

Induced Psychopathology in Monkeys

by Harry F. Harlow and Stephen J. Suomi

We are trying to produce psychopathological syndromes as analogous to human disorders as possible. From that base may come techniques for rehabilitation of depression.

Some 10 years ago the staff at the University of Wisconsin Primate Laboratories initiated a research program designed to induce psychopathology in infant monkeys by means of abusive surrogate mothers. The program was far from successful, and we thought we had failed completely to produce psychiatric syndromes in these specific monkey infants. Then John Bowlby, a British psychiatrist, visited us, listened to our sorrows, and toured the laboratory. After he had observed our monkeys individually housed in bare wire cages, he asked, "Why are you trying to produce psychopathology in monkeys? You already have more psychopathological monkeys in the laboratory than have ever been seen on the face of the earth."

We call the housing situation where Bowlby observed abnormal monkeys "partial social isolation." Here monkeys live alone in wire cages where they can see and hear other monkeys, but cannot physically interact with them. Our monkeys had lived in this situation since a few hours after birth, and their personal-social behavior had progressively deteriorated. Because of this confinement the monkeys had been deprived of a mother's love. Perhaps of even more importance, they had never associated with agemates or peers, and therefore they had never had the opportunity for development of agemate love through play. Actually, mother love and agemate love are not competitive entities. Each has its own role, a complex interactive role, in the normal sequence of affectional

development. However, when both types of love are absent, the monkeys' personal-social-sexual lives are destroyed.

When our monkeys were maintained in partial social isolation for several years, some of them developed what we call the catatonic stare: They stood in front of the cage looking vacantly into open space, paying no attention to other monkeys or people. Often the head of such an animal would turn to the left, the right arm would gradually be raised as if it had nothing to do with the body, and the wrist and fingers would go into a tight fist. When the monkey looked at the elevated arm, he would jump. He would be scared to death of this awesome appendage which he did not recognize as a part of himself.

Another interesting result of partial social isolation was that after a period of time aggression progressively developed. Aggression is a late-maturing development in human as well as nonhuman primates. The only reason that all of us are not sadistic monsters is that the maturation of love probably, for all animals, is antecedent to the maturation of aggression. Where there is antecedent mother love and agemate love, there is an amelioration of aggression toward social group members. However, aggression does mature, and when outside aggressional release was blocked in our partial isolates, these monkeys turned against themselves. This self-aggression is akin to Menninger's man-against-himself or Freud's death instinct. Self-aggressing monkeys do not ordinarily rip and rend their bodies apart, but under unusual stress some of these monkeys would rip their own arms and legs down to the bone.

There is a technique to raise nearly normal monkeys in partial social isolation—by providing them with a cloth "mother" monkey. In our original study on the surrogate mothers we saw and were not surprised that the babies would cling 23 hours a day to these cloth mothers. The behavior that did surprise us was that these inanimate cloth mothers imparted to the infant a sense of security,



When a monkey is reared in partial social isolation, self-destructive behavior may be his only way to express aggression. This monkey is actually ripping his own body—not ordinary behavior, but possible under conditions of unusual stress.

probably homologous to psychoanalyst Eric Erickson's first developmental stage—the stage of security—in the human child, which we feel is the mother's primary contribution to the infant's social-sexual development. It is maternal security that enables the infant to leave the mother and explore the inanimate world about him and, of even more importance, the animate world of playmates. This is why mother love is indispensable. It is an essential antecedent condition for the development of the totally important agemate or peer affection. Incidentally, there is little difference, aside from cultural and cortical factors, between human children and monkey children—except age. Monkeys grow up four or five times faster than human children by a wealth of different criteria.

Knowing that a mother could give an infant love and security, we thought many years ago that we could produce anaclitic (dependency) depression by allowing baby monkeys to attach to cloth surrogate mothers who could become monsters. It was a fascinating idea, but as we have already conceded, the methods were less than totally successful.

