainly from close bodily contact

by Harry F. Harlow

The first love of the human infant is for his mother. The tender intimacy of this attachment is such that it is sometimes regarded as a sacred or mystical force, an instinct incapable of analysis. No doubt such compunctions, along with the obvious obstacles in the way of objective study, have hampered experimental observation of the bonds between child and mother.

Though the data are thin, the theoretical literature on the subject is rich. Psychologists, sociologists and anthropologists commonly hold that the infant's love is learned through the association of the mother's face, body and other physical characteristics with the alleviation of internal biological tensions, particularly hunger and thirst. Traditional psychoanalysts have tended to emphasize the role of attaining and sucking at the breast as the basis for affectional development. Recently a number of child psychiatrists have questioned such simple explanations. Some argue that affectionate handling in the act of nursing is a variable of importance, whereas a few workers suggest that the composite activities of nursing, contact, clinging and even seeing and hearing work together to elicit the infant's love for his mother.

Now it is difficult, if not impossible, to use human infants as subjects for the studies necessary to break through the present speculative impasse. At birth the infant is so immature that he has little or no control over any motor system other than that involved in sucking. Furthermore, his physical maturation is so slow that by the time he can achieve precise, coordinated, measurable responses of his head, hands, feet and body, the nature and sequence of development have been hopelessly confounded and obscured. Clearly research into the infant-mother relationship has need of a more suitable laboratory animal. We believe we have found it in the infant monkey. For the past several years our group at the Primate Laboratory of the University of Wisconsin has been employing baby rhesus monkeys in a study that we believe has begun to yield significant insights into the origin of the infant's love for his mother.

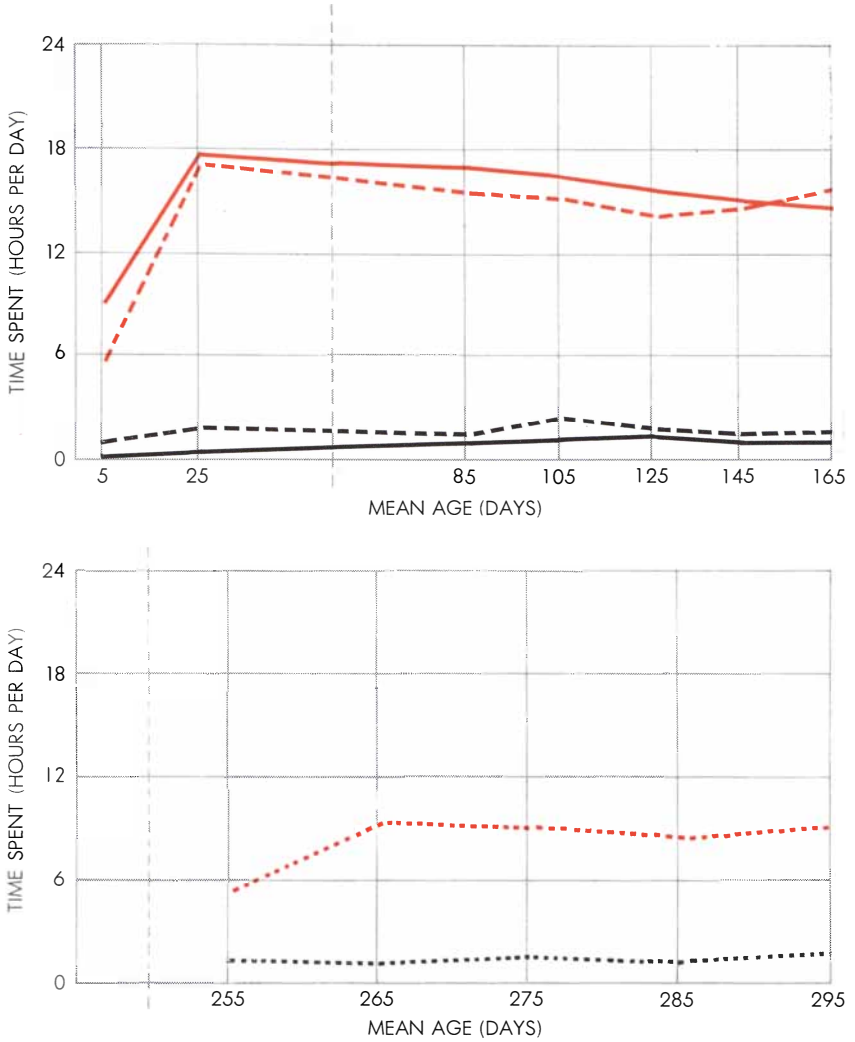
Baby monkeys are far better coordinated at birth than human infants. Their responses can be observed and evaluated with confidence at an age of 10 days or even earlier. Though they mature much more rapidly than their human contemporaries, infants of both species follow much the same general pattern of development.

