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Assessment Of Long Term Deficits Produced By Early Total Social Isolation

Robert George Frank

ASSESSMENT OF LONG TERM DEFICITS PRODUCED BY EARLY TOTAL SOCIAL ISOLATION

BY
ROBERT GEORGE FRANK
B.S., The University of New Mexico, 1974

THESIS

Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Arts in Psychology
in the Graduate School of
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ACKNOWLEDGMENTS

This thesis is dedicated to the memory of G-44. She unquestioningly made the greatest and noblest sacrifice any member of Macaca mulatta can make; she died while serving science. May she rest in peace.

Others have made important contributions to this research. The members of my committee, Drs. F. Harnick, R. Harris, and K. Koenig thought that perhaps they would die while waiting to see the final draft of this work. Their patience is appreciated. More importantly, their input into this work was excellent and I am thankful to them. Mrs. E. Orth waded through enough misspellings while she proofread this work to wear out her pencil, and I thank her for doing so. Jeff Young provided many crucial hours of scoring; without his help, it is doubtful that this work could have been completed.

I would like to thank my parents and family for providing me with a variety of rich early and later experiences which have allowed me to reach this point. My parents and family have warmly supported me in all my efforts. I rarely tell them how much I appreciate their encouragement and support; it means much more than I can tell.

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Without my mentor, John Gluck, I would never have seriously considered attending graduate school. He has provided me with a model which has few peers. I feel no shame in attempting to emulate it. His generosity in providing me with support, resources, and encouragement has been unbounded. I wish there were a better way to say it, but I certainly don't know it. Thank you John.

My faithful companion, the Hopper, has listened to my ravings for hours, and, thankfully, never replied.

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Lastly, I would like to thank Carol. Here again words escape me. All I can say is that you are truly the sunshine of my life.

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ABSTRACT OF THESIS

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Robert George Frank, M.A.
Department of Psychology
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Abstract

The long term effects of early total social isolation in rhesus monkeys have been assumed to be static. This assumption, that young isolates' behavior does not differ from older, fully mature isolates' behavior, may not be valid in view of behavioral changes which have been shown to occur as monkeys age. The present research examined the effects of early, total social isolation in fully mature monkeys.

Two groups were formed and allowed to live together for 14 weeks in an indoor-outdoor facility. The first group was composed of 7 controls reared for the first 9 months of life with peer and maternal contact. The second group was composed of 6 isolates reared for the first 9 months of life in total social isolation. Both groups were composed of animals of similar age, ranging from 8-13 years of age. Each animal was observed daily for 3 minutes using a modified frequency scoring system with 11 categories. Periodically, each group was challenged with water deprivation, novel objects, monkey strangers, and apple incentive tests. During weeks 13-14 the dominant male was removed from the control group to assess his effect on the group's behavior.

The results indicated that fully mature social isolates exhibited very low levels of social behavior when compared to controls. Isolates exhibited no sexual behavior while controls had two live births as a function of their housing. Isolates were not found to be hyper-aggressive or overly fearful as had been reported earlier. Isolates displayed higher levels of nonsocial behavior (explore-self-manipulation) but did not differ otherwise.

Removal of the dominant male from the control group resulted in increased levels of social behavior within that group but did not significantly reduce aggression or domininance-submission behaviors. Results of the group's challenge tests indicated that isolates had a "tighter," more predictable dominance hierarchy than controls.

Fully mature, early total social isolates were found to be asocial and asexual. Isolates were not hyper-aggressive but were more likely to engage in self-directed behaviors than controls. The behavior of fully mature social isolates was found to be influenced by aging although many of the characteristic isolate behaviors remained.

TABLE OF CONTENTS

LIST OF FIGURES

Figure		Page

LIST OF TABLES

Introduction

The effects of early social isolation have generally been assessed in one standard paradigm. Monkeys are reared for some specified period in a chamber which prohibits social contact as well as eliminating all but subject produced stimulation. Comparison groups are formed by rearing other monkeys for the same time period with some minimal or major social contact. This is achieved by either rearing monkeys in single cages which allow the monkey to see and hear other monkeys but prohibits contact (partial isolation) or by rearing monkeys with peer and/or maternal contact. Monkeys reared in early social isolation are markedly affected. Early social isolates exhibit high levels of fear, stereotypes, inactivity, and self-directed behaviors. Social behaviors are aberrant and sexual behavior is non-functional (Harlow, 1964; Harlow, Rowland, & Griffen, 1964; Sackett, 1968). These findings are typically found during tests conducted during the second and third year of life. Social assessment customarily occurs in a playroom setting where control and experimental subjects are allowed brief daily within or between group social encounters for some period of time.

Several authors have taken issue with this assessment paradigm. Pratt (1967, 1969) pointed out that when the control groups were formed using monkeys reared in wire cages (partial isolation), the value of any contrast is limited. Partial social isolates exhibit deficits qualitatively similar to total social isolation but quantitatively less intense than total social isolates. Thus, a comparison of deficits between total isolates and partial isolate controls is not as illuminating as a comparison which includes more completely socialized animals in the control group.

Fittinghoff, Lindburg, Gomber, and Mitchell (1974) have pointed out that most of the published research dealing with early social isolation effects has utilized infants, juveniles, or young adults rather than fully mature animals. The importance of cataloguing basic early social isolation deficits as well as the initial absence of fully adult social isolates made this the only alternative. Clearly the extended maturational period as well as the increased animal maintenance costs have continued to limit the long term assessment of early social isolation deficits.

Anderson and Mason (1974) have made a third cogent criticism of the basic early isolation testing paradigm. These authors have cited the necessity for more ethological relevance in the testing situation. According to this position, monkeys must be assessed in an environment that bears some resemblance to natural conditions. For example, since the modal social unit is the group, social behaviors must be assessed with animals that are fully acclimated to continual social housing. Testing which allows the isolate only 30 minutes per day of social contact, during the test, may tap a limited sample of social skills.

The pertinence of these criticisms becomes readily apparent when the literature is examined. Rowland (1964) performed the hallmark study on the effects of early social isolation. Rowland reared rhesus monkeys for the first 6 or 12 months of life in total social isolation. A third group was reared for the first 6 months of life in partial isolation and the second 6 months of life in total social isolation. One year partial isolates formed the last group that served as controls. Rowland found that 12 months total isolates were quantitatively more devastated than 6 month early isolates and that both groups of total isolates were lacking more social behaviors than the 6 month late isolates or the partial isolate controls. The 6 and 12 months early isolates showed high levels of fear and bizarre movements, and low levels of social contact, sex, and play. Interestingly, the 6 month early isolates were showing some behavioral improvement at the end of the 32 week testing period. The 12 month isolates remained completely inept in social encounters.

Mitchell, Raymond, Ruppenthal, and Harlow (1966) paired Rowland's 6 and 12 month early isolates with socially sophisticated controls when they were 35 months of age. Pairings were 30 minutes long and took place in a playroom. Both isolate groups were characterized by infantile disturbance, low environmental orality, high levels of fear and aggression, low levels of sexual behavior and play, and frequent idiosyncratic bizarre movements. Although the 12 month isolates threatened many attacks, they were primarily fearful and nonaggressive. The 6 month isolates were both fearful and physically aggressive. Mitchell (1968) examined Rowland's isolates just as they reached puberty. Fear behaviors which had pervaded the isolates' repertoire earlier were diminished, but aggressive behaviors had increased. The isolates showed more emotional behavior than partial isolate controls but exhibited less play, sex, exploration, and vocalizations. While the isolates were quite hostile toward infants, there was a significant decrease in infant-directed hostility with age. Mitchell concluded that "Even though total social isolates remain socially inept at 4 1/2 years of age, their behavior appears to improve somewhat over time. Maturational and perhaps experiential factors attenuate previous debilitation."