The first of these monsters was a cloth monkey mother

who, upon schedule or demand, would eject high-pressure compressed air. It would blow the animal's skin practically off its body. What did the baby monkey do? It simply clung tighter and tighter to the mother, because a frightened infant clings to its mother at all costs. We did not achieve any psychopathology.

However, we did not give up. We built another surrogate monster mother that would rock so violently that the baby's head and teeth would rattle. All the baby did was cling tighter and tighter to the surrogate. The third monster we built had an embedded wire frame within its body which would spring forward and eject the infant from its ventral surface. The infant would subsequently pick itself off the floor, wait for the frame to return into the cloth body, and then again cling to the surrogate. Finally we built our porcupine mother. On command, this mother would eject sharp brass spikes over all of the ventral surface of its body. Although the infants were distressed by these pointed rebuffs, they simply waited until the spikes receded and then returned and clung to the mother.

These infant monkeys' behaviors were not surprising. The only recourse of an injured or rebuked child—monkey or human—is to make intimate contact with the mother at any cost.

We then measured the effects of total social isolation, where from a few hours after birth for as long as the experimenter desired the monkeys saw no animal of any kind. When monkeys that were totally socially isolated for 3 months were put with other infants, one or two of them died of emotional shock, self-induced anorexia (loss of appetite). But if they survived the shock—and they all survived when we understood the problem—these animals became normal within a period of a couple of weeks or a month at most. They played effectively with other normal 90-day-old animals and showed absolutely no intellectual deficit.

However, 6 months of total social isolation is very different from 3 months. Three months is like putting a human child in an inadequate orphanage for a year—and all orphanages are inadequate. Six months for a monkey is like 2 years of orphanage isolation for a human child.

The prognosis for a human child living in an orphanage confinement less than 1 year is favorable. After 2 years of orphanage confinement the prognosis for a human child is not hopeless, but it is unfavorable. Our 6-month isolates showed very little contact play, which is an effective social

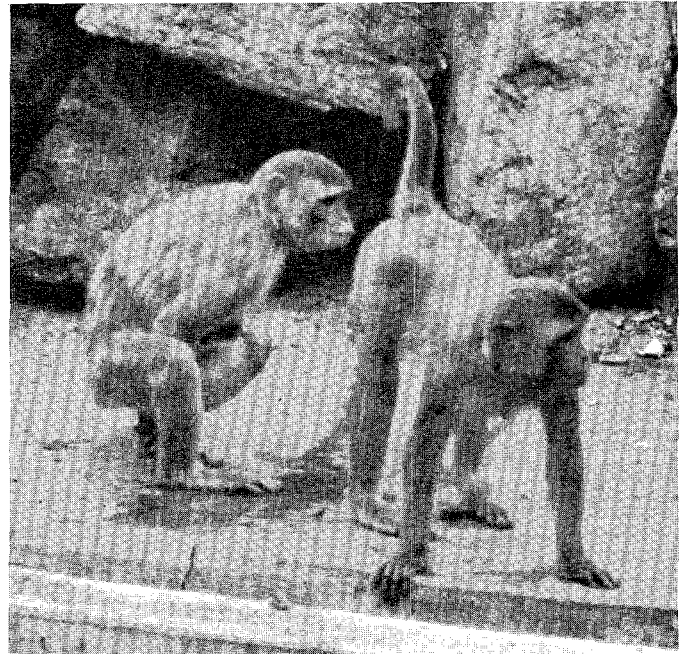
The babies that survived rehabilitated their mothers, because by attaching themselves to the breast and the ventral surface, they eventually elicited maternal affection.

measure, when placed with normally raised monkeys of the same age. Actually, over a long period of time, the 6-month isolates made slight recovery. They showed some social behavior with other 6-month isolates, but not with normal agemates.

Activity play is a very simple measure of social adjustment for rhesus monkeys. Even this pattern does not exist in the 1-year monkey isolate, a condition homologous to that of a human child raised in a very inadequate orphanage for 4 years. In the experiment involving 12 months of social isolation our standard technique of placing isolate monkeys with equal-aged normal agemates had to be terminated after 10 weeks, because by this time the normal 1-year animals were virtually tearing these isolates to ribbons. Aggression had developed in the normal monkey, and the 1-year isolates were totally defenseless. It is a standard psychological rule that dead animals do not make adequate subjects for social research.