Our interest in infant-monkey love grew out of a research program that involved the separation of monkeys from their mothers a few hours after birth. Employing techniques developed by Gertrude van Wagenen of Yale University, we had been rearing infant monkeys on the bottle with a mortality far less than that among monkeys nursed by their mothers. We were particularly careful to provide the infant monkeys with a folded gauze diaper on the floor of their cages, in accord with Dr. van Wagenen's observation that they would tend to maintain intimate contact with such soft, pliant surfaces, especially during nursing. We were impressed by the deep personal attachments that the monkeys formed for these diaper pads, and by the distress that they exhibited when the pads were briefly removed once a day for purposes of sanitation. The behavior of the infant monkeys was reminiscent of the human infant's attachment to its blankets, pillows, rag dolls or cuddly teddy bears.

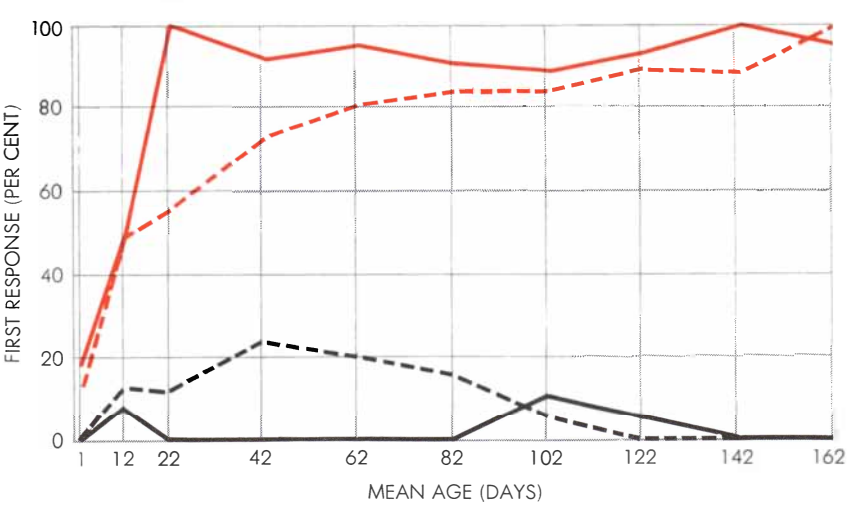
These observations suggested the series of experiments in which we have sought to compare the importance of nursing and all associated activities with that of simple bodily contact in engendering the infant monkey's attachment to its mother. For this purpose we contrived two surrogate mother monkeys. One is a bare welded-wire cylindrical form surmounted by a wooden head with a crude face. In the other the welded wire is cushioned by a sheathing of terry cloth. We placed eight newborn monkeys in individual cages, each with equal access to a cloth and a wire mother [*see illustration on opposite page*]. Four of the infants received their milk from one mother and four from the other, the milk being furnished in each case by a nursing bottle, with its nipple protruding from the mother's "breast."

The two mothers quickly proved to be physiologically equivalent. The monkeys in the two groups drank the same amount of milk and gained weight at the same rate. But the two mothers proved to be by no means psychologically equivalent. Records made automatically showed that both groups of infants spent far more time climbing and clinging on their cloth-covered mothers than they did on their wire mothers. During the infants' first 14 days of life the floors of the cages were warmed by an electric heating pad, but most of the infants left the pad as soon as they could climb on the unheated cloth mother. Moreover, as the monkeys grew older, they tended to spend an increasing amount of time clinging and cuddling on her pliant terry-cloth surface. Those that secured their nourishment from the wire mother showed no tendency to spend more time on her than feeding required, contradicting the idea that affection is a response that is learned or derived in asso-

CLOTH AND WIRE MOTHER-SURROGATES were used to test the preferences of infant monkeys. The infants spent most of their time clinging to the soft cloth "mother," (*foreground*) even when nursing bottles were attached to the wire mother (*background*).



STRONG PREFERENCE FOR CLOTH MOTHER was shown by all infant monkeys. Infants reared with access to both mothers from birth (*top chart*) spent far more time on the cloth mother (*colored curves*) than on the wire mother (*black curves*). This was true regardless of whether they had been fed on the cloth (*solid lines*) or on the wire mother (*broken lines*). Infants that had known no mother during their first eight months (*bottom chart*) soon came to prefer cloth mother, but spent less time on her than the other infants.