Arling, Rupentahl, and Mitchell (1969) reported that the decreasing trend of aggressive behavior seen by Mitchell et al. (1966) and Mitchell (1968) continued in 8 year old nulliparious isolate females. In testing encounters with agemates and infants, the older isolate females demonstrated less aggression toward infants and more aggression toward agemates than 4 year old isolate females. Fittinghoff, Lindburg, Gomber, and Mitchell (1974) exposed 13 year old partial isolates to a variety of semi-social and environmental challenges. Generally, they found that partial isolates at 13 years of age had behavioral profiles similar to younger partial isolates, with high levels of self-punishment, stereotypes, bizarre movements, and autoeroticism. However, the frequency and kind of disturbance behaviors were markedly reduced by age. The repertoire of disturbance behaviors exhibited by younger partial isolates greatly exceeded that shown by older isolates.

Clearly, the effect of early isolation on behavior is not static. Although little is known about adult isolates' behavior, the evidence, as cited above, indicates that age produces marked changes in the behavior of monkeys reared in early social isolation. Mitchell's (1968) remarks indicated that not only age, but experiential factors were operating in the attenuation of isolation indices deficits.

Social experience is critical to any analysis of early isolation deficits. Anderson and Mason (1974) argued that social behavior is best assessed in situations which permit higher order social interactions to occur. In this way a more complete picture of early isolation deficits could be revealed. This type of assessment offers two main advantages. First, it allows an expansion of the present data base which is largely concerned with dyadic interactions to encompass triadic and other higher order interactions. Secondly, it offers the early social isolates experience in a seminatural context.

The evidence available to date indicates that not only does age produce changes in the early isolate's behavioral profile, but extensive social experience also affects the adult's behavioral repertoire. Harlow and Harlow (1962) allowed 19 partial isolates to live on an island in the Vilas Park Zoo in Madison, Wisconsin. Sexual behavior was closely followed as were other general behaviors to determine if social living increased the sexual proficiency of the partial isolates. Over the course of the experiment, grooming increased dramatically among the isolates but appropriate sexual behaviors failed to develop. The social behaviors which did develop proved to be only temporary gains disappearing after extended single cage housing. Missiakian (1969) paired male monkeys that were wild reared, cage reared with adult social experience, or cage reared without social experience with sexually receptive females. Periodically, the experienced partial isolates had been paired with other females. Each pairing lasted 24 hours and 2 hours of each encounter was scored. In all measures of social and sexual behavior the feral reared males had higher levels of appropriate behaviors than either group of partial isolates. However, the partial isolate males with social experience showed higher, but nonsignificant levels of social contact than the partial isolates without social experience.

Missiakian (1972) placed three partial isolate males in separate groups of three to four feral reared females. The groups remained intact for periods ranging from three to six months. Missiakian reported increases in play, social grooming, and mounting, accompanied by decreases in self-aggression and stereotypes in two of the subjects. The third subject showed no improvement. The two subjects that improved were younger and engaged in social play while the older partial isolate did not. Missiakian attributed the improvement of the two isolates to their high levels of play behavior.

The most dramatic example of the effects of social experience on early isolation behaviors was produced by Suomi and Harlow (1972) and Novak, Harlow, and Suomi (1975). These workers demonstrated that if young socially reared monkeys were placed with isolates shortly after removal from the isolation chamber, tremendous social gains could be made by the isolate. With enough social experience, the young isolate developed a behavioral profile very similar to normally reared monkeys.

In summary, the studies cited above clearly indicate that adult isolate behavior differs from the younger isolate's behavior. Although little is known about fully mature isolates, the available evidence indicates that as a function of age their behavioral profiles change. Fear behaviors decrease, aggressive behaviors generally increase but decrease in pairings with infants. Whether these changes are merely artifacts of the brief testing periods or truly reflect underlying changes is unclear. Similarly, the role of social experience in producing later changes in adult isolate behaviors remains clouded. Prolonged social experience ameliorates early isolation deficits but the role of the age of the isolate in this, and the permanence of the changes remains unclear.

The following research will attempt to reduce some of the uncertainty concerning early isolation effects in fully mature monkeys. As well as assessing the behavior of fully mature (10-13 years) social isolates, the study will compare the isolates to feral and lab reared social controls. These comparisons will thus offer a complete picture of adult social isolate functioning as contrasted to normally reared adults with both groups being followed throughout a long term social experience. Both groups will be housed with similarly reared peers, 24 hours a day for a period of 14 weeks. Behaviors from three basic categories will be observed: positive social behaviors (e.g., grooming), negative social behaviors (e.g., aggression), nonsocial behaviors (e.g., passive, self-manipulative). This will not only facilitate a comparison which shows the adult behavior of early social isolates when compared to normally reared controls but also will allow an assessment of gains made by isolates as a function of prolonged social experience.

Method

Subjects

Two groups of rhesus monkeys (*Macaca mulatta*) served as subjects. One group of seven monkeys, three males and four females, was reared for the first nine months of life in total social isolation. Shortly after birth the infants were removed from their mothers and placed into individual isolation chambers. The stainless steel chambers, which measured .6 x .6 x .6 meters, housed the infants without any social contact for the next nine months. The infants received limited handling for feeding during their first 20 days in the chambers. Light was provided on a typical 12 hour cycle. No attempt was made to deprive the monkeys sensorily during the isolation period. At nine months of age, the monkeys were removed from the isolation chambers and placed in standard lab housing where they remained until the time of this test. The monkeys were involved in sporadic learning and social testing during the post-isolation period. At the beginning of the present experiment, the subjects ranged in age from 8 to 12 years (mean age = 10 years).

The second group of eight rhesus monkeys, three males and five females, was reared with peer and maternal contact. Three of the females were born and reared in the feral environment. They were captured as adults and brought to the lab. The remaining five monkeys were reared in the lab with peer and maternal contact during the first nine months of life. At nine months of age the infants were placed in standard lab housing. From that time, until the present testing the subjects experienced periodic learning and social testing. The subjects ranged in age from 8 to 12 years with a mean age of 10 years. The age of the feral subjects was estimated by weight and canine eruptions.

