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From Thought to Therapy: Lessons from a Primate Laboratory

Social attachment helps individuals maintain an emotional bond with one another. We now know that the development of attachment during the first year of infancy is important to a person's self-concept and ability to interact successfully with others. However, due to the difficulty in using human infants for research, psychologists had to develop animal models of attachment to study the attachment process. One successful research program was conducted at the University of Wisconsin and is discussed in this selection.

Harry F. Harlow (1905–1981) received his Ph.D. in experimental psychology in 1930 from Stanford University. He began teaching psychology that same year at the University of Wisconsin, where he remained until he retired in 1974. Margaret K. Harlow (d. 1971) received her Ph.D. from the University of Iowa in 1944 and was a professor of educational psychology at the University of Wisconsin. Stephen J. Suomi earned his Ph.D. in developmental psychology from the University of Wisconsin in 1971, where he now teaches. He is also currently with the National Institutes of Health.

This selection, "From Thought to Therapy: Lessons from a Primate Laboratory," published in the *American Scientist* in 1971, gives a glimpse of how one major research program developed—specifically, Harlow et al.'s studies on the learning abilities of rhesus monkeys at the Primate Laboratory in Wisconsin. Note how the various studies tie in to one another, providing a significant overall picture of the research area. Harlow's surrogate mother model for studying attachment in primates has helped psychologists to better understand the role of contact comfort in human attachment formation.

Key Concept: development of attachment

A basic maxim of scientific investigation is that significant research directed toward providing an answer for a particular question will inevitably generate a host of new problems awaiting resolution. Rarely is a scientific inquiry germinated and subsequently resolved in a vacuum. The endless effort required to solve any major problem frequently leads to other channels of thought and the creation of new areas of interest—often by chance or almost chance associations.

Multiple illustrative cases substantiating this point have evolved from research carried out over the years at the University of Wisconsin Primate Laboratory. We have never completely forsaken any major research goal once we pursued it, and we are still searching for the end of each and every rainbow—even though we have already found our fair share of research gold.

During the Primate Laboratory's 40 years of existence we have maintained an ongoing research program investigating the learning capability of rhesus monkeys. Learning has been the key directing the creation, not the culmination, of many of our major research efforts. The first of a series of studies stemming from the earlier learning researches determined the effects of lesions in specific cortical regions, including unilateral and bilateral occipital (*1*), frontal (2), and temporal (*3*) lobes, on learning task performance. Just as the early lesion research developed from learning, later learning research stemmed from the lesion research. To assess lesion effects we were forced to create more reliable and lucid learning tasks and to develop and standardize them into a battery of tests that covered varied abilities and cortical locations. A natural problem raised then concerned the ontogenetic development (*4*) of ability to perform these various tests, for we already knew that some tests were so difficult that they could not be solved by monkeys younger than three years, and some were so simple they could be solved by monkeys in the first weeks of life.

To study developing learning abilities in monkeys required a large number of subjects spanning the age range from birth through adolescence, and so we instituted a breeding program and devised means for rearing monkey subjects in the laboratory from birth onward. In order to reduce the incidence of both confounding variables and contagious disease, we separated the babies from their mothers a few hours after birth and raised them in individual cages where they were hand-fed and received human care (*5*). The infants were provided with cheesecloth diapers to serve as baby blankets, and we noticed that many of the neonates developed such strong attachments to the cheesecloth blanket that it was hard to tell where the diaper ended and the baby began. Furthermore, the monkeys became greatly disturbed when the diapers were removed from their cages for essential sanitary services.

THE SURROGATE MOTHERS

Dirty diapers and distressed infants were produced for some years—an adequate time for insightful learning to occur—before the true significance of the

diaper was duly recognized. It is a long way from brains to blankets, but this is the strange, mysterious way in which research programs develop. Many creative ideas have suddenly appeared in a flight of fancy, but the surrogate mother concept appeared during the course of a fancy flight. The cloth surrogate mother was literally born, or perhaps we should say baptized, in 1957 in the belly of a Boeing stratocruiser high over Detroit during a Northwest Airlines champagne flight. . . . The senior author turned to look out the window and saw the cloth surrogate mother sitting in the seat beside him with all her bold and barren charms. The author quickly outlined the researches and drafted part of the text and verses which would form the basis of his American Psychological Association presidential address (*6*) a year later. The research implications and possibilities seemed to be immediately obvious, and they were subsequently brought to full fruition by three wise men—one of whom was a woman.

