# NATURE OF LOVE—SIMPLIFIED [1]

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THE cloth surrogate and its wire surrogate sibling (see Figure 1) entered into scientific history as of 1958 (Harlow, 1958). The cloth surrogate was originally designed to test the relative importance of body contact in contrast to activities associated with the breast, and the results were clear beyond all expectation. Body contact was of overpowering importance by any measure taken, even contact time, as shown in Figure 2.

However, the cloth surrogate, beyond its power to measure the relative importance of a host of variables determining infant affection for the mother, exhibited another surprising trait, one of great independent usefulness. Even though the cloth mother was inanimate, it was able to impart to its infant such emotional security that the infant would, in the surrogate's presence, explore a strange situation and manipulate available physical objects (see Figure 3), or animate objects (see Figure 4). Manipulation of animate objects leads to play if these animate objects are age-mates, and play is the variable of primary importance in the development of normal social, sexual, and maternal functions, as described by Harlow and Harlow (1965). It is obvious that surrogate mothers, which are more docile and manipulative than real monkey mothers, have a wide range of experimental uses.

## SIMPLIFIED SURROGATE

Although the original surrogates turned out to be incredibly efficient dummy mothers, they presented certain practical problems. The worst of the problems was that of cleanliness. Infant monkeys seldom soil their real mothers' bodies, though we do not know how this is achieved. However, infant monkeys soiled the bodies of the original cloth surrogates with such efficiency and enthusiasm as to present a health problem and, even worse, a financial problem resulting from laundering. Furthermore, we believed that the original cloth surrogate was too steeply angled and thereby relatively inaccessible for cuddly clinging by the neonatal monkey.

In the hope of alleviating practical problems inherent in the original cloth surrogate, we constructed a family of simplified surrogates. The simplified surrogate is mounted on a rod attached to a lead base 4 inches in diameter, angled upward at 25°, and projected through the surrogate's body for 4 inches, so that heads may be attached if desired. The body of the simplified surrogate is only 6 inches long, $2\frac{1}{2}$ inches in diameter, and stands approximately 3 inches off the ground. Figure 5 shows an original cloth surrogate and simplified surrogate placed side by side.

As can be seen in Figure 6, infants readily cling to these simplified surrogates of smaller body and decreased angle of inclination. Infant monkeys do soil the simplified surrogate, but the art and act of soiling is very greatly reduced. Terry cloth slipcovers can be made easily and relatively cheaply, alleviating, if not eliminating, laundry problems. Thus, the simplified surrogate is a far more practical dummy mother than the original cloth surrogate.

## SURROGATE VARIABLES

### *Lactation*

Although the original surrogate papers (Harlow, 1958; Harlow & Zimmermann, 1959) were written as if activities associated with the breast, particularly nursing, were of no importance, this is doubtlessly incorrect. There were no statistically significant differences in time spent by the babies on the lactating versus nonlactating cloth surrogates and on the lactating versus nonlactating wire surrogates, but the fact is that there were consistent preferences for both the cloth and the wire lactating surrogates and that these tendencies held for both the situations of time on surrogate and frequency of surrogate preference when the infant was exposed to a fear stimulus. Thus, if one can accept a statistically insignificant level of confidence, consistently obtained from four situations, one will