Apparatus

Subjects were housed in an indoor-outdoor facility. The indoor portion, constructed of cinderblock, measured 4.6 x 4 x 2.4 meters (Figure 1). It connected to the outside run by a swinging door which could be locked from outside the facility. The blockhouse was temperature, but not humidity, controlled. On the north, east, and west walls of the blockhouse were perches which measured 1 x .5 m and were 1.5 m from the floor. In the center of the room a climbing pole stood from floor to ceiling; a perch, which measured 1 x .5 m, stood tangentially to the pole 180 degrees from the perch, on the pole, was a pressure valve which, when depressed, allowed the monkey to drink water. The outdoor run was constructed from .3 m chain link fence and was slightly larger than the blockhouse, measuring 4.6 x 5.7 x 2.4 m. Perches were located on the north, south, and west walls. On the north wall there were two perches 1 x .5 m and 1.2 m above the ground. The west wall was similar in that

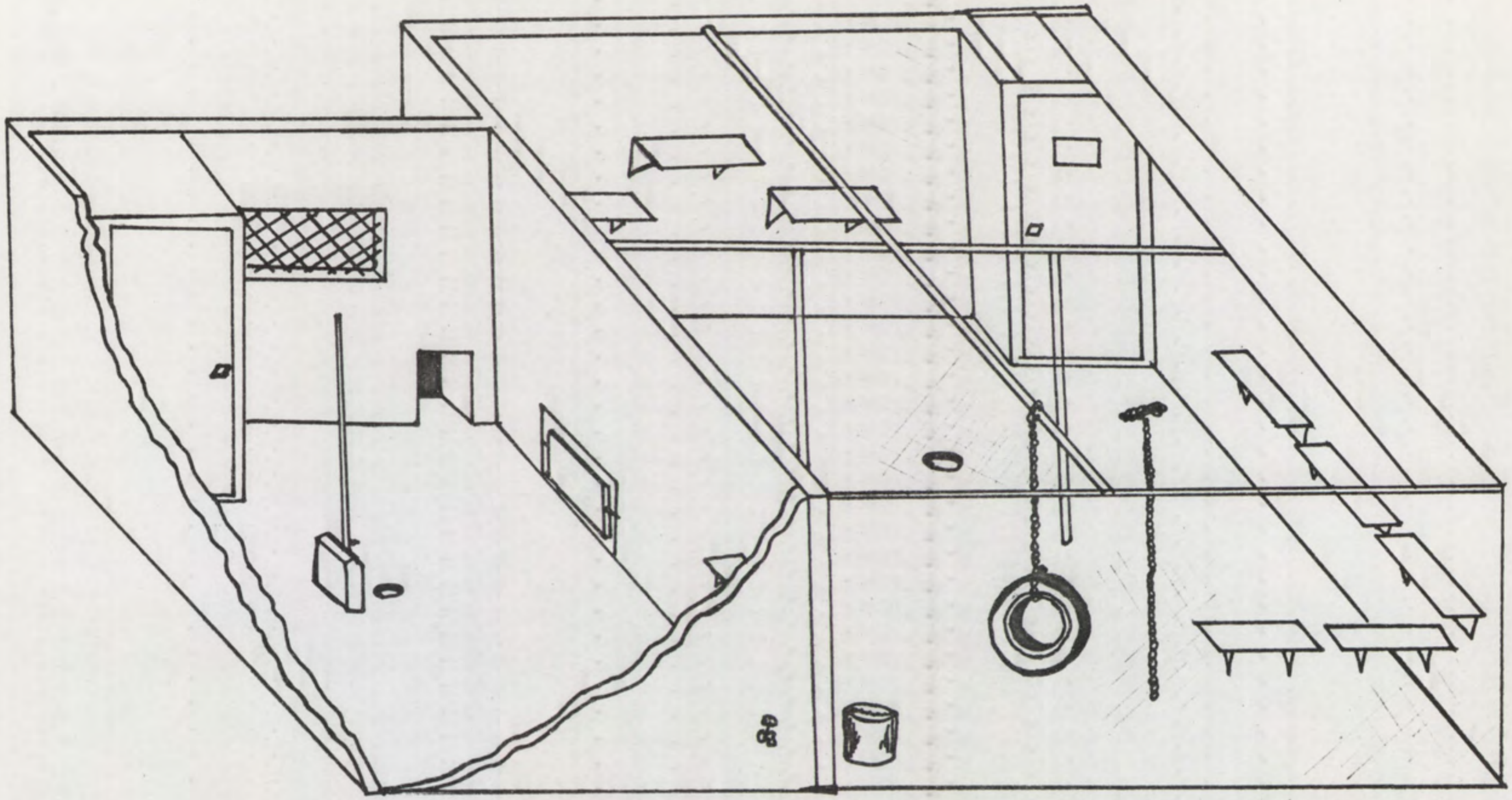

Figure 1. Schematic representation of the living facility for both groups.

the perches were the same size and the same height, but there were three perches instead of two. On the south wall there were three perches, all 1 x .5 m. The center perch was 1.5 m from the ground, the two perches flanking it were 1 m from the ground and .5 m from the center perch. In the center of the outdoor run an old tire was suspended from the ceiling 1 m from the ground. A link chain hung from the ceiling to the floor adjacent to the tire 1 m from the north wall. Additionally, a cylinder which held a large dish was in the compound; the dish was frequently filled with water.

Procedure

The normally reared group was formed first. The subjects were introduced to the inside enclosure in order of size, smallest monkeys being introduced first. The monkeys lived together continuously for the next 14 weeks except when removed for medical treatment. Food was broadcast about the inside enclosure twice daily at 0900 and 1600. Water was available ad lib except during water dominance tests. Each evening all the monkeys were locked inside the blockhouse until 0800 the next morning.

During weeks 5, 7, 9, and 14, water dominance tests were conducted. Access to water was denied 24 hours before the test. The subjects were then locked inside the blockhouse and the water was turned on. The order of access to the water spout and the duration of the drink were recorded.

Additionally, the amount of time the animal spent within a .6 x .6 m perimeter enclosing the water spout and the number of times the animal was displaced from the box were tabulated. These measures were collected immediately following water access and continued for 30 minutes. After the first water dominance test water access was restricted for 48 hours before the test instead of the initial 24 hours. This was done by turning off the water 48 hours before the test; 26 hours before the test the water was turned back on for 2 hours, then turned off until the test. Animals would then be more likely to drink in the last free 2 hour drinking session due to the earlier deprivation. This technique was thought to achieve more universal deprivation in all animals.

A second type of dominance test using apples as the incentive was conducted in weeks 6, 10, and 14. In this test, apples were sliced into eighths and placed in the food bin. The same measures were used as were used in the water dominance test; duration in the .6 x .6 m perimeter in front of the food bin, number of apples eaten, and number of displacements from the area were recorded.

During weeks 11 and 12, the group was challenged with a series of novel stimuli similar to the tests conducted by Bernstein (1964). Each test followed a procedure very similar to the dominance tests. Each object was introduced to the inside area while the monkeys were locked in the outer area. The monkeys were then chased into the room containing the test object. Again a .6 x .6 m box was designated around the object. The order of entry, duration in the area, and displacements from the area were recorded.

Six novel objects were used, three in week 11 and three in week 12. At least one day was allowed between each test. The first object introduced resembled a cart with wire mesh sides (Figure 2). The cart was on wheels and measured .8 x .5 . 1.3 m. The second object introduced was an empty, standard, lab cage for monkeys measuring .6 x .6 x .8 m. In the third test an adult male rhesus monkey was placed in the cage. In the next test an adolescent female rhesus monkey was placed in the cage. In the fifth test an adult female rhesus monkey was placed in the cage. In the last novelty test an inanimate stimulus was again used. A 50 gallon diesel oil can on rollers was introduced. In all of the six tests data were collected for the first 30 minutes after the stimulus was introduced. All of the monkeys were strangers to the monkeys in the group.