Furthermore, the effects of social isolation for 6 months or more (we also have data on 9, 12, and 18 months) appear to be permanent. Six months of total social isolation forever devastated these monkeys socially.

Another activity destroyed by total social isolation was normal adult heterosexual behavior. When we first separated monkeys from their mothers, we wanted to build a great colony of disease-free breeding stock. There was just one flaw in our plan: There wasn't any breeding. In desperation we tried our first group-psychotherapy program, which utterly failed. We took 15 of the oldest males and 15 of the oldest females who had been separated from their mothers at birth and put them on an island in the Madison Zoo. We had the pious hope that on some enchanted summer evening the full moon would rise over the waters of the neighboring lake, the wind would waft its fingers through the leaves of the trees, and something other than just seeing eye to eye would take place. At the end of the summer we had seen no example of normal adult heterosexuality, only ill-directed and infantile efforts.



Monkeys raised in total social isolation are destroyed for normal heterosexual behavior. Here in a zoo, where an attempt was made to breed such animals after they grew to adults, they could make only ill-directed and infantile efforts at copulation.

We wanted to test the effect of social isolation on maternal behavior, but no one can study maternal behavior unless someone has babies. Actually, for about 50 percent of our isolated females we eventually found ways to breed them under controlled conditions. The technique we devised in desperation was a rape rack.

When motherless monkeys that had been raised in total isolation for 6 to 9 months became mothers, at least two-thirds of them turned out to be inadequate or evil mothers. They tended to show one of two syndromes. One pattern of the motherless mothers was to pay no attention to their infants. (Any normal monkey mother hearing one cry from its baby would have clasped the baby to its breast in no time flat.) The other mothers were brutal or lethal. One of their favorite tricks was to crush the infant's skull with their teeth. But their really sickening behavior pattern was that of smashing the infant's face to the floor, then rubbing it back and forth.

Now the interesting thing from a psychotherapeutic point of view was that the baby monkeys raised by these monster mothers (we had given up on the artificial monster mothers because we couldn't produce any as evil as a real monster mother) never gave up unless they were killed. The babies went back and back and back to their mothers, trying forever to attach to the mothers' back and then worm around to the ventral surface and breast. We kept the infants that survived with their mothers for 6 months. By the fourth to sixth month the babies were making as frequent—we won't say as long—contact with the monster

mothers as were the babies with the good mothers. In a manner of speaking, the infants had healed the mothers. And these mothers, who eventually became maternalized by their first babies, were, on the second, third, or fourth pregnancies, for all practical purposes, perfectly normal mothers. The babies had rehabilitated the mothers, because, by attaching themselves to the breast and the ventral surface, they eventually elicited maternal affection.

These studies convinced us that production and study of psychopathological behavior in monkey subjects was feasible, despite the failure of our earlier efforts. Subsequently we have embarked on a serious program to produce psychopathological syndromes as analogous to human disorders as possible. The specific human disorder we are attempting to simulate is depression. There exists a considerable body of research on depressive effects of monkey mother-infant separation stemming from both our own efforts and those of other laboratories. The depressive syndrome produced in infant monkeys is similar to human childhood or anaclitic depression resulting from maternal separation as described by the Swiss psychologist Rene Spitz and by Bowlby.

In our first two studies of mother-infant separation in monkeys, we put eight infants who had been separated from their mothers in play areas. The baby monkeys exhibited Bowlby's first two stages of separation—protest (locomotion and vocalization) and then despair (self-clasp, rocking, and huddling). The most striking illustration of the despair stage was near-total abolition of all play behavior. All studies of primate mother-infant separation have obtained these same results.