The original theoretical problem to be solved by the surrogate mother researches was to measure the relative strength of bodily contact comfort as opposed to satisfaction of nutritional needs, or activities associated with the breast, as motivational forces eliciting love for mother in rhesus neonates. Actually the primary purpose was to continue to dismantle derived drive theory (*7*). The results of the now famous cloth-mother and wire-mother experiments provided total support for contact comfort as the superordinate variable or motive binding infant to mother. As pictures of baby monkeys clinging contentedly to soft surrogates unfolded across tabloid pages throughout the world, the downfall of primary drive reduction as the predominant theory to account for the development of social attachment was assured. The cloth mother became the first female to attain fame so quickly while still retaining her virginal virtues. There is more than merely milk to human kindness.

On the basis of the diaper data it came as no great surprise to find that monkey infants overwhelmingly preferred nonlactating cloth mothers to lactating wire surrogates. However, during the course of testing infants in novel environments we discovered an unexpected trait possessed by our cloth surrogates: the capacity to instill a sense of basic security and trust in their infants (*8*). This is the way creative research often arises—sometimes by insight and sometimes by accident. Baby monkeys placed in an unfamiliar playroom devoid of a cloth surrogate, or with a wire surrogate present, typically rolled into tight furry balls, screeching in terror.

When the same infants were placed in the same environment in the presence of cloth surrogate mothers, they initially scurried to the surrogates and clung for dear life. After their first fears abated, the monkeys would then venture away from the surrogates and explore the environment, but often returned to their inanimate mothers for a reassuring clasp or a deep embrace to desensitize fear or alleviate insecurity. This response was predicated upon a psychiatric principle discovered by baby monkeys long before the advent of Watson (*9*), Wolpe (*10*), or any of the Skinnerians. Basic trust was the achievement of the first of Erikson's (*11*) eight human developmental crises, and although basic trust may not be fashioned out of whole cloth, for baby monkeys it apparently can be fashioned from cloth alone.

Subsequently we recognized the obvious truth that no major act of animal behavior is determined by a single variable. To illustrate this axiom we created surrogates of varying form and function, and they disclosed that many variables other than contact comfort possessed more than measurable effects on infant monkey maternal attachment (*12*). These findings led naturally to a series of studies designed to measure all possible variables, regardless of importance, relating to the maternal efficiency of our man-made mothers. The researches disclosed a number of variables secondary in importance to contact comfort. With contact comfort held constant by constructing lactating and nonlactating terry-cloth surrogates, it was possible to demonstrate that nursing, or activities associated with the breast, was a significant variable during the first 90 days of life. Thus, by this ingenious research we learned what had been totally obvious to everyone else, except psychologists, for centuries. Furthermore, rocking surrogates and rocking cribs were preferred to nonrocking surrogates and cribs for about 160 days. Body surfaces other than wire or cloth were also investigated, with predictable results. Satins and silks might be adult symbols of prestige, but they do not warm the infant heart as does terry cloth.

Infant rhesus monkeys preferred a warm wire surrogate to a cool cloth surrogate for the first 15 days of life, illustrating the limited temporal span of some variables and confirming the well-known "hot mama" or "warm woman" hypothesis. Warmth was the only variable to lend even transient preference to the wire surrogate. However, the most striking maternal temperature data were recently obtained by Suomi (*13*), who constructed a cold cloth surrogate with ice water in her veins. Neonatal monkeys tentatively attached to this cold cloth figure, but then retreated to a far corner of the cage, and remained aloof from mother forever. There is only one social affliction worse than an ice-cold wife, and that is an ice-cold mother.