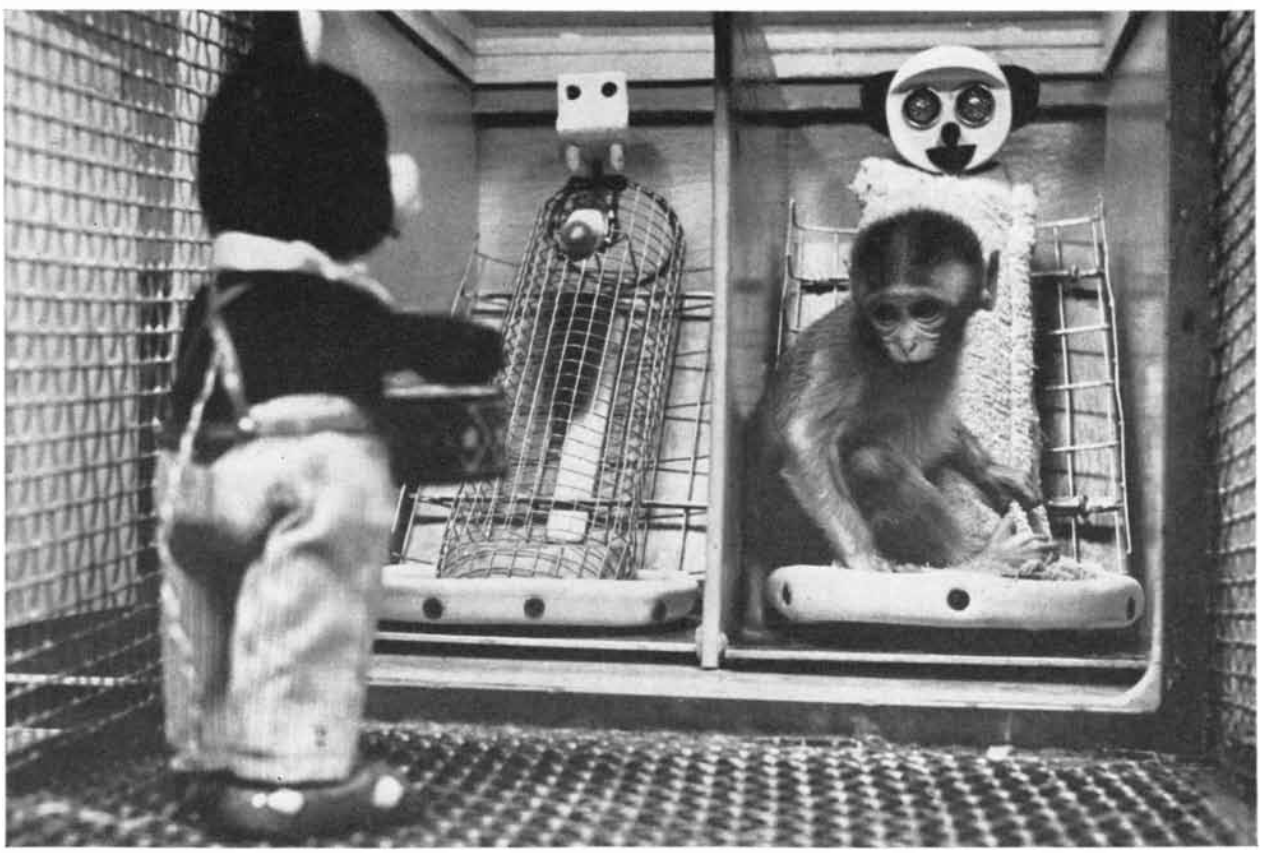
RESULTS OF "FEAR TEST" (*see photographs on opposite page*) showed that infants confronted by a strange object quickly learned to seek reassurance from the cloth mother (*colored curves*) rather than from the wire mother (*black curves*). Again infants fed on the wire mother (*broken lines*) behaved much like those fed on cloth mother (*solid lines*).

ciation with the reduction of hunger or thirst.