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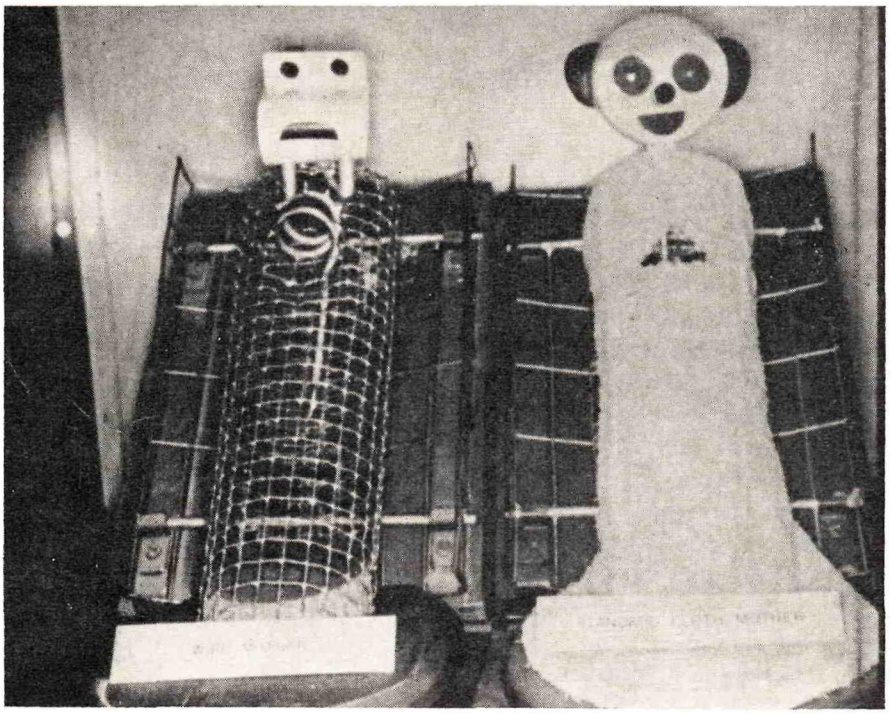

FIG. 1. Cloth and wire surrogate mothers.

properly conclude that nursing is a minor variable but one of more than measurable importance operating to bind the infant to the mother.

To demonstrate experimentally that activities associated with the breasts were variables of significant importance, we built two sets of differentially colored surrogates, tan and light blue; and using a 2 × 2 Latin square design, we arranged a situation such that the surrogate of one color lactated and the other did not. As can be seen in Figure 7, the infants showed a consistent preference for the lactating surrogate when contact comfort was held constant. The importance of the lactational variable probably decreases with time. But at least we had established the hard fact that hope springs eternal in the human breast and even longer in the breast, undressed.

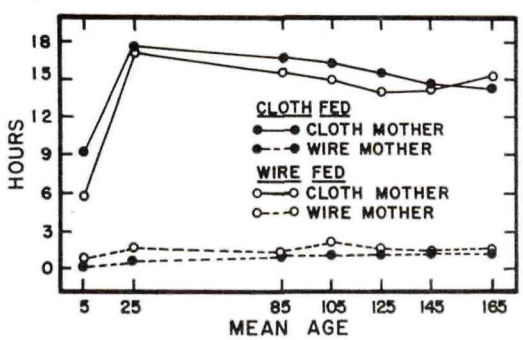


FIG. 2. Contact time to cloth and wire surrogate.

*Facial Variables*

In the original surrogates we created an ornamental face for the cloth surrogate and a simple dog face for the wire surrogate. I was working with few available infants and against time to prepare a presidential address for the 1958 American Psychological Association Convention. On the basis of sheer intuition, I was convinced that the ornamental cloth-surrogate face would become a stronger fear stimulus than the dog face when fear of the unfamiliar matured in the monkeys from about 70 to 110 days (Harlow & Zimmermann, 1959; Sackett, 1966). But since we wanted each surrogate to have an identifiable face and had few infants, we made no effort to balance faces by resorting to a feebleminded 2 × 2 Latin square design.

