

Development of Social Behavior in an Adult Total Isolate Rhesus Monkey (*Macaca mulatta*)¹

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A 12-year-old female total isolate rhesus monkey was pretested with age mates and subsequently housed for 20 weeks with an infant "therapist" monkey. Daily observations during that period revealed a 24-fold increase in the probability of social behavior. Self-directed behaviors also increased significantly. Disturbance behaviors (self-slapping, self-biting, bizarre limb movements, etc.) remained unchanged. Although problems obviously exist in cross-species generalization, and are here considered, these results emphasize the importance of early therapeutic intervention as well as the need for a more comprehensive approach to both social and disturbance behaviors if the treatment of adults is to be as successful as the treatment of immature isolate subjects.

INTRODUCTION

It has been amply demonstrated that early social deprivation has devastating effects on the behavior of human and nonhuman primates. In rhesus monkeys, 6, 9, or 12 months of total social isolation (removing infant from its mother and rearing it where it can neither see, hear, nor touch conspecifics) beginning at birth have been shown to cause enduring deficits in normal social behavior. Monkeys so reared show high levels of social withdrawal, inadequate sexual behavior, and abnormal levels of aggression. Additionally, total social isolation has been shown to cause unusually high levels of self-directed behaviors, including huddling, rocking,

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self-slapping, self-biting, and bizarre limb movements (Harlow & Harlow, 1966).

In spite of the severity of social deficits exhibited by isolates, it has been shown that they can perform at levels similar to normally reared controls on all but complex learning tasks (Gluck, Harlow, & Schiltz, 1973). This apparent substantial retention of learning ability supports the possibility that isolates may be capable of modifying other behavior as a consequence of therapeutic experience.

Previous attempts to enhance the social behavioral repertoire of social isolates have included presenting photographs of monkeys in social interaction to isolates during the isolation period, punishment in the form of shock for failure to approach other monkeys, and gradual phasing-in of social experience with age mates. Until recently, all have met with only limited success (Clark, 1966; Sackett, 1968; Pratt, 1969). However, in two recent studies (Harlow & Suomi, 1971; Suomi, Harlow, & Novak, 1974) successful social rehabilitation of young isolates appears to have been achieved. The procedures used involve pairing an infant monkey with an isolate immediately after the isolate's removal from its deprived rearing environment. By gradually increasing the complexity and duration of social interaction with the "infant therapist" (who forces nonaggressive physical contact and attention on the isolate), increased levels of social interaction and ultimately play have been observed. Although animals released from isolation show social deficits and, untreated, show no improvement, the behavioral profiles of isolates and therapists housed together become virtually indistinguishable and normal after several months of social interaction (Suomi & Harlow, 1972).

With respect to the development of social behavior, the question of the importance of the age of the isolate at the time of intervention remains at issue. Specifically, can adult social isolates benefit from paired housing with a developing infant therapist, or is such intervention beneficial to monkeys only immediately after their release from social isolation? There is presently only one study in the literature which is directly concerned with this question (Gomber & Mitchell, 1974). In this study a 15-year-old male partial isolate (reared where it could see and hear but not reach conspecifics) was continuously housed with an infant for 7 months. It was reported that the isolate developed patterns of social interaction with the infant but showed no concomitant decrease in abnormal behaviors such as self-biting and self-slapping. In an attempt to extend these findings to the more extreme total isolation condition, results of a study in which an 11-year-old female total isolate monkey was continuously housed with an infant monkey for 20 weeks are now presented.

METHOD

Subjects

The female isolate (E 15) was obtained from the University of Wisconsin Primate Laboratory, where she had been reared from birth to 9 months in an enclosure which completely prohibited social and visual contact with other monkeys (total social isolation). The isolate was 11 years old at the beginning of the experiment. Since its release from isolation, the subject had lived alone in a standard, wire mesh cage and participated in several tests of learning ability. The infant "therapist" was separated from its feral mother at 3 months, at which time it was paired with the isolate in a 152 X 76 X 107 cm stainless steel cage. Additionally, four adult rhesus monkeys (two normal, two isolate) were used in a series of social pretests, and a 6-month-old male rhesus was used in a test of transfer of social behavior during the 10th week of the experiment. Observations of the isolate's behavior in a group of adult isolates were conducted after the infant was removed.

Behavioral Assessment

The animals were observed for 5 minutes a day, seven times weekly, for 20 consecutive weeks. In all observations, behavior was scored using a modified frequency scoring system. Specifically, observers recorded the presence or absence of behaviors on a checklist of mutually exclusive and exhaustive categories. The occurrence of each behavior was scored only once in each of 30 10-second periods. Observations were dictated onto magnetic tape which was later transcribed for analysis. The subjects appeared to be well habituated to observation and it seemed to have no effect on their behavior. Interobserver reliability coefficients exceeded .90 (Pearson's *r*) for all reported categories. The behavioral categories are listed below.