In addition to the dominance and novelty tests the behavior of each monkey was recorded. Scoring occurred between 0800 and 1700 hours six days per week. Each monkey was observed for 3 minutes during each scoring session. Scoring was done with a modified frequency scoring system (Sackett, 1976). Briefly, this system allows the recording of ongoing behavior by weighing the frequency of behavior by its duration. The 3 minute scoring session is broken down into smaller segments, in this study, 10

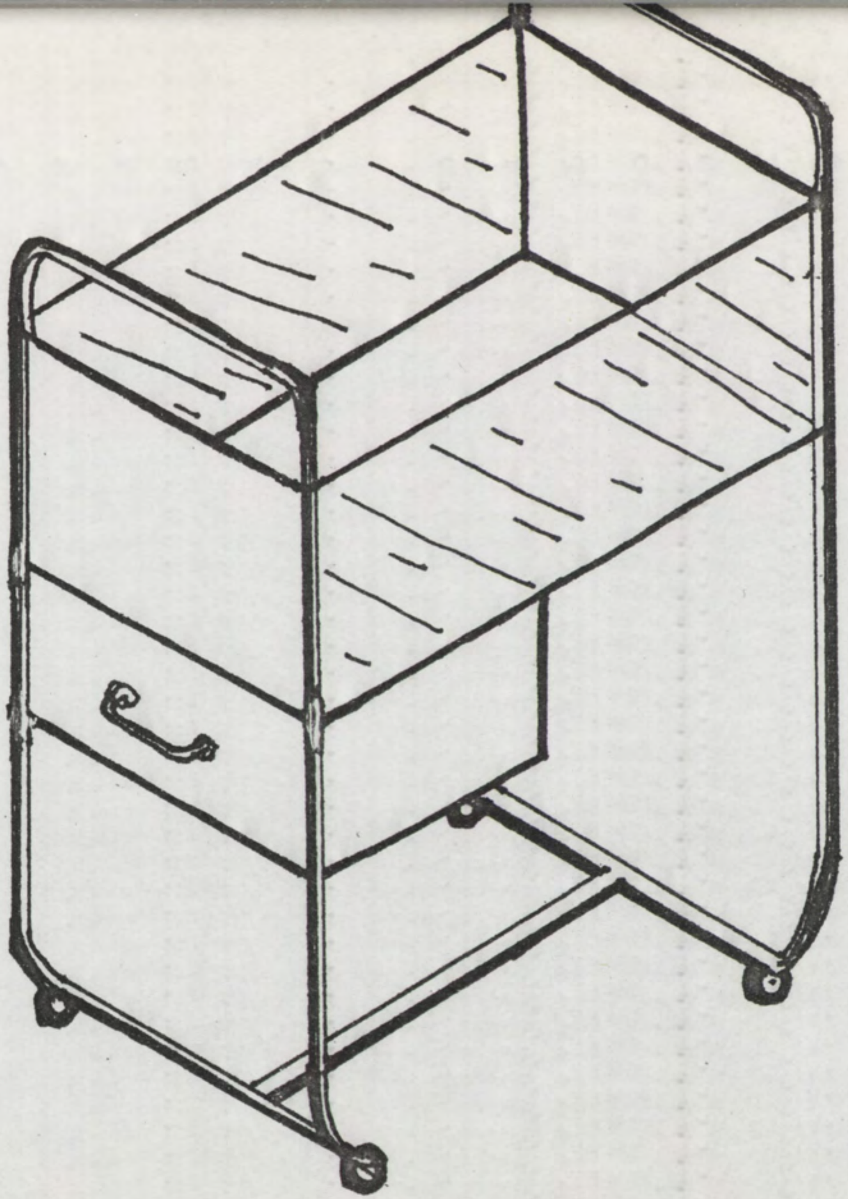

Figure 2. First object introduced during novel object test.

second blocks. Each category of behavior that occurs during the 10 second block is recorded only once. In this manner, frequent, short duration behaviors do not outweigh less frequent, long duration behaviors. The order in which the monkeys were observed was determined by assigning each monkey a number ranging from 1 to 7 from a random number table. From another random number table, 8 possible sequences of the numbers 1 to 7 were were compiled. During each scoring session one of these 8 possible orders was used with the only restriction being that the same sequence was not used two scoring sessions in a row. The categories of behavior used and their reliability coefficients are given in Table 1. Locomotion was scored in the modified frequency system and was also scored using an electronic clock and counter.

After the normally reared group had lived together for 14 weeks, the group was broken up and the animals were returned to standard lab housing. The isolation reared group was then formed using the same procedure as was used with the normally reared group. The same series of dominance and novelty tests was given to the isolates. As in the first group, the group was deprived of water for 24 hours before the first water deprivation test and then the deprivation was increased to 48 hours before the second test as described above. The same behavioral sampling techniques were used with the isolates.

Table 1

A Description of the Eleven Behavioral Categories and Their Subcategories

1. Social contact. (.99[a]) Positive social contact involving two or more subjects. Three types of social contact will be delineated: (a) Initiator, the subject being scored initiates social contact with another subject. (b) Recipient, the subject being scored is the recipient of the social contact. (.99) (c) Passive, the subject being scored comes within 33cm of another subject for more than 2 seconds. (.99)

2. Play. Restrained biting, wrestling, and chase-be-chased behavior. Nonsocial play will be scored if an animal assumes a number of possible body positions in sequence for more than 2 seconds.[b]

3. Sexual. Stiff-legged presentation of the genital area, oriented toward another animal. Mount is defined as a double foot clasp hold on the legs of the female, followed by pelvic thrusting.[b]

4. Inappropriate sexual. Sexual behavior that is either misoriented or incompletely executed. Like-sex mounts accompanied by pelvic thrusting, female collapsing under the weight of a male, and the male attempting to mount an inappropriate part of the female are three common examples of this category.[b]

5. Passive. A lack of any other behavior for more than 2 seconds. (.95)

6. Bizarre. Stereotypic behavior repeated three or more times as well as species atypical behavior repeated three or more times. (.93)

7. Eat-Drink. Overtly eating or drinking any nutritive substance or eating food stored in cheek pouches. (.99)

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[a]Pearson product moment correlations were computed to determine interobserver realiabilities. Correlations were determined for both the major category and for subcategories.

[b]Behavior was observed too infrequently to determine a correlation coefficient.

Table 1 (continued)

8. Dominance-Submission. (.87) Dominance is scored when a subject displaces another subject by either walking toward the subject or visually threatening another subject. Visual dominance is accompanied by an ear flick and a stare directed at the subject to be displaced. (.87) Submission is scored when the subject is displaced by another animal as described above. It is also scored when fear grimacing in response to another animal. (.83)

9. Aggression. (.97) Frenzied chasing, biting, slapping, wrestling accompanied by piloerection and vocalization.

10. Explore-self-manipulation. (.95) Exploration consists of direct visual or tactile investigation of the environment. (.96) Self-manipulation consists of self-groom or any other self-manipulation of the skin or fur. (.98)

11. Locomotion. (.97) Movement more than .5m in any direction.

During the course of the experiment several monkeys were either temporarily or permanently removed from the group. At the end of week 1, in the normally reared group, G-44, a lab reared female, died. She was replaced two days later by a feral reared female. During week 4 of the same group, G-49, a female, was removed for three days for treatment of an eye injury. A male, J-90, was removed from the same group during weeks 13 and 14.

In the isolation reared group a slightly higher injury rate prevailed. The day after the group formed, a male E-12 was removed. He proved to be suffering from chronic kidney failure; as no other monkey with his rearing history was available he was not replaced. This left a total of six monkeys, two males and four females in the isolation reared group. E-15, a female, was removed during week 3 for treatment of a tail bite. K-9, also a female, was removed during week 2 for treatment of an eye injury. During week 4, E-8, a female, was removed from the group for treatment of a bite wound on her flank.