Subsequently, we have run two brief unpublished experiments. We tested four rhesus infants unfamiliar with surrogate faces at approximately 100 days of age and found that the ornamental face was a much stronger fear stimulus than the dog

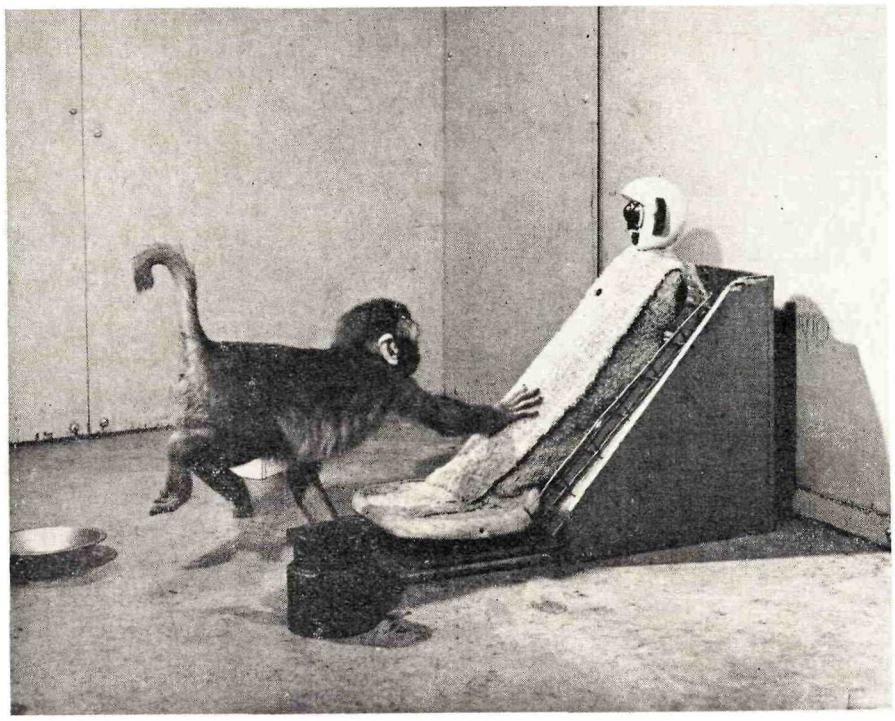

FIG. 3. Infant monkey security in presence of cloth surrogate.

FIG. 4. Infant play in presence of surrogate.

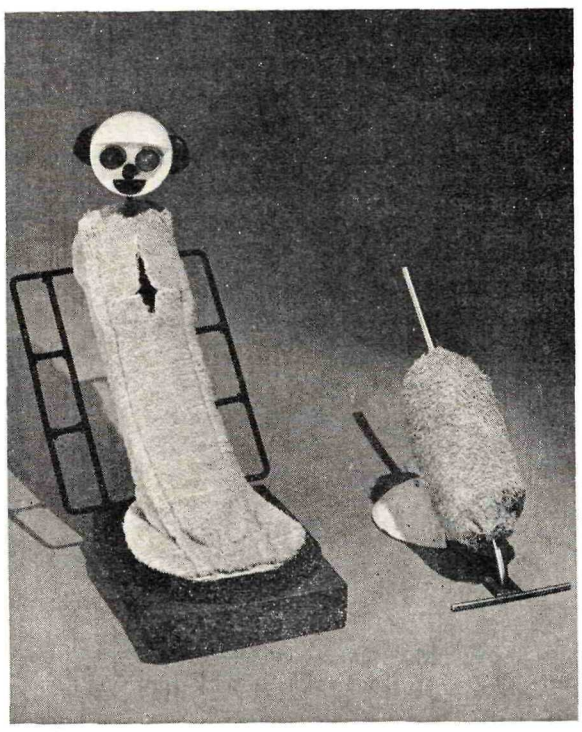

FIG. 5. Original surrogate and simplified surrogate.

FIG. 6. Infant clinging to simplified surrogate.

face. Clearly, the early enormous preference for the cloth surrogate over the wire surrogate was not a function of the differential faces. Later, we raised two infants on cloth and two on wire surrogates, counterbalancing the ornamental and dog faces. Here, the kind of face was a nonexistent variable. To a baby all maternal faces are beautiful. A mother's face that will stop a clock will not stop an infant.