Suomi measured the effect of multiple repetitive separations of infants from other infants instead of single separations of infants from mothers. The technique gave elegant results and with relatively minor individual differences. During each of the 20 separations, the infants showed a period of protest, followed by a period of despair. Each time they were reunited, recovery rapidly ensued. However, a phenomenon that no one could have predicted was that these multiple separations drastically changed the infants' development—it infantilized the behavioral growth process. We collected normative data over the period of the first 9 months in normal monkeys, and normal infants do not behave the same way at 9 months as they do at 3 months. Normal infants are only beginning to play at 3 months and display much clinging and self-orality. But by 9 months clinging and self-orality have virtually disappeared, and play dominates their social activities. For the infants suffering from the effects of multiple separations, ventral clinging to another monkey and compulsive self-orality, which are very infantile responses, were as high or higher in the last 3 months as in the first 3 months. Play should have been higher than



Smashing her infant's face to the floor, this monkey displays a sadistic maternal behavior pattern characteristic of motherless monkeys raised in social isolation. Other "monster mothers" may be totally indifferent to their offspring.

We put the isolates in pairs with normal, younger "therapist" monkeys; after 6 weeks it was hard to distinguish between them, because the isolates were exhibiting normal behavior.

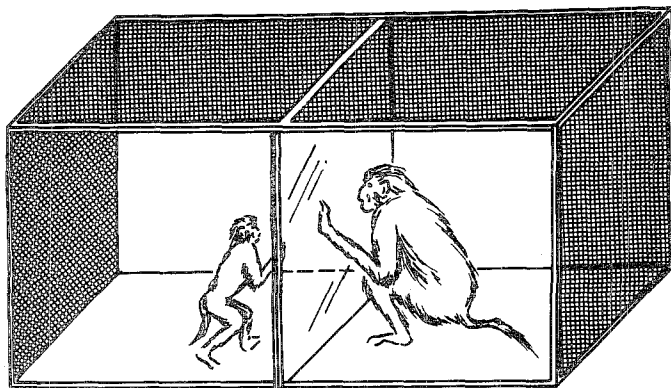
cling or self-mouth at 9 months, but the converse was true, even though the subjects were in a situation where they had every opportunity to play. This experiment achieved effects similar to running a flatiron over the maturational process.

Buoyed by these results, we have continued to search for techniques to produce depression. Our criteria for operationally defining depression are primarily behavioral. We want to produce subjects who, prior to manipulations, show essentially normal behavior and, following manipulations, display very low levels of motor, exploratory, and play behaviors, very high levels of passivity, and possibly decreased food and water intake. One reason for producing such a syndrome is that one cannot do effective research on any antidepressant agent until a behavioral syndrome

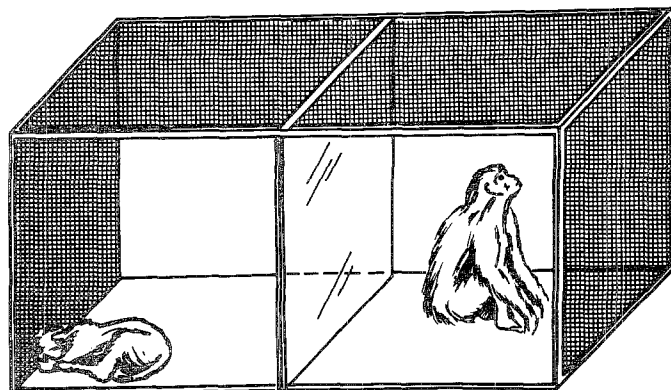
has been achieved that is descriptively unequivocal and reliable and can be maintained for weeks and months on end.

Obviously, one cannot combine physical and psychological disturbance and draw proper conclusions concerning depression. Accordingly, we have designed a device for producing depressive behavior without imposing physical discomfort on the animal. This device is called a vertical chamber or pit. Confinement in the vertical chamber produces an extremely depressed monkey, and one that remains depressed for many months following removal.