Data Analysis

The results were analyzed using the Manova Computer program to perform a series of repeated measures based on two week blocks. The data were compiled for analysis by determining the probability of each behavioral category being observed during one session for each two week block. Each category was then analyzed separately. Those categories which were scored with subcategories as well as major categories were analyzed both as a composite and as subcategories. Those categories in which the behavior was observed less than five times were not analyzed. In those categories where the behavior was seen more than five times but only in one group, a Mann Whitney U test was used to analyze the data.

Results

The results can be viewed as 3 sets of comparisons: analysis of between group differences for the first 12 weeks of group living, between group differences for the blocks of weeks 11-12 vs. weeks 13-14 when the dominant male was removed from the control group, and between group differences during the challenge tests. Additionally, the 11 major behavioral categories were subdivided into 3 groups: positive social behaviors, negative social behaviors, and nonsocial behaviors.

Weeks 1-12

Positive social behaviors. As can be seen by examining Figure 3, large differences were apparent in the level of social behaviors observed. Examination of Figure 3 reveals that control animals exhibited significantly higher levels of social behavior than isolation reared animals F (1, 11) = 19.698, $p < .001$. Figure 3 reveals that controls were consistently higher than isolates across the 12 week period. Isolates demonstrated a slight rise during the fourth two week block which gradually dropped to the earlier level by the last two week block. Controls peaked during the second two week block and gradually dropped until the last two weeks when they showed a large increase in social contact. This trend was

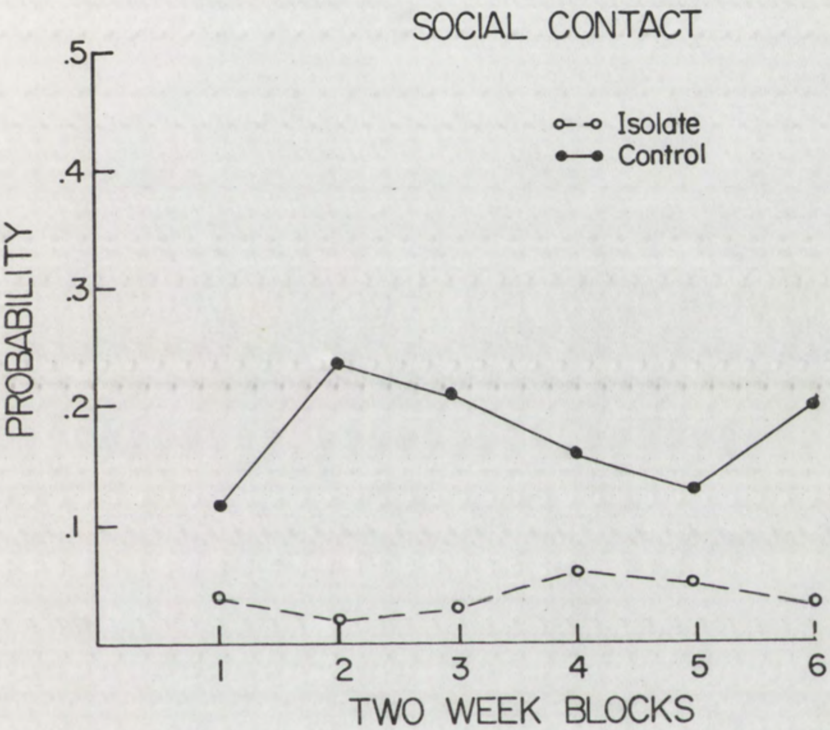

Figure 3. Changes in social contact during the first 12 weeks of observation.

apparent in the subcategories of social behavior as well. Figure 4 displays the data from the subcategory social passive. Here again controls were significantly higher than isolation reared animals $\underline{F}$ (1, 11) = 9.245, $\underline{p} < .011$. A significant rearing by time interaction, $\underline{F}$ (5, 11) = 25.1, $\underline{p} < .001$, is evidenced in Figure 4. Examination of that figure shows that as time progressed, normally reared animals showed decreasing levels of social passive behavior while isolation reared animals demonstrated an increase in social passive behavior up to weeks 7 and 8 which was apparent for the duration of the study.

In the other two subcategories of social behaviors, controls were again higher than isolation reared monkeys in the levels of the behavior observed. Figure 5 reveals that when analyzed by a Mann Whitney U test, significant group differences were apparent in the frequency of initiation of social responses, U = 0, $\underline{p} < .002$. Examination of Figure 5 shows that isolates remained at or close to zero throughout the 12 week period. Controls showed an increasing function until the end of the fourth week. Thereafter, controls dropped until the end of the 10th week where they increased considerably. Social recipient behaviors are exhibited in Figure 6. Figure 6 displays a significant interaction $\underline{F}$ (1, 11) = 3.97, $\underline{p} < .025$. Figure 6 reveals that controls exhibited a positively increasing step-like function. In contrast, isolates displayed much lower

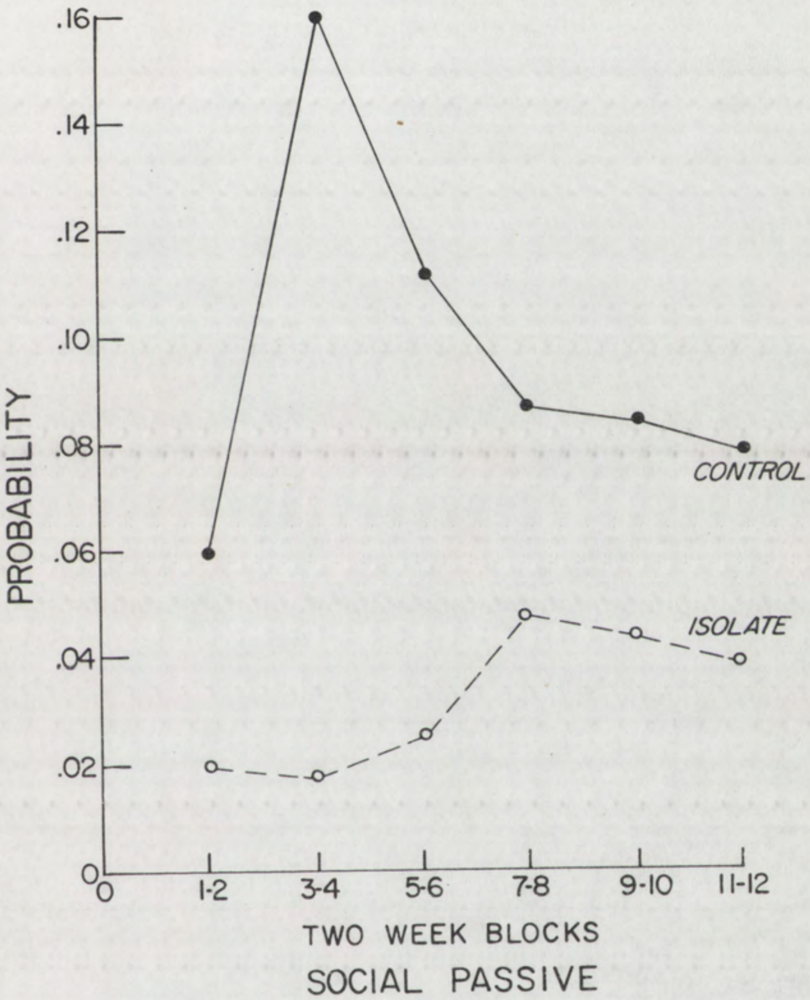

Figure 4. Changes in social passive during the first 12 weeks of observation.