The first surrogate mother we constructed came a little late, or phrasing it another way, her baby came a little early. Possibly her baby was illegitimate. Certainly it was her first baby. In desperation we gave the mother a face that was nothing but a round wooden ball, which displayed no trace of shame. To the baby monkey this featureless face became beautiful, and she frequently caressed it with hands and legs, beginning around 30–40 days of age. By the time the baby had reached 90 days of age we had constructed an appropriate ornamental cloth-mother face, and we proudly mounted it on the surrogate's body. The baby took one look and screamed. She fled to the back of the cage and cringed in autistic-type posturing. After some days of terror the infant solved the medusa-mother problem in a most ingenious manner. She revolved the face 180° so that she always faced a bare round ball! Furthermore, we could rotate the maternal face dozens of times and within an hour or so the infant would turn it around 180°. Within a week the baby resolved her unfaceable problem once and for all. She lifted the maternal head from the body, rolled it into the corner, and abandoned it. No one can blame the baby. She had lived with and loved a faceless mother, but she could not love a two-faced mother.

These data imply that an infant visually responds to the earliest version of mother he encounters, that the mother he grows accustomed to is the mother he relies upon. Subsequent changes, especially changes introduced after maturation of the fear response, elicit this response with no holds barred. Comparisons of effects of baby-sitters on human infants might be made.

*Body-Surface Variables*

We have received many questions and complaints concerning the surrogate surfaces, wire and terry cloth, used in the original studies. This mountain of mail breaks down into two general categories: that wire is aversive, and that other substances would be equally effective if not better than terry cloth in eliciting a clinging response.

The answer to the first matter in question is provided by observation: Wire is not an aversive

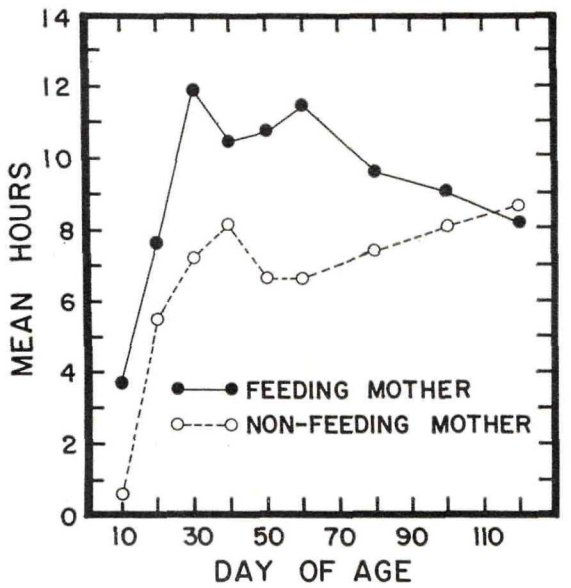


FIG. 7. Infant preference for lactating cloth surrogate.

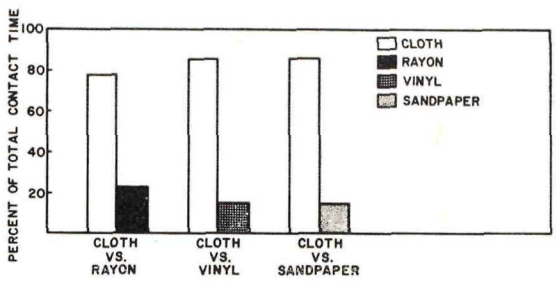


FIG. 8. Effect of surface on surrogate contact.

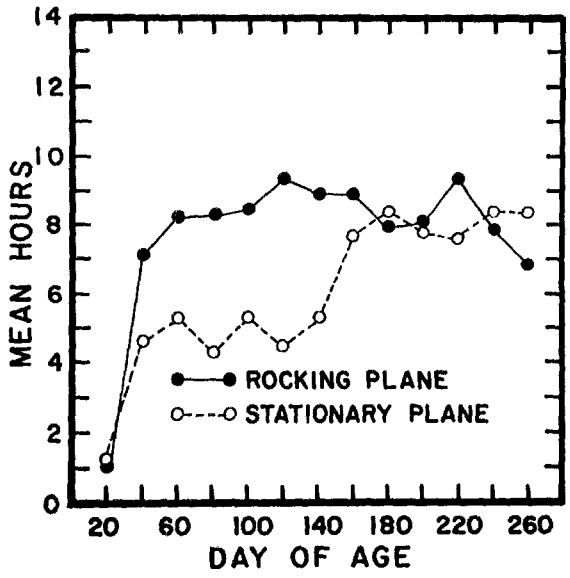


FIG. 9. Infant contact to stationary and rocking planes.