Finally, we compared the efficiency of our man-made mothers with their natural counterparts, and we are convinced that real motherhood is superior and that it is here to stay. The cloth mother may serve milk, but not in the cozy continuous containers provided by the real mother. The real mother eliminates nonnutritional sucking by her infant, whereas no surrogate mother . . . can inhibit nonnutritional sucking. The real monkey mother trains her infant to be a placer, rather than a spreader, of feces (*14*). The real mother trains her infant to comprehend the gestural and vocal communications of other monkeys (*15*), while language learning is beyond surrogate love. The real mother is dynamic and responds to the infant's needs and behavior, but the surrogate can only passively accept. Subsequently the mother plays an active role in separating the infant from her body, which results, probably inadvertently, in the exploration of the surrounding animate and inanimate environment. Finally, and of most importance for future peer adjustment, the real mother is far more efficient than the cloth surrogate in the regulation of early infant play, the primary activity leading to effective age-mate love.

We might have remained imprinted on surrogate mothers forever had it not been for a comment made to the senior author independently by an eminent psychologist and an eminent psychiatrist within a single month. Both said, "You, know, Harry, you are going to go down in the history of psychology

as the father of the cloth mother!" This was too much! In a desperate effort to escape this fate we branched out into new areas of research . . . : the nature of normal and natural love of rhesus monkeys. . . .

THE NATURAL NATURE OF LOVE

I enlisted the aid of my wife, and we fell in love, or at least in love with love, in all its multifaceted forms. Normal and natural love in rhesus monkeys develops through the sequencing and interaction of five major love systems: maternal love; infant love, or love of the infant for the mother; peer love, which other psychologists and psychoanalysts will someday discover; heterosexual love; and paternal love.

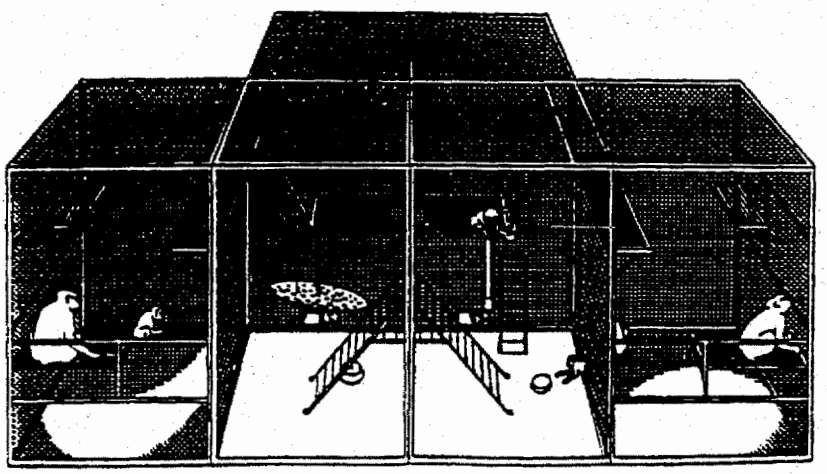
Maternal love has always been obvious, and even Freud was fully aware of it. We have already described its social functions. An extremely important basic function is the management of infant play so that infant monkeys play together effectively instead of in a disorganized manner. Maternal love serves as an important antecedent to the development of peer or age-mate love.

The variables underlying the love of the infant for the mother have already been described in the surrogate researches. It is our opinion that a more important love system, in fact, the most important from the view of the whole life span, is age-mate love, which develops first through curiosity and exploration and later through multiple forms of play. Peer interactions enhance the formation of affection for associates, the development of basic social roles, the inhibition of aggression, and maturation of basic sexuality. We believe heterosexual behavior in primates is another love system, evolving from peer love very much as peer love evolves from maternal love.