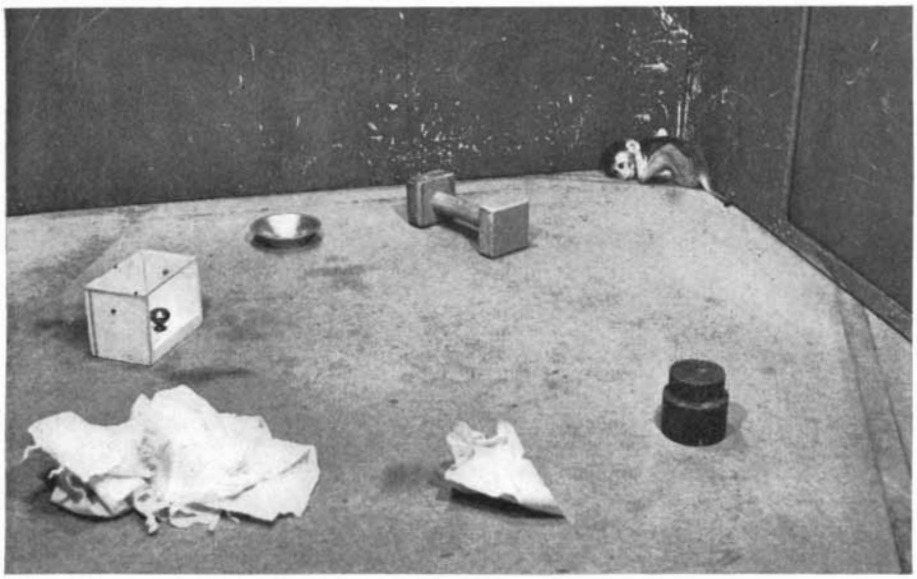
These results attest the importance—possibly the overwhelming importance—of bodily contact and the immediate comfort it supplies in forming the infant's attachment for its mother. All our experience, in fact, indicates that our cloth-covered mother surrogate is an eminently satisfactory mother. She is available 24 hours a day to satisfy her infant's overwhelming compulsion to seek bodily contact; she possesses infinite patience, never scolding her baby or biting it in anger. In these respects we regard her as superior to a living monkey mother, though monkey fathers would probably not endorse this opinion.

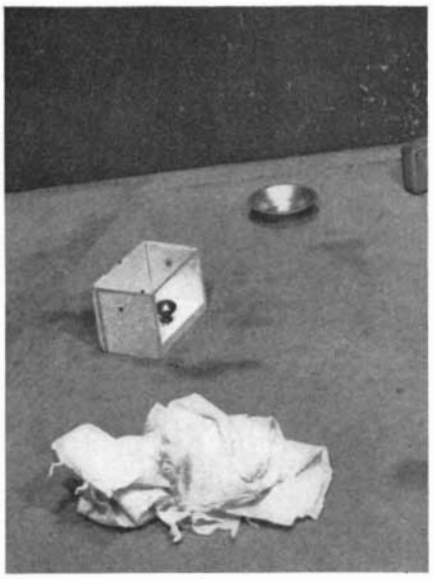
Of course this does not mean that nursing has no psychological importance. No act so effectively guarantees intimate bodily contact between mother and child. Furthermore, the mother who finds nursing a pleasant experience will probably be temperamentally inclined to give her infant plenty of handling and fondling. The real-life attachment of the infant to its mother is doubtless influenced by subtle multiple variables, contributed in part by the mother and in part by the child. We make no claim to having unraveled these in only two years of investigation. But no matter what evidence the future may disclose, our first experiments have shown that contact comfort is a decisive variable in this relationship.

Such generalization is powerfully supported by the results of the next phase of our investigation. The time that the infant monkeys spent cuddling on their surrogate mothers was a strong but perhaps not conclusive index of emotional attachment. Would they also seek the inanimate mother for comfort and security when they were subjected to emotional stress? With this question in mind we exposed our monkey infants to the stress of fear by presenting them with strange objects, for example a mechanical teddy bear which moved forward, beating a drum. Whether the infants had nursed from the wire or the cloth mother, they overwhelmingly sought succor from the cloth one; this differential in behavior was enhanced with the passage of time and the accrual of experience. Early in this series of experiments the terrified infant might rush blindly to the wire mother, but even if it did so it would soon abandon her for the cloth mother. The infant would cling to its cloth mother, rubbing its body against hers. Then, with its fears assuaged through intimate contact with the moth-



FRIGHTENING OBJECTS such as a mechanical teddy bear caused almost all infant monkeys to flee blindly to the cloth mother, as in the top photograph. Once reassured by pressing and rubbing against her, they would then look at the strange object (*bottom*).





"OPEN FIELD TEST" involved placing a monkey in a room far larger than its accustomed cage; unfamiliar objects added an additional disturbing element. If no mother was present, the infant would typically huddle in a corner (*left*). The wire mother did

er, it would turn to look at the previously terrifying bear without the slightest sign of alarm. Indeed, the infant would sometimes even leave the protection of the mother and approach the object that a few minutes before had reduced it to abject terror.