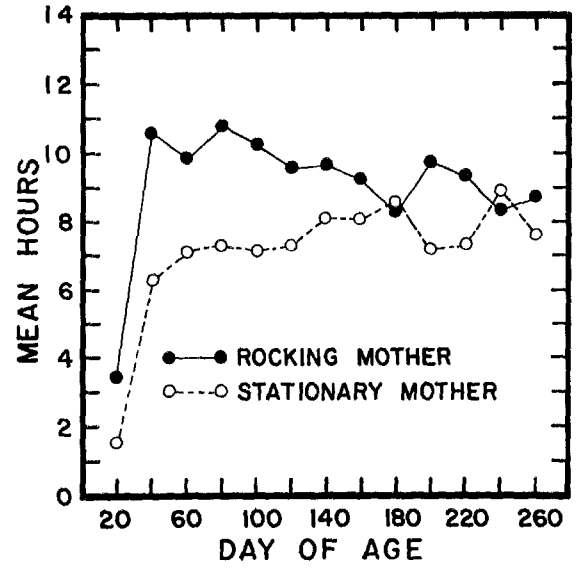


FIG. 10. Infant contact to stationary and rocking surrogates.

stimulus to neonatal monkeys, for they spend much time climbing on the sides of their hardware-cloth cages and exploring this substance orally and tactually. A few infants have required medical treatment from protractedly pressing their faces too hard and too long against the cage sides. Obviously, however, wire does not provide contact comfort.

In an attempt to quantify preference of various materials, an exploratory study [2] was performed in which each of four infants was presented with a choice between surrogates covered with terry cloth versus rayon, vinyl, or rough-grade sandpaper. As shown in Figure 8, the infants demonstrated a clear preference for the cloth surrogates, and no significant preference difference between the other body surfaces. An extension of this study is in progress in which an attempt is being made to further quantify and rank order the preference for these materials by giving infants equal exposure time to all four materials.

*Motion Variables*

In the original two papers, we pointed out that rocking motion, that is, proprioceptive stimulation, was a variable of more than statistical significance, particularly early in the infant's life, in binding the infant to the mother figure. We measured this by comparing the time the infants spent on two identical planes, one rocking and one stationary (see Figure 9) and two identical cloth surrogates, one rocking and one stationary (see Figure 10).

*Temperature Variables*

To study another variable, temperature, we created some "hot mamma" surrogates. We did this by inserting heating coils in the maternal bodies that raised the external surrogate body surface about 10° F. In one experiment, we heated the surface of a wire surrogate and let four infant macaques choose between this heated mother and a room-temperature cloth mother. The data are presented in Figure 11. The neonatal monkeys clearly preferred the former. With increasing age this difference decreased, and at approximately 15

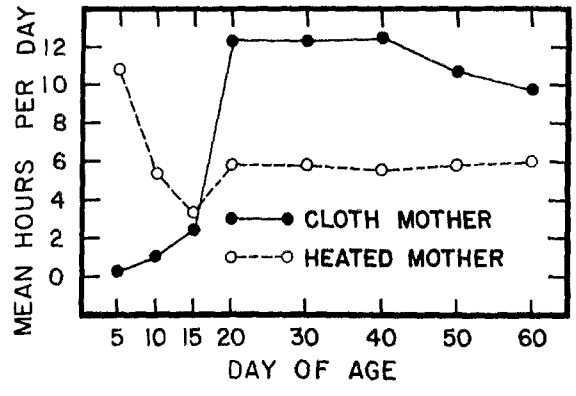


FIG. 11. Infant contact to heated-wire and room-temperature cloth surrogates.