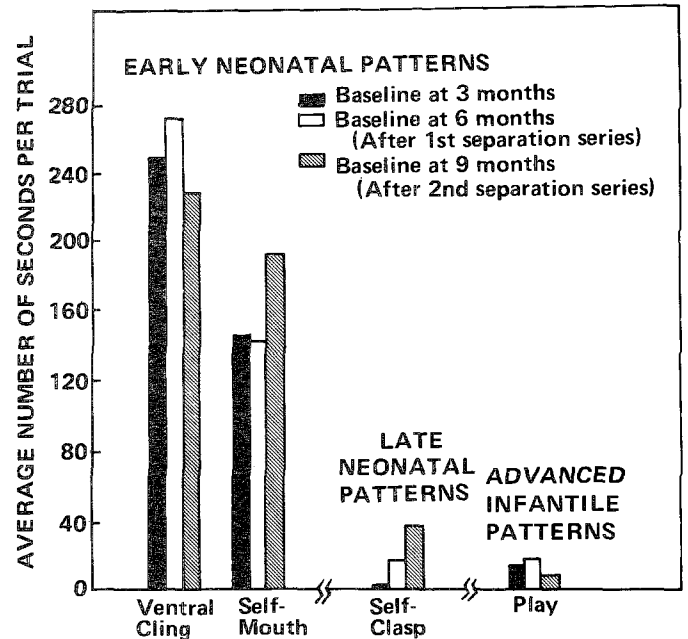
The animals in this vertical chamber can move about freely in all three dimensions, but they gradually cease to move at all. After a day or two, or for some a week or two, the monkeys assume a crouched posture akin to depression: It is a "giving up" posture. This kind of response in monkeys looks like human-type depression.