The analogy with the behavior of human infants requires no elaboration. We found that the analogy extends even to less obviously stressful situations. When a child is taken to a strange place, he usually remains composed and happy so long as his mother is nearby. If the mother gets out of sight, however, the child is often seized with fear and distress. We developed the same response in our infant monkeys when we exposed them to a room that was far larger than the cages to which they were accustomed. In the room we had placed a number of unfamiliar objects such as a small artificial tree, a crumpled piece of paper, a folded gauze diaper, a wooden block and a doorknob [*a similar experiment is depicted in the illustrations on these two pages*]. If the cloth mother was in the room, the infant would rush wildly to her, climb upon her, rub against her and cling to her tightly. As in the previous experiment, its fear then sharply diminished or vanished. The infant would begin to climb over the mother's body and to explore and manipulate her face. Soon it would leave the mother to investigate the new world, and the unfamiliar objects would become playthings. In a typical behavior sequence, the infant might manipulate the tree, return to the mother, crumple the wad of paper, bring it to the mother, explore the block, explore the doorknob, play with the paper and return to the mother. So long as the mother provided a psychological "base of operations" the infants were unafraid and their behavior remained positive, exploratory and playful.

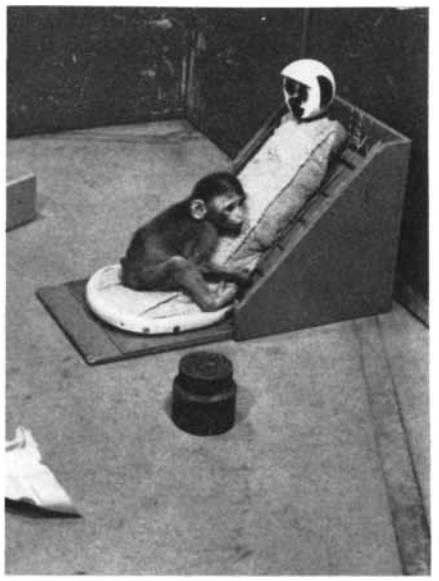
If the cloth mother was absent, however, the infants would rush across the test room and throw themselves face-down on the floor, clutching their heads and bodies and screaming their distress. Records kept by two independent observers—scoring for such "fear indices" as crying, crouching, rocking and thumb- and toe-sucking—showed that the emotionality scores of the infants nearly tripled. But no quantitative measurement can convey the contrast between the positive, outgoing activities in the presence of the cloth mother and the stereotyped withdrawn and disturbed behavior in the motherless situation.

The bare wire mother provided no more reassurance in this "open field" test than no mother at all. Control tests on monkeys that from birth had known only the wire mother revealed that even these infants showed no affection for her and obtained no comfort from her presence. Indeed, this group of animals exhibited the highest emotionality scores of all. Typically they would run to some wall or corner of the room, clasp their heads and bodies and rock convulsively back and forth. Such activities closely resemble the autistic behavior seen frequently among neglected children in and out of institutions.

In a final comparison of the cloth and wire mothers, we adapted an experiment originally devised by Robert A. Butler at the Primate Laboratory. Butler had found that monkeys enclosed in a dimly lighted box would press a lever to open and reopen a window for hours on end for no reward other than the chance to look out. The rate of lever-pressing depended on what the monkeys saw through the opened window; the sight of another monkey elicited far more activity than that of a bowl of fruit or an empty room [see "Curiosity in Monkeys," by Robert A. Butler; SCIENTIFIC AMERICAN, February, 1954]. We now know that this "curiosity response" is innate. Three-day-old monkeys, barely able to walk, will crawl across the floor of the box to reach a lever which briefly opens the window; some press the lever hundreds of times within a few hours.

When we tested our monkey infants in the "Butler box," we found that those reared with both cloth and wire mothers showed as high a response to the cloth mother as to another monkey, but displayed no more interest in the wire mother than in an empty room. In this test, as in all the others, the monkeys fed on the wire mother behaved the same as those fed on the cloth mother. A control group raised with no mothers at all found the cloth mother no more interesting than the wire mother and neither as interesting as another monkey.

Thus all the objective tests we have been able to devise agree in showing that the infant monkey's relationship to its surrogate mother is a full one. Comparison with the behavior of infant monkeys raised by their real mothers confirms this view. Like our experimental monkeys, these infants spend many



not alter this pattern of fearful behavior, but the cloth mother provided quick reassurance. The infant would first cling to her (*center*) and then set out to explore the room and play with the objects (*right*), returning from time to time for more reassurance.

hours a day clinging to their mothers, and run to them for comfort or reassurance when they are frightened. The deep and abiding bond between mother and child appears to be essentially the same, whether the mother is real or a cloth surrogate.