[2] We wish to thank Carol Furchner, who conducted this experiment and the described experiment in progress.

days the preference reversed. In a second experiment, we used two differentially colored cloth surrogates and heated one and not the other. The infants preferred the hot surrogate, but frequently contacted the room-temperature surrogate for considerable periods of time.

More recently, a series of ingenious studies on the temperature variable has been conducted by Suomi, who created hot- and cold-running surrogates by adaptation of the simplified surrogate. These results are important not only for the information obtained concerning the temperature variable but also as an illustration of the successful experimental use of the simplified surrogate itself.

The surrogates used in these exploratory studies were modifications of the basic simplified surrogate, designed to get maximum personality out of the minimal mother. One of these surrogates was a "hot mamma," exuding warmth from a conventional heating pad wrapped around the surrogate frame and completely covered by a terry cloth sheath. The other surrogate was a cold female; beneath the terry cloth sheath was a hollow shell within which her life fluid—cold water—was continuously circulated. The two surrogates are illustrated in Figure 12, and to the untrained observer they look remarkably similar. But looks can be deceiving, especially with females, and we felt that in these similar-looking surrogates we had really simulated the two extremes of womanhood—one with a hot body and no head, and one with a cold shoulder and no heart. Actually, this is an exaggeration, for the surface temperature of the hot surrogate was only 7° F. above room temperature, while the surface temperature of the cold surrogate was only 5° F. below room temperature.

In a preliminary study, we raised one female infant from Day 15 on the warm surrogate for a period of four weeks. Like all good babies she quickly and completely became attached to her source of warmth, and during this time she exhibited not only a steadily increasing amount of surrogate contact but also began to use the surrogate as a base for exploration (see Figure 13). At the end of this four-week period, we decided that our subject had become spoiled enough and so we replaced the warm surrogate with the cold version for one week. The infant noticed the switch within two minutes, responding by huddling in a corner and vocalizing piteously. Throughout the week of bitter maternal cold, the amount of surrogate contact fell drastically; in general, the infant avoided

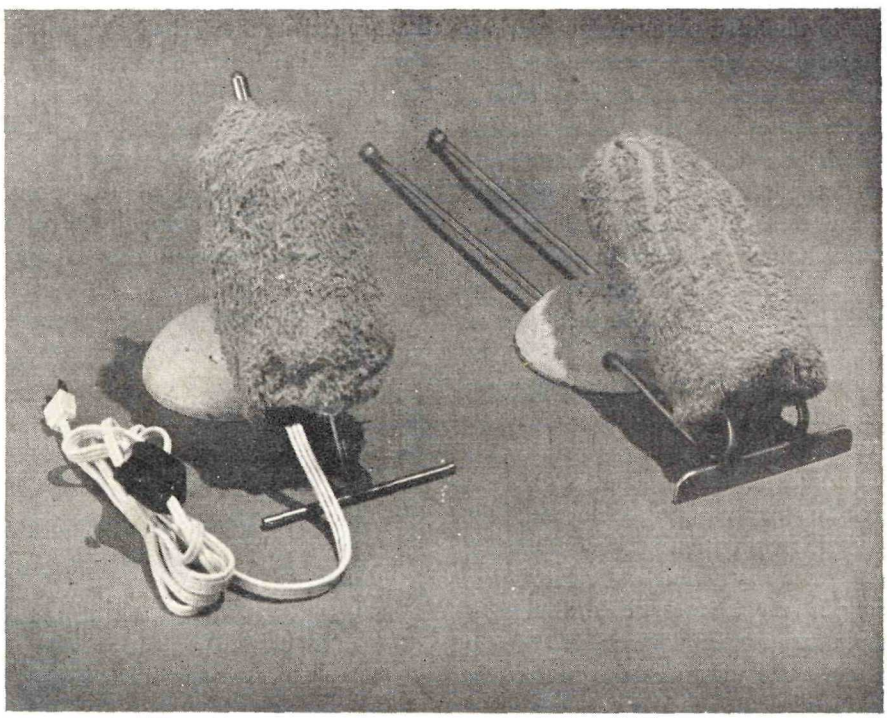

FIG. 12. Warm (left) and cold simplified surrogates.