Heterosexual love was not discovered by Freud. Freud became lost in the libido even before he experienced it, and he never fully learned about love. Heterosexual love differs in form and function in various animal families. Beach (*16*) eventually discovered love in beagles, but so had the beagles. . . . Heterosexual love in rats and people is planned in different fashions. If you are a rat, your sex life may be endocrinologically determined, and you will do very well. However, if you are a primate—monkey, ape, or man—and your heterosexual life is primarily gonadally determined, you face a grim and grave future, and the sooner the grave, the better. Sex without antecedent and concurrent love is disturbed and disordered (*17*).

After resolving the nurture and nature of maternal, infant, peer, and heterosexual love, the only thing that remained was paternal love. Having analyzed monkey love as far as we could with our existing facilities, I realized that we had no love with father, and I dejectedly proclaimed to my wife that, although paternal love in feral baboons and monkeys had been described, this love system could not be analyzed and resolved under laboratory restraints. A month later Margaret Harlow brought me the experimental design for paternal laboratory love and a plan for the necessary housing facilities. After the rela-

FIGURE 1 *Nuclear Family Living Apparatus*



⊢—⊣ = 1 Foot

tively simple task of rebuilding the attic over our laboratory had been achieved, the analysis of paternal love was on its way.

THE NUCLEAR FAMILY

The nuclear family apparatus, shown in Figure 1, is a redesigned, redefined, replanned, and magnified playpen apparatus where four pairs of male and female macaques live with their offspring in a condition of blissful monogamy. In the nuclear family apparatus each and every male has physical access to his own female and communicative access to all others. It is obvious from time to time that some males and females would like to have physical access to their neighbors' mates, but their courting must be limited to calls and lip-smacking and visual fixation. Fortunately, they accept their frustration with minimal effects on their mates.

Most important of all, each and every infant has access to every male, and, perhaps because of the cunning and curiosity of all the infants, most nuclear fathers responded socially to most infants. Finally, the apparatus provides unrivaled opportunities to study sibling interactions and friendship formation in infants of similar and disparate ages.

Creation of the nuclear family has provided us with a body of basic information concerning paternal love. The nuclear fathers do not allow mothers, their mates, and neighbors, to abuse or abandon infants, and the fathers serve as a cohesive force guarding the group against predators—primarily ex-

perimenters. In addition, the fathers, through some developmental mechanism which we do not yet understand, show affection in varying degrees to all infants. Many fathers engage in reciprocal play with the infants at a level far surpassing that of the mothers, and the fathers ignore aggression from the infants and juveniles, including pinching, biting, and tail- and ear-pulling—behaviors the fathers would never accept from adolescents and adults of either sex.

Preadolescent monkey males, unlike females, exhibit limited interest in all new infants except their siblings until the babies can play. The males largely ignore them, while the female preadolescents continually struggle to make contact with the new babies. The precursors of paternal behavior are present, however, for the older male infants and juveniles cradle, carry, and protect young infants that venture in their path. The watchful eyes of the adults and their ready threats may abet the gentle behavior of the older infants and possibly begin the inculcation of protection of all young. We have still much more to learn about the variables in the development of paternal behavior.

The advent of the second and third infants in the families has disclosed interesting aspects of maternal love and sibling interaction. We had long presumed that the appearance of a second monkey gift from Heaven would exaggerate the mother-infant separative mechanisms long in progress, and that neonatal fairy fingers playing upon the maternal heartstrings would rapidly dissipate the love for the older infant. True to prediction, the immediate reaction of the newly delivered mother to her older infant was negative. She threatened body contact, prevented nipple contact, and cradled the new infant continuously. But every mother eventually reversed this policy toward the older infant. The only individual difference was the interval between the new birth and contact with the older infant, which ranged from 8 hours to a matter of days. Most displaced infants or juveniles spent a night or two without maternal contact, often with their fathers, but one managed to achieve contact with mother the very first night and every night thereafter by persistent approach, cooing and squealing until her mother made room for her too. Although she had a good relationship with her father, she made no attempt to substitute him.