While bodily contact clearly plays the prime role in developing infantile affection, other types of stimulation presumably supplement its effects. We have therefore embarked on a search for these other factors. The activity of a live monkey mother, for example, provides her infant with frequent motion stimulation. In many human cultures mothers bind their babies to them when they go about their daily chores; in our own culture parents know very well that rocking a baby or walking with him somehow promotes his psychological and physiological well-being. Accordingly we compared the responsiveness of infant monkeys to two cloth mothers, one stationary and one rocking. All of them preferred the rocking mother, though the degree of preference varied considerably from day to day and from monkey to monkey. An experiment with a rocking crib and a stationary one gave similar results. Motion does appear to enhance affection, albeit far less significantly than simple contact.

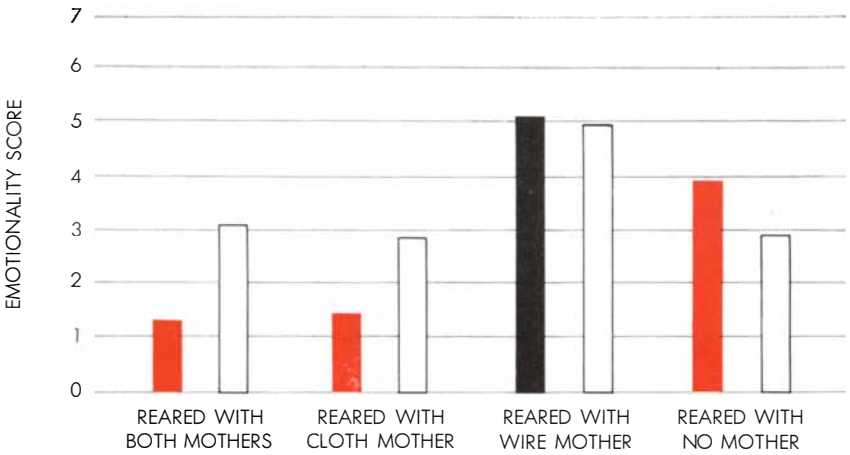
The act of clinging, in itself, also seems to have a role in promoting psychological and physiological well-being. Even before we began our studies of affection, we noticed that a newborn monkey raised in a bare wire cage survived with difficulty unless we provided it with a cone to which it could cling. Recently we have raised two groups of monkeys, one with a padded crib instead of a mother and the other with a cloth mother as well as a crib. Infants in the latter group actually spend more time on the crib than on the mother, probably because the steep incline of the mother's cloth surface makes her a less satisfactory sleeping platform. In the open-field test, the infants raised with a crib but no mother clearly derived some emotional support from the presence of the crib. But those raised with both showed an unequivocal preference for the mother they could cling to, and they evidenced the benefit of the superior emotional succor they gained from her.

Still other elements in the relationship remain to be investigated systematically. Common sense would suggest that the warmth of the mother's body plays its part in strengthening the infant's ties to her. Our own observations have not yet confirmed this hypothesis. Heating a cloth mother does not seem to increase her attractiveness to the infant monkey, and infants readily abandon a heating pad for an unheated mother surrogate. However, our laboratory is kept comfortably warm at all times; experiments in a chilly environment might well yield quite different results.

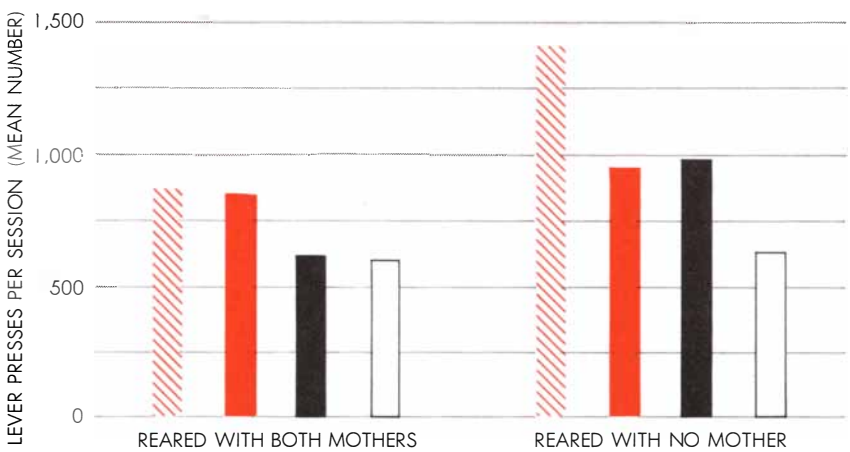
Visual stimulation may forge an additional link. When they are about three months old, the monkeys begin to observe and manipulate the head, face and eyes of their mother surrogates; human infants show the same sort of delayed responsiveness to visual stimuli. Such stimuli are known to have marked effects on the behavior of many young animals. The Austrian zoologist Konrad Lorenz has demonstrated a process called "imprinting"; he has shown that the young of some species of birds become attached to the first moving object they perceive, normally their mothers [see "'Imprinting' in Animals," by Eckhard H. Hess; SCIENTIFIC AMERICAN, March, 1958]. It is also possible that particular sounds and even odors may play some role in the normal development of responses or attention.