Disturbance behaviors. Self-slapping, self-biting, head banging, pacing, and stereotypy (repetition of a movement three or more times).

Self-directed. Oral or manual manipulation of the skin, fur, or digits, and passive inactivity or sleeping.

Social interaction. Appropriate threat, social grooming, social approach within 6 inches of another animal, social physical contact, appropriate fear grimace, oral-nipple contact by infant.

Active environmental exploration. Physical manipulation of inanimate objects (excluding food) and locomotion more than 12 inches without repeating a path more than three times in succession.

Passive environmental exploration. Visual orientation to specifiable environmental objects, eating and drinking behaviors.

Procedure

The isolate was observed for 1 week in her home cage (where she was housed alone). After initial observation and prior to social pairing with the infant, the isolate was paired with four individual adult rhesus monkeys (two socially reared, two isolate) in 12 10-minute dyadic test periods in order to assess current social abilities. Next the infant was continuously housed with the isolate. During the 10th week of testing, an unfamiliar 6-month-old male rhesus monkey was introduced for eight 10-minute dyadic test periods. At the end of the study the isolate was placed in a large open run with six other adult isolates as part of a study of their group formation.

Data Analysis

A multivariate analysis of repeated measures was used to analyze changes over 20 weeks. Probabilities were computed by taking the total number of observed behaviors for one session and dividing the number of occurrences of one category by the sum. The resulting probability is a percentage measure of the likelihood of observing a particular behavior during a random observation. Although it was recognized that many of the assumptions of the analysis were violated, the statistic was used to demonstrate that the daily observations that contributed to each 4 week block had far less variance within the 4 week periods than between them. As such, they support the notion that changes in observed behavioral probability were due to genuine behavioral changes and not to erratic observations.

RESULTS

Results are presented as the average probability of observing each behavior during home cage, pretreatment social assessment, the strange-infant test, and the 20 weeks of infant housing broken into five 4-week blocks. The results are presented in Table I.

The most significant change observed in the isolate's behavior was a nearly 24-fold increase in the probability of social interactions between the first and last 4 weeks of the study, $F(1,51) = 73.27, p < .001$. Self-directed behavior showed a similar increase, $F(1,51) = 47.56, p < .001$, although

Table I. Probabilities of Occurrence of Behavioral Categories During Five 4-Week Periods and During Pretest, Dyadic Tests, and Novel Infant Tests

Behavioral categories	Pretest alone (home cage)	Dyadic tests with adult	Weeks 1-4 with infant	Weeks 5-8 with infant	Novel infant (week 10)	Weeks 9-12 with infant	Weeks 13-16 with infant	Weeks 17-20 with infant
Disturbance (self-slap, self-bite, bizarre, etc.)	.161	.048	.092	.076	.059	.065	.073	.059
Self-directed (self-groom, self-mouth, passive)	.312	.038	.011	.036	.069	.089	.152	.125
Social interaction (groom, physical and nipple contact, appropriate social signalling)	n/a	.057	.007	.072	.123	.146	.157	.166
Passive environmental exploration (visual)	.346	.688	.605	.583	.513	.480	.440	.505
Active environmental exploration (physical, locomotion)	.180	.170	.277	.238	.238	.222	.187	.200

the probability of disturbance behaviors did not change significantly during the course of the experiment. Active and passive environmental behaviors decreased in probability, reflecting the gains made in social and self-directed behaviors. Passive environmental behaviors decreased about 17%, $F(1,51) = 18.65$, $p < .001$, while active environmental behaviors decreased about 28%, $F(1,51) = 16.48$, $p < .001$.

When the stranger-infant was placed in the isolate's living cage and the therapist was removed, the isolate's behavioral profile changed little (see novel infant column, Table I). The trends in the isolate's behavior toward the infant therapist are consistent with the probabilities obtained in the stranger test.

Observations conducted during the social pretest revealed high percentages of social behavior. This was, however, composed primarily of appropriate social threats, fear grimaces, and physical contact resulting from panicked flight by the isolate. There was no grooming or hugging during the pretest, contrary to high levels of cuddling and holding as well as grooming and nipple contact which made up the social behaviors observed with the infant.