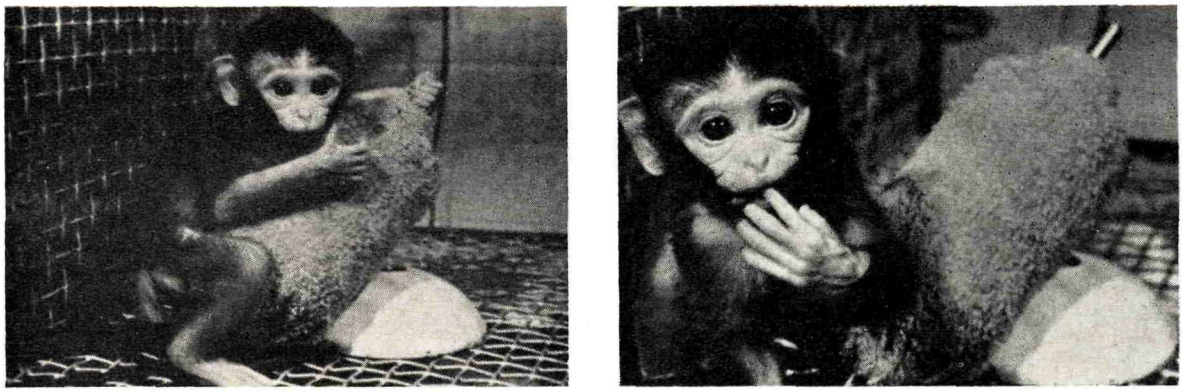

FIG. 13. Infant clinging to and exploring from warm simplified surrogate.

the surrogate in her feeding, exploratory, and sleeping behaviors. Feeling somewhat guilty, we switched surrogates once more for a week and were rewarded for our efforts by an almost immediate return to previously high levels of surrogate contact. Apparently, with heart-warming heat, our infant was capable of forgiveness, even at this tender age. At this point, we switched the two surrogates daily for a total two weeks, but by this time the infant had accepted the inherent fickle nature of her mothers. On the days that her surrogate was warm, she clung tightly to its body, but on the days when the body was cold, she generally ignored it, thus providing an excellent example of naive behaviorism.

With a second infant we maintained this procedure but switched the surrogates, so that he spent four weeks with the cold surrogate, followed by one week with the warm, an additional week with the cold, and finally a two-week period in which the surrogates were switched daily. This infant became anything but attached to the cold surrogate during the initial four-week period, spending most of his time huddling in the corner of his cage and generally avoiding the surrogate in his exploratory behavior (see Figure 14). In succeeding weeks, even with the warm surrogate, he failed to approach the levels of contact exhibited by the other infant to the cold surrogate. Apparently, being raised with a cold mother had chilled him to mothers in general, even those beaming warmth and comfort.

Two months later both infants were exposed to a severe fear stimulus in the presence of a room-temperature simplified surrogate. The warm-mother infant responded to this stimulus by running to the surrogate and clinging for dear life. The cold-mother infant responded by running the other way and seeking security in a corner of the cage. We seriously doubt that this behavioral difference can be attributed to the sex difference of our subjects. Rather, this demonstration warmed our hopes and chilled our doubts that temperature may be a variable of importance. More specifically,