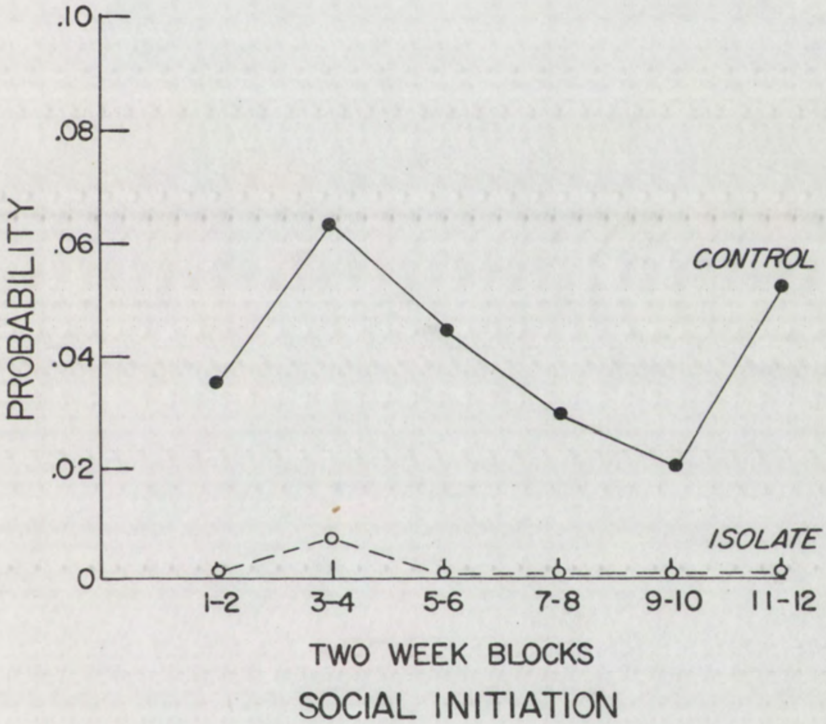

Figure 5. Changes in social initiation during the first 12 weeks of observation.

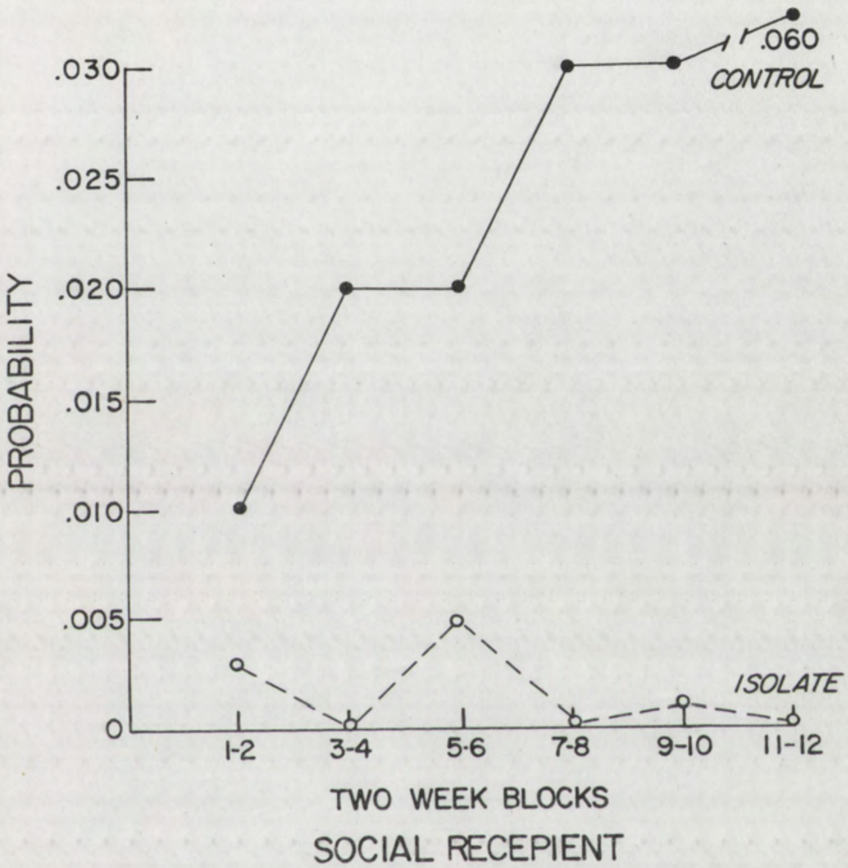

Figure 6. Changes in social recipient during the first 12 weeks of observation.

levels that hovered near zero except during the third two week block when a precipitous increase and decrease occurred.

Sexual behavior differed markedly between the two groups. Controls produced two live births as a function of their housing. Isolates, in contrast, never exhibited a single mount, no less, an intromission. Generally, isolate males exhibited little interest in female solicitations. Female isolates did present appropriately to the males but no mounts were ever attempted by the males. On several occasions isolate males were noted masturbating while sitting near a female. This behavior occurred so rarely that it was impossible to test statistically.

Figure 7 displays the level of sexual behavior observed. Examination of the figure shows that controls showed little sexual behavior until weeks 5 and 6 when they showed a sharp increase that was followed by a gradual decrease until no sexual behavior was again observed during the 5th two week block. During the last 2 weeks a sharp increase in sexual behavior was observed. Isolates consistently failed to show any sexual behavior. A Mann-Whitney U test indicated significant group differences $U = 0$, $\underline{p} < .01$.

In the last positive social behavior category, play, no significant differences were found, $\underline{F}\ (1, 11) = .17$.

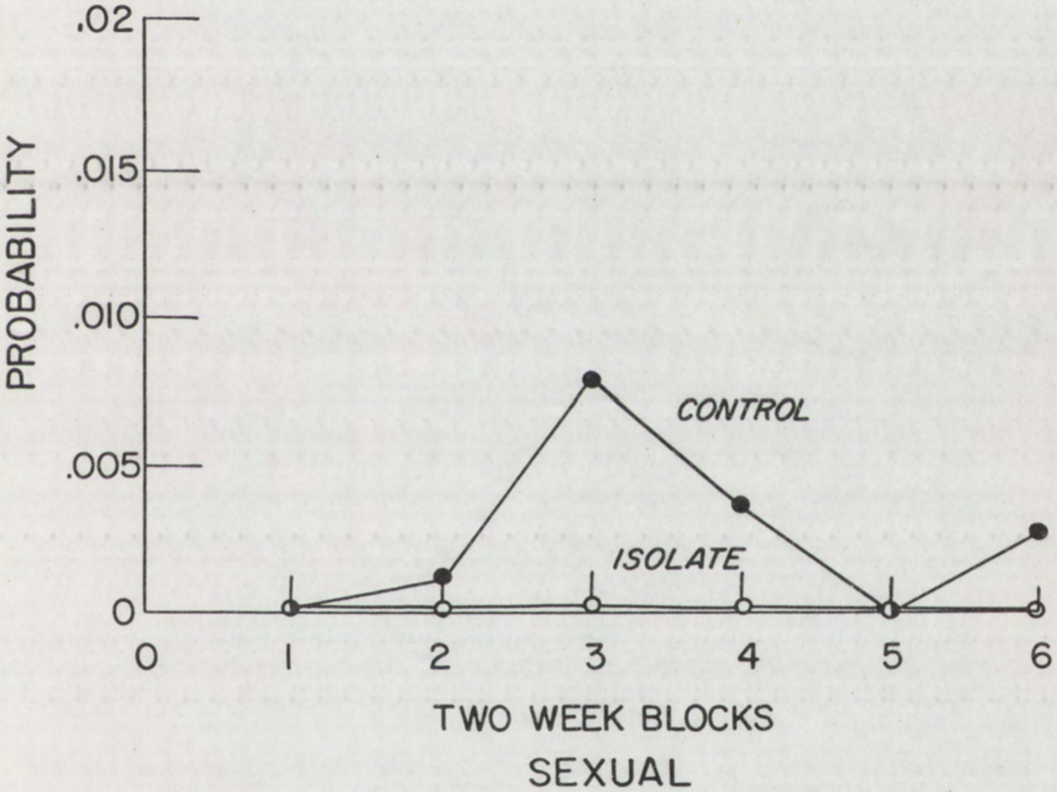

Figure 7. Changes in sexual behavior during the first 12 weeks of observation.