Observations conducted during the group-formation posttest yielded little evidence of normal social behavior in the isolate. In spite of her recent satisfactory social interactions with the infant, her probability of social be-

havior fell to zero for the first 2 weeks of social housing. Disturbance behaviors increased from their previous levels and occupied 11% of the total observed behavior of the isolate. Follow-ups conducted over several months revealed that a pattern of social avoidance and disturbance behavior persisted. The probability of social behavior remained at zero for each of the first 2 weeks of housing and was replaced by locomotor behavior, which by itself occupied 40% of the isolate's time.

DISCUSSION

It is apparent that an adult total social isolate rhesus monkey can recover some social behaviors during housing with an infant. It was observed that the isolate slept with the infant, tolerated occasional oral-nipple contact, and engaged in rudimentary reciprocal grooming. Equally important was the failure to obtain a reliable decline in the probability of such disturbance behaviors as self-slapping, self-biting, and bizarre limb movements.

The dramatic increase in social behavior by the isolate over time appears, indeed, to be primarily a function of the isolate's behavior. Harlow and Harlow (1965) published an extensive discussion of the ontogeny of social behavior in the rhesus monkey. It was reported that whether housed with their own mothers or with inanimate terry cloth surrogates as infants, they spent decreasing amounts of time in physical contact with their mother. Furthermore, the frequency of both rough-and-tumble and approach-avoidance play was found to begin to decline before the age at which this infant was paired with the isolate. Exploratory behavior and self-manipulation occur with increasing frequency as play and contact behaviors decline. Thus, the increasing frequency of physical contact, including ventral cling and nipple contact, runs counter to expectations for an infant of increasing age and was probably due to the isolate's increasing tolerance of physical contact, and not to the developmental process of the infant. To this end, the infant is currently behaving normally in a mixed sex, social housing situation.

Cross-species generalizations must be made with caution. Rosenblum and Kaufman (1967) noted behavioral differences in mother-infant interaction in two species of macaques, and Sackett, Holm, and Ruppenthal (1976) reported significant differences between rhesus and pigtail macaques in their behavior upon release from total social isolation. It is important, however, to note that socially isolated rhesus monkeys behave very much like socially isolated chimpanzees (which are phylogenetically closer to humans than the macaque) after release from isolation (Mason, Davenport,

& Menzel, 1968). The value of the isolation effect does not lie in its reproducibility and consistency across species. However, it may provide a model for the study of human psychopathologies.

There are similarities between the conceptualizations of psychotherapy for autistic children presented by Mahler, Furer, and Settlege (1959) and the explanations of the effect of social housing presented by Suomi and Harlow (1972). Mahler et al. advocated an analytically based therapy including involving the child in a symbiotic relationship. By developing an infantile symbiosis with the therapist, the autistic child could subsequently develop more normal social functioning as the therapist provided a substitute ego, and brought the child along in the development of his own. Suomi and Harlow (1972) described the effect of their social housing situation as the imposition by the infant therapists of their undeniable presence on the isolate. The isolates were ultimately forced to recognize the existence of the therapists. The development of more complex social interactions by the therapists necessarily involved the isolates and assisted them in the development of social repertoires that culminated in normal social interaction.

Previous failures to effect therapeutic diminution of bizarre self-injurious behavior in humans have been discussed by Lovaas and Newson (1976). They have suggested that many serious cases of self-injurious behavior require direct intervention rather than indirect psychotherapy. This position runs parallel with the present experiment. The self-injurious and bizarre behaviors exhibited by isolated monkeys seem to be exacerbated by stress. The intervention strategy used in this study, albeit similar to the successful one used by Suomi and Harlow (1972) and Suomi et al. (1974), appeared to be insufficient to overcome the strength of the disturbance habits developed over the years.

The limited generalizability of the isolate's newly developed social behavior appears to be due not only to the stress induced by aggressive isolate age-mates, but also to interference by persisting bizarre and self-injurious behaviors. The need for a more comprehensive approach is clearly indicated in the treatment of adult social isolates. Although social housing and extended contact seem to be a sufficient therapy for isolates just removed from their rearing environment, the deeply entrenched patterns of disturbance behaviors in adult isolates do not surrender to the attentions of the infant therapist. Similarly, Dennis (1973) has reported that children reared in environments approximating the isolation conditions used by Harlow and his co-workers recover if intervention occurs before the second year but fare worse the later intervention begins.

These findings suggest that attempts to develop social behavior in adult isolates must move along two lines. Not only must the frequency and quality of social behavior be improved, but a direct manipulation of distur-

bance behaviors seems necessary. The implications for the treatment of severely disturbed children seem clear. In cases where bizarre and self-destructive behaviors interfere with the development and generalization of social skills, those behaviors must be altered. This must be done as soon as possible, before such behaviors become even stronger and thwart further therapeutic efforts.

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