Much to our surprise, the displaced infants did not overtly exhibit punitive signs of jealousy toward the newcomers, probably because of fear of the mother, although one male juvenile did engage in teasing his little sister at every opportunity when mother was not looking. All displaced infants showed disturbance in this situation of denial and despair, of suspicion and separation, and the older infants would spend hours trying to achieve contact comfort, real or symbolic, from the body of the mother—both awake and asleep. Indeed, initial contact was usually made when the mother was sleepy and had reduced her vigilance. In desperation, when this failed, some would enter adjacent living chambers and make overtures to other mothers, who generally accepted their presence but denied them bodily contact. Alternatively, proximity and contact with their fathers were sought when mothers were not available.

In spite of the fact that the nuclear families provided a wealth of new data on the affectional systems, the most striking psychological contribution of the nuclear family has not been to love but to learning.

LONELY LEARNING

For a number of years we had assiduously studied the effects of early environment upon later learning capability, and to achieve this we had always used groups of normal monkeys and groups of socially isolated monkeys. We knew that total social isolation damaged or destroyed the social-sexual capabilities of monkeys, . . . but it did not depress learning ability. Our socially deprived monkeys were reared under conditions of 6, 9, or 12 months of total social isolation, a condition of deprivation or privation so severe that no one will ever impose it upon human children.

Our "normal" monkeys had been reared in partial social isolation. We had recognized the fact that partial social isolation would hardly qualify as a haven or Heaven, but because of limited facilities this is the manner in which we had always reared our normal monkeys. For decades our normal monkeys have achieved learning performances better than those achieved in any other laboratory, owing no doubt to the unusual care we took in adapting them to the test situation.

Finally, S. D. Singh (*18*), who had had extensive test experience on the Wisconsin General Test Apparatus (WGTA) in the United States and in India, reported that feral animals (reared in forests or in temples) were not intellectually different from each other and were not superior to our monkeys reared in partial social isolation. Furthermore, Singh's test battery was adapted from our own, utilizing discrimination problems which rhesus monkeys are able to solve at 6 months of age, delayed-response tests at 10 months of age, learning-set tasks mastered at 12 months of age, and, later, complex oddity-learning-set tasks which are not efficiently solved by monkeys until 36 months of age. Singh's data gave every indication that partial isolation cages were just as stimulating to intellectual development as were temples and forests.

We had assumed that "enriched" environments were in no way superior to the deprived environments in stimulation and development of the intellectual processes. To demonstrate this, we compared the performance of monkeys reared from birth in the nuclear family apparatus with that of totally socially isolated monkeys and our normal monkeys. Just as predicted, the enormously socially enriched monkeys reared in interacting family groups did no better than deprived monkeys or control monkeys on discrimination tasks, delayed-response tasks, and complex learning-set tasks. My world of happy intellectual isolation was jolted, however, when the socially enriched preadolescents and adolescents, as contrasted with the socially isolated adolescents and controls, proved to be superior at the .001 significance level on our most complex problem-oddity-learning set. Had there been a progressive separation in performance between enriched and deprived monkeys as they traversed through tests of increasing complexity, we would gladly have conceded a difference, but the difference appeared only when the most complicated learning test was administered.

One can only conclude that this enriched early environment, at least, enables monkeys adequately adapted and trained to reach more lofty intellectual performance levels than those attained by deprived monkeys. The basis

for the performance difference, however, is by no means established. Superiority could stem from nonintellectual factors as readily as from intellectual differences. The nuclear family animals give every evidence of being the most self-confident, self-assured, fearless animals we have ever tested. They are more relaxed in the test situation than other subjects and could well be more persistent, thus persevering after "normal" subjects give up. This difference would not be apparent on unchallenging tasks, but when the problems become very difficult, the personality factors could operate to produce performance differences. Unfortunately, it is as difficult to test as is the hypothesis that middle-class children excel intellectually over lower-class children because of their environmental advantages. . . .

CONCLUSION

Thus we have traveled from thought to therapy by a route neither straight nor narrow. There have been obstacles and detours, but we have found throughout the years that these are to be cherished, not chastised, as blessings in disguise. . . . Tomorrow there will be new problems, new hopes, and new horizons. Since knowledge is itself forever changing, the search for knowledge never ends.

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