Negative social behaviors. Surprisingly, aggressive behavior did not differ between isolation reared monkeys and controls F (1, 11) = .79. Figure 8 portrays the data from the category of aggression. Controls showed a decreasing function initially displaying high levels which decreased as time progressed. Isolates showed high levels initially which dropped during weeks 3 through 4, and shot back up during weeks 5-6. During weeks 7-8 and 9-10, aggression dropped in the isolates and then increased during the last two week block. In the major combination category of dominance submission behavior, Figure 9 reveals no significant group differences, F (1, 11) = 3.36, $p < .08$. Figure 9 displays a positively increasing function for controls that drops during weeks 3 and 4 and weeks 11 and 12. Isolates exhibited lower levels than controls and showed peaks during weeks 5-6 and 11-12 and lower levels between those weeks. In the subcategories of dominance and submission, Figures 10 and 11 respectively, no significant differences were noted, F (1, 11) = .43 and F (1, 11) = 1.15. Figure 10 reveals that in the category of dominance, the control monkeys exhibited a slightly increasing function. Isolates were lower than controls except during the fourth two week block when they exceeded the controls. Figure 11 shows that in the category of submission, controls increased up to the fifth two week block when their level dropped substantially. Isolates were initially higher than controls but did not increase

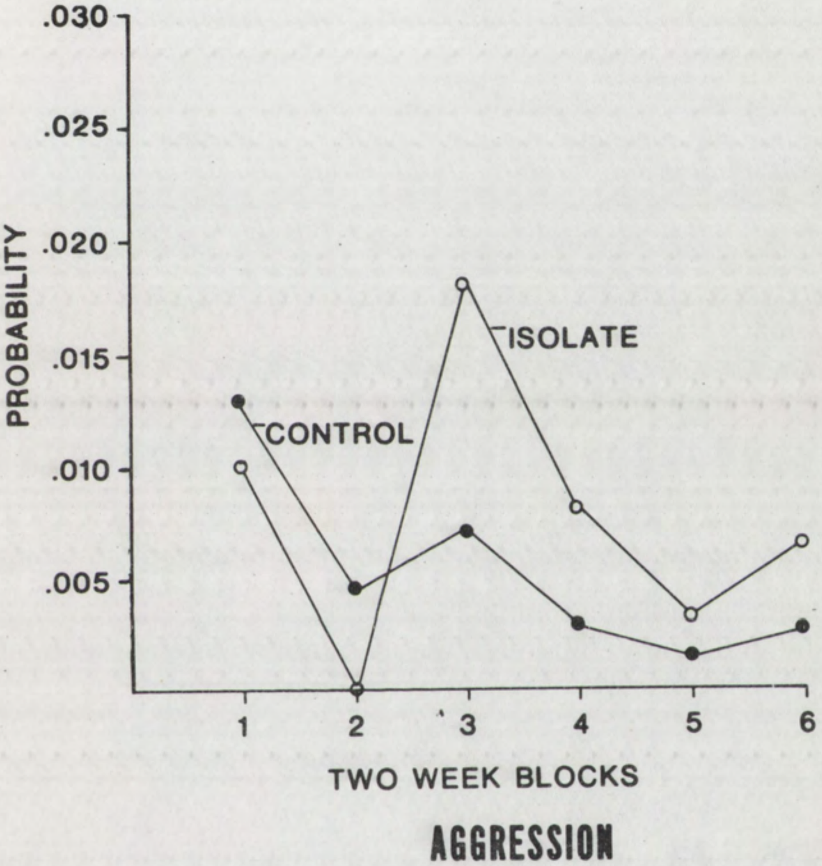

Figure 8. Changes in aggression during the first 12 weeks of observation.

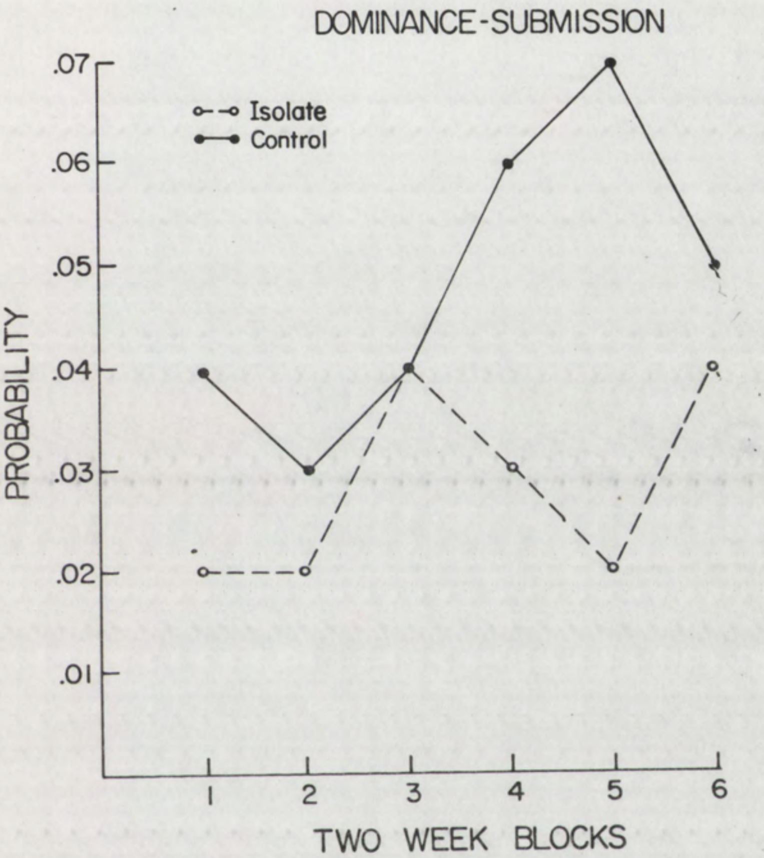

Figure 9. Changes in dominance-submission during the first 12 weeks of observation.