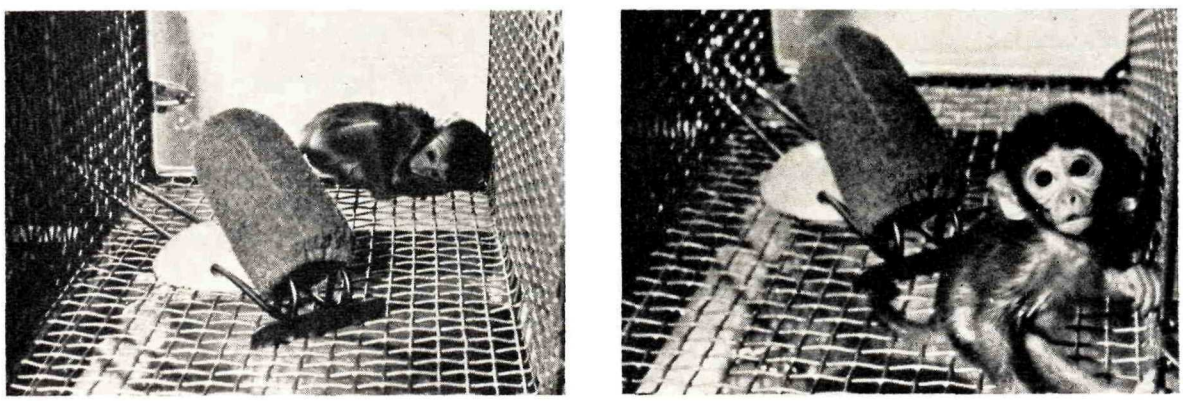

FIG. 14. Typical infant reactions to cold simplified surrogate.

FIG. 15. The supersimplified surrogate.

it suggested that a simple linear model may not be adequate to describe the effects of temperature differences of surrogates on infant attachment. It is clear that warmth is a variable of major importance, particularly in the neonate, and we hazard the guess that elevated temperature is a variable of importance in the operation of all the affectional systems: maternal, mother-infant, possibly age-mate, heterosexual, and even paternal.

## PROSPECTIVES

Recently we have simplified the surrogate mother further for studies in which its only function is that of providing early social support and security to infants. This supersimplified surrogate is merely a board 1½ inches in diameter and 10 inches long with a scooped-out, concave trough having a maximal depth of ¾ inch. As shown in Figure 15, the supersimplified surrogate has an angular deviation from the base of less than 15°, though this angle can be increased by the experimenter at will. The standard cover for this supremely simple surrogate mother is a size 11, cotton athletic sock, though covers of various qualities, rayon, vinyl (which we call the "linoleum lover"), and sandpaper, have been used for experimental purposes.

Linoleum lover, with you I am through
The course of smooth love never runs true.

This supersimplified mother is designed to attract and elicit clinging responses from the infant during the first 15 days of the infant's life.

We have designed, but not yet tested, a swinging mother that will dangle from a frame about 2 inches off the floor and have a convex, terry cloth or cotton body surface. Observations of real macaque neonates and mothers indicate that the infant, not the mother, is the primary attachment object even when the mother locomotes, and that this swinging mother may also elicit infantile clasp and impart infant security very early in life. There is nothing original in this day and age about a swinger becoming a mother, and the only new angle, if any, is a mother becoming a swinger.

Additional findings, such as the discovery that six-month social isolates will learn to cling to a heated simplified surrogate, and that the presence of a surrogate reduces clinging among infant-infant pairs, have substantiated use of the surrogate beyond experiments for its own sake. At present, the heated simplified surrogate is being utilized as a standard apparatus in studies as varied as reaction to fear, rehabilitation of social isolates, and development of play. To date, additional research utilizing the cold version of the simplified surrogate has been far more limited, possibly because unused water faucets are harder to obtain than empty electrical outlets. But this represents a methodological, not a theoretical problem, and doubtlessly solutions will soon be forthcoming.

It is obvious that the surrogate mother at this point is not merely a historical showpiece. Unlike the proverbial old soldier, it is far from fading away. Instead, as in the past, it continues to foster not only new infants but new ideas.

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