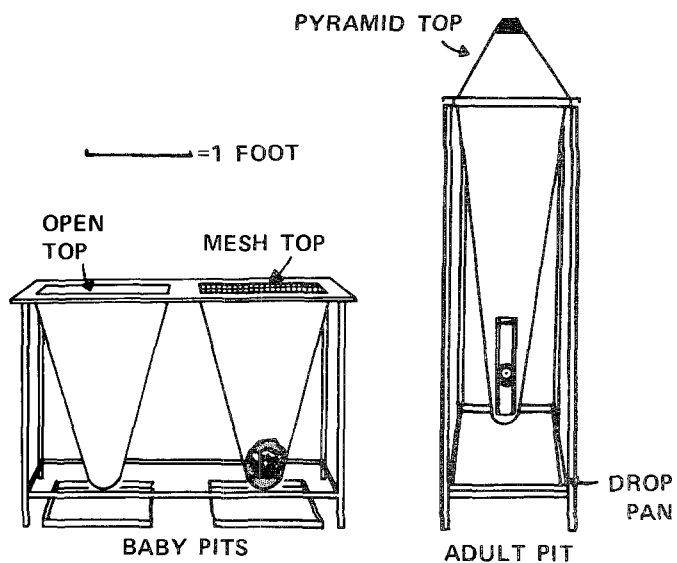
PROTEST STAGE OF SEPARATION



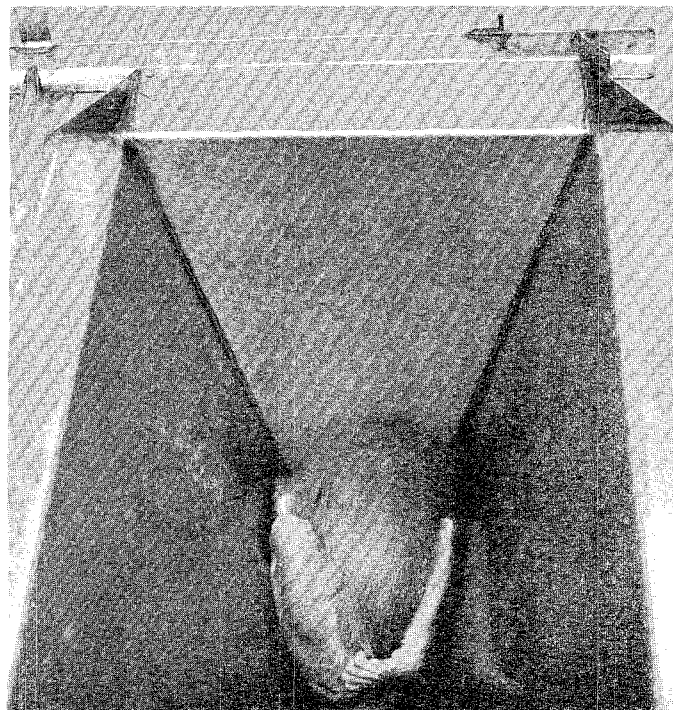
DESPAIR STAGE OF SEPARATION



Infant monkeys separated from their mothers (left) first protest, then despair. The separations, repeated over a period of time, effectively wipe out the more advanced behavior that the infants would develop under normal conditions (above).



The vertical chamber, in which monkeys can move freely without restraints, produces depressed behavior without making the animals physically uncomfortable.

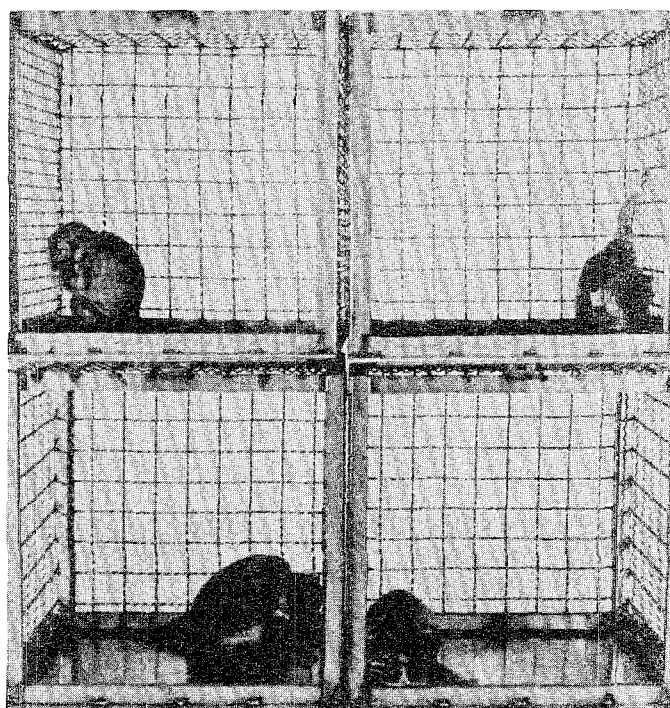


After a few days—or perhaps a week or two—the monkey in the vertical chamber stops moving about and assumes a “giving up” posture (above). Even long after removal from the chambers, young monkeys (below) show depressed and infantile behavior.

Following removal from the chamber, these responses persist. Infantile behavior increases enormously after vertical-chamber housing, and the ability to perform the more complex social tasks is simply wiped out. Vertical-chamber confinement produces effects homologous to human infant anaclitic depression.

We are now comparing animals raised under three different conditions. One group had 6 weeks of isolation in the vertical chamber; one was raised in a wire cage from birth; and the members of the third group were raised as together-together animals—infants put together without any mother, real or artificial. Simple infantile response patterns remain very high for months in those monkeys chambered for only 6 weeks. More complicated social behaviors were simply eradicated in these animals long after chamber release.

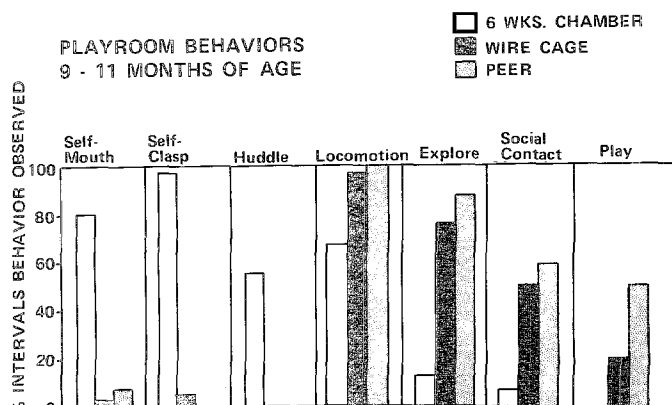
While the immediate goal of our present research is to produce reliable, generalized, stable, long-lasting syndromes of behavior analogous to those exhibited by human patients diagnosed as depressed, it represents only a first stage of our over-all depression project. The next step is to modify existing procedures so that the *degree* of depression subsequently exhibited by the monkeys can be controlled. When this is accomplished, it will open up vast possibilities for parametric study of factors antecedent to depression-inducing manipulations which should either facilitate or hinder production of the syndrome. For instance, it would be possible to determine if monkeys with limited social experience are more susceptible to such manipulations than monkeys given unlimited social interaction throughout their lives, or