The depth and persistence of attachment to the mother depend not only on the kind of stimuli that the young animal receives but also on when it receives them. Experiments with ducks show that imprinting is most effective during a critical period soon after hatching; beyond a certain age it cannot take place at all. Clinical experience with human beings indicates that people who have been deprived of affection in infancy may have difficulty forming affectional ties in later life. From preliminary experiments with our monkeys we have found that their affectional responses develop, or fail to develop, according to a similar pattern.

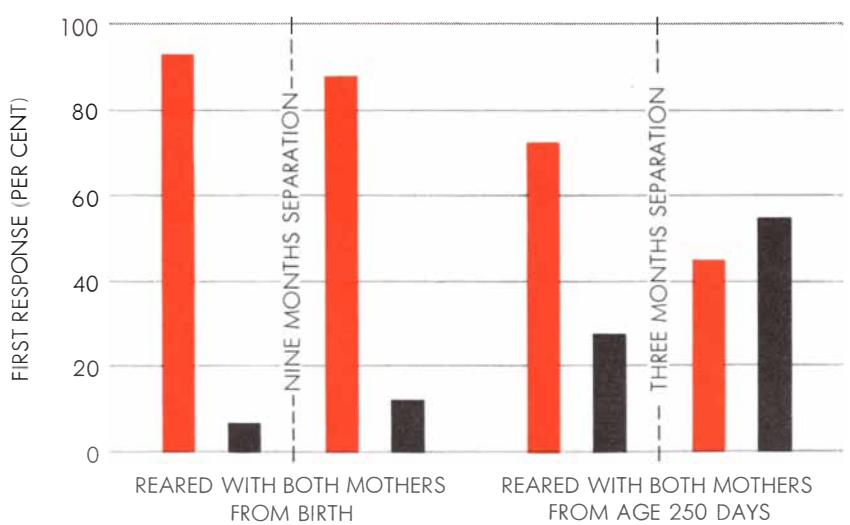
Early in our investigation we had segregated four infant monkeys as a general control group, denying them physical contact either with a mother surrogate or with other monkeys. After about eight months we placed them in cages with access to both cloth and wire mothers. At first they were afraid of both surrogates, but within a few days they began to respond in much the same way as the other infants. Soon they were



SCORES IN OPEN FIELD TEST show that all infant monkeys familiar with the cloth mother were much less disturbed when she was present (*color*) than when no mother was present (*white*); scores under 2 indicate unfrightened behavior. Infants that had known only the wire mother were greatly disturbed whether she was present (*black*) or not (*white*).



"CURIOSITY TEST" SHOWED THAT monkeys reared with both mothers displayed as much interest in the cloth mother (*solid color*) as in another monkey (*hatched color*); the wire mother (*black*) was no more interesting than an empty chamber (*white*). Monkeys reared with no mother found cloth and wire mother less interesting than another monkey.



EARLY "MOTHERING" produced a strong and unchanging preference for the cloth mother (*color*) over the wire mother (*black*). Monkeys deprived of early mothering showed less marked preferences before separation and no significant preference subsequently.

spending less than an hour a day with the wire mother and eight to 10 hours with the cloth mother. Significantly, however, they spent little more than half as much time with the cloth mother as did infants raised with her from birth.

In the open-field test these "orphan" monkeys derived far less reassurance from the cloth mothers than did the other infants. The deprivation of physical contact during their first eight months had plainly affected the capacity of these infants to develop the full and normal pattern of affection. We found a further indication of the psychological damage wrought by early lack of mothering when we tested the degree to which infant monkeys retained their attachments to their mothers. Infants raised with a cloth mother from birth and separated from her at about five and a half months showed little or no loss of responsiveness even after 18 months of separation. In some cases it seemed that absence had made the heart grow fonder. The monkeys that had known a mother surrogate only after the age of eight months, however, rapidly lost whatever responsiveness they had acquired. The long period of maternal deprivation had evidently left them incapable of forming a lasting affectional tie.