whether early exposure to stress-inducing situations inhibits or exaggerates the effect of the depression-promoting manipulations. Such information could conceivably provide valuable insight and aid in the understanding of factors predisposing to human depression. The primary current source of such information concerning human beings is retrospective analysis, a useful method in formulating hypotheses but of limited value in experimental control and manipulation of key variables.

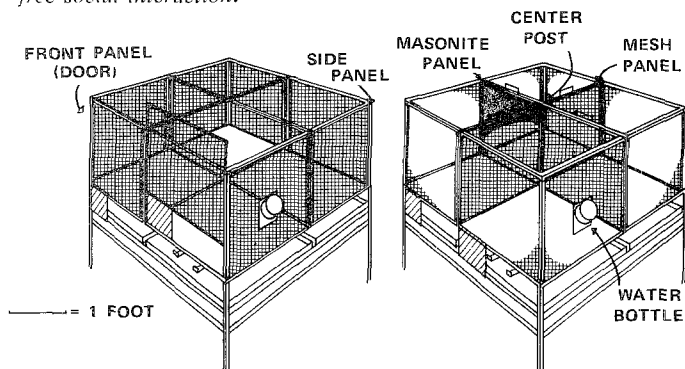
To accomplish these aims we are using a combined

living-experimental cage, named the quad cage, designed by Suomi, where four animals can live in separate chambers. These animals can be separated within the quad cage by wire, Plexiglas, or movable opaque slides, or allowed to interact freely. Social interaction behavior in the home cage is the simplest behavior in the simplest test situation that can be studied. The home cage also provides the environment in which deprived monkeys best show recovery. In addition, we are using what we call the playroom as a test situation, which has been highly standardized for studying development of infant-infant affection and for studying recovery from social loss following various antecedent events.



This chart shows the responses at nearly one year for monkeys raised under three different abnormal conditions: total isolation (chamber); partial isolation (wire cage); and together with another infant but with no mother, real or artificial (peer).

This quad cage is designed for maximum flexibility in arranging test situations that range from isolation to free social interaction.



COMBINED LIVING EXPERIMENTAL CAGE

A final, and perhaps most important, aspect of our research program involves the development of techniques for rehabilitation of depressed subjects. Possible techniques include behavioral, physiological, or pharmaceutical manipulations, either alone or in combination. Some conceivably could be modeled from existing therapies for human patients, such as electroshock therapy or anti-depressant drugs.

We are also employing our own technique of "group therapy." Remember that if you place infant monkeys raised in total isolation for 6 months with equal-aged normal monkeys, the isolates remain socially damaged. However, we have recently raised a group in total social isolation for 6 months, along with a follow-up group 3 months younger. This younger group has been carefully raised so that they would be socially normal, having had both surrogate mothers and playmates. When the isolates, who without special intervention would have been destroyed for life, were removed from their isolation chambers, we put them in pairs with the normal, younger "therapist" monkeys. After about 6 weeks it was very difficult to distinguish between isolates and therapists, because the isolates were exhibiting normal social behavior. It appears that this experiment, which is very close to completion, will disclose highly significant effects of rehabilitation for these 6-month isolates.

It is essential to realize that the findings of such work hold implications for human depression only at the level of analogy and within the limitations of comparative behavioral research. Nevertheless, we feel that our findings from investigations of depression in monkeys will be important to human therapists working in an area currently devoid of data from controlled research.