The effects of maternal separation and deprivation in the human infant have scarcely been investigated, in spite of their implications concerning child-rearing practices. The long period of infant-maternal dependency in the monkey provides a real opportunity for investigating persisting disturbances produced by inconsistent or punishing mother surrogates.

Above and beyond demonstration of the surprising importance of contact comfort as a prime requisite in the formation of an infant's love for its mother —and the discovery of the unimportant or nonexistent role of the breast and act of nursing—our investigations have established a secure experimental approach to this realm of dramatic and subtle emotional relationships. The further exploitation of the broad field of research that now opens up depends merely upon the availability of infant monkeys. We expect to extend our researches by undertaking the study of the mother's (and even the father's!) love for the infant, using real monkey infants or infant surrogates. Finally, with such techniques established, there appears to be no reason why we cannot at some future time investigate the fundamental neurophysiological and biochemical variables underlying affection and love.

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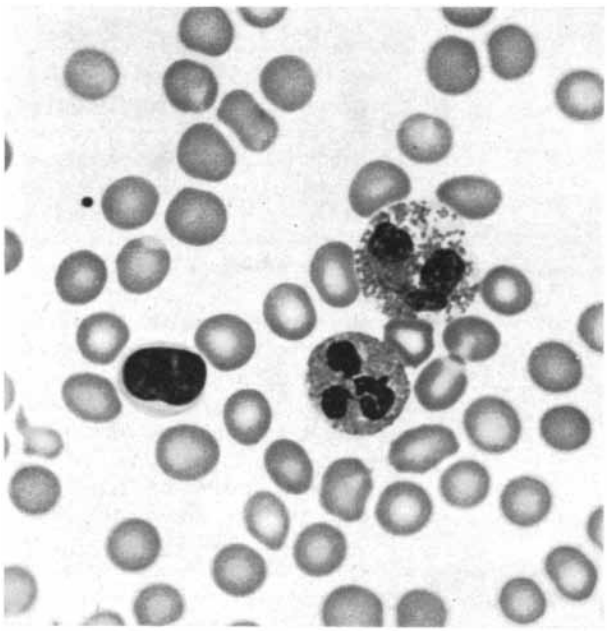
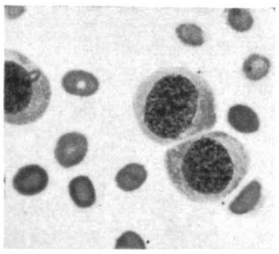
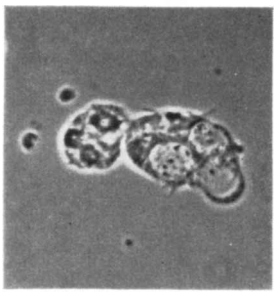


Among the red cells, three of the principal types of white cells, left to right: a lymphocyte, representing about 30% of the white cells; a neutrophil, representing 60%; an eosinophil, representing about 2%.



Megaloblastic cells, characteristic of the pattern of red cell maturation in pernicious anemia.



Erythrophagocyte, seen in an uncommon blood condition, where white cells swallow red cells. Here is one that has eaten three.

The objective documentation of hematological observations through properly controlled photomicrography is treated with some depth in the current issue of our periodical *Medical Radiography and Photography*. It contains some excellent color photomicrographs, including a series which depicts the maturation of human blood cells. However, if we were to go to the expense of reproducing the color on this page, it would use up money better spent in face-to-face instruction in hematological photomicrography for those who need it. You can look at the color all you want to by requesting a copy of the blood issue of *M. R. & P.* from Eastman Kodak Company, Medical Sales Division, Rochester 4, N. Y.

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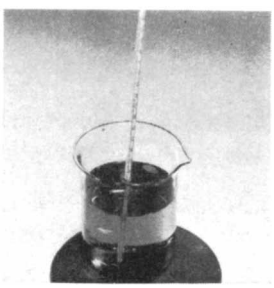
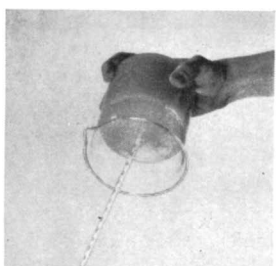


2. Heat to about 75°C and cool.



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