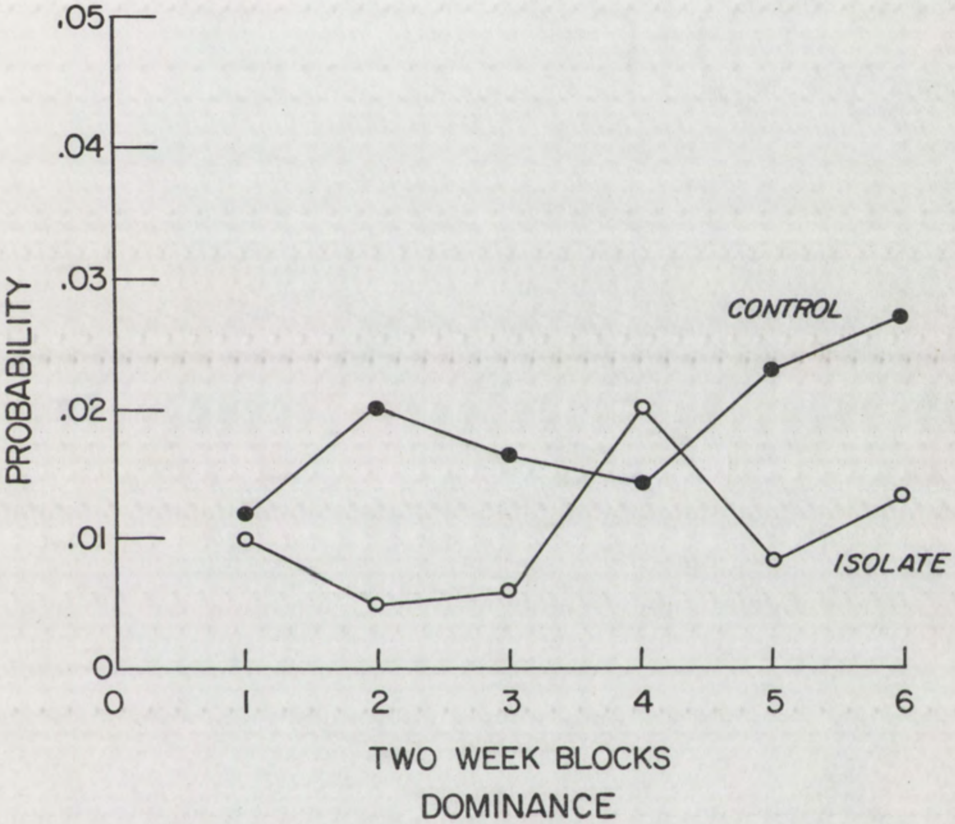

Figure 10. Changes in dominance during the first 12 weeks of observation.

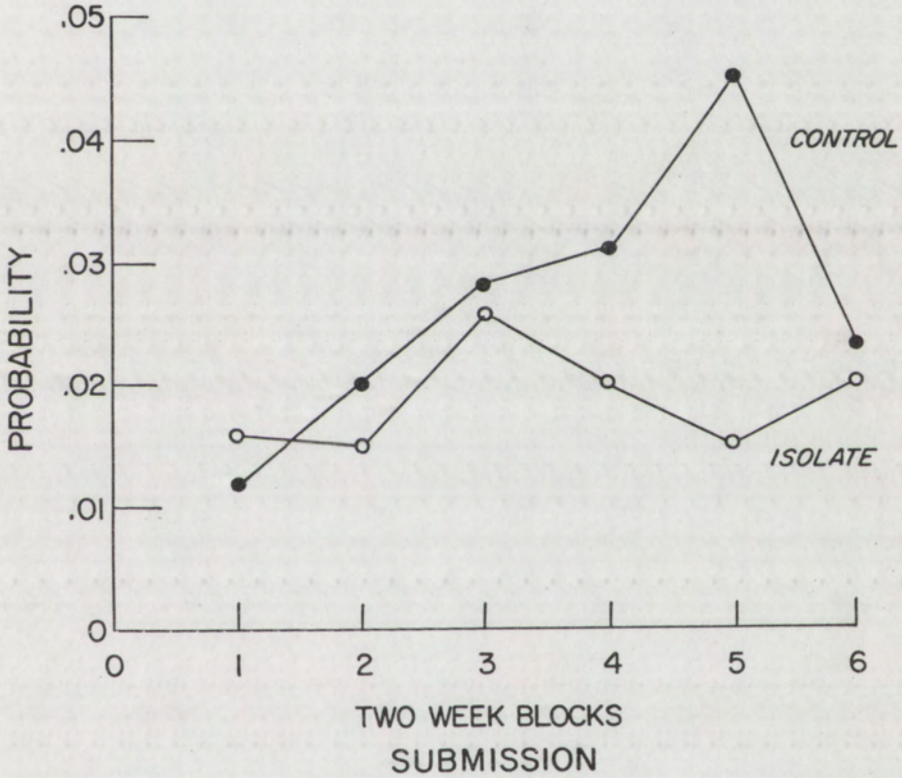

Figure 11. Changes in submission during the first 12 weeks of observation.

their level of submission until weeks 5-6 while controls increased consistently. Isolates dropped from weeks 5-6 until weeks 9-10 during the last two week block.

Nonsocial behaviors. Examination of Figure 12 reveals a significant main effect of rearing in the category of bizarre behaviors, F (1, 11) = 12.58, $p < .005$. Isolates were consistently higher than controls across the entire observation period. While controls rarely exhibited bizarre behaviors, isolates generally increased in the level of bizarre behavior observed until the last two week block. The major category of self-manipulation-exploration is shown in Figure 13. A significant group difference was found in this category, F (1, 11) = 4.87, $p < .05$. Figure 13 displays roughly parallel functions for both groups with isolates initially starting lower than controls but rapidly climbed to a higher level which they maintained for the rest of the period. Controls remained consistent except for a slight drop during weeks 5-6. In the subcategories of explore and self-manipulate no significant differences were found. Figure 14 displays the data from the category explore. Examination of Figure 14 reveals that although controls were initially higher, isolates soon surpassed them and remained above the controls for the duration, F (1, 11) = 1.16. Figure 15 displays the results of the subcategory self-manipulate. No significant differences were found in this subcategory

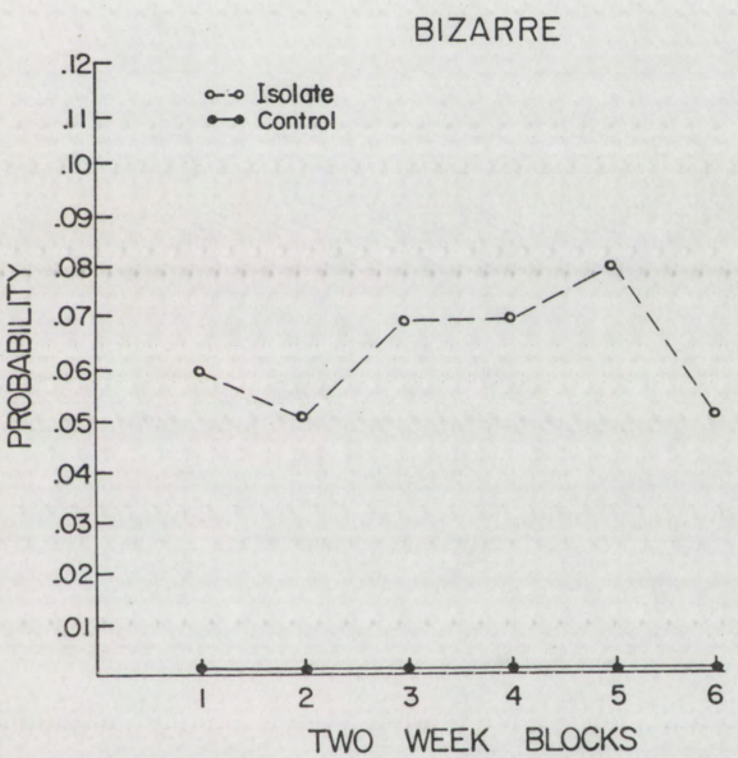

Figure 12. Changes in bizarre behavior during the first 12 weeks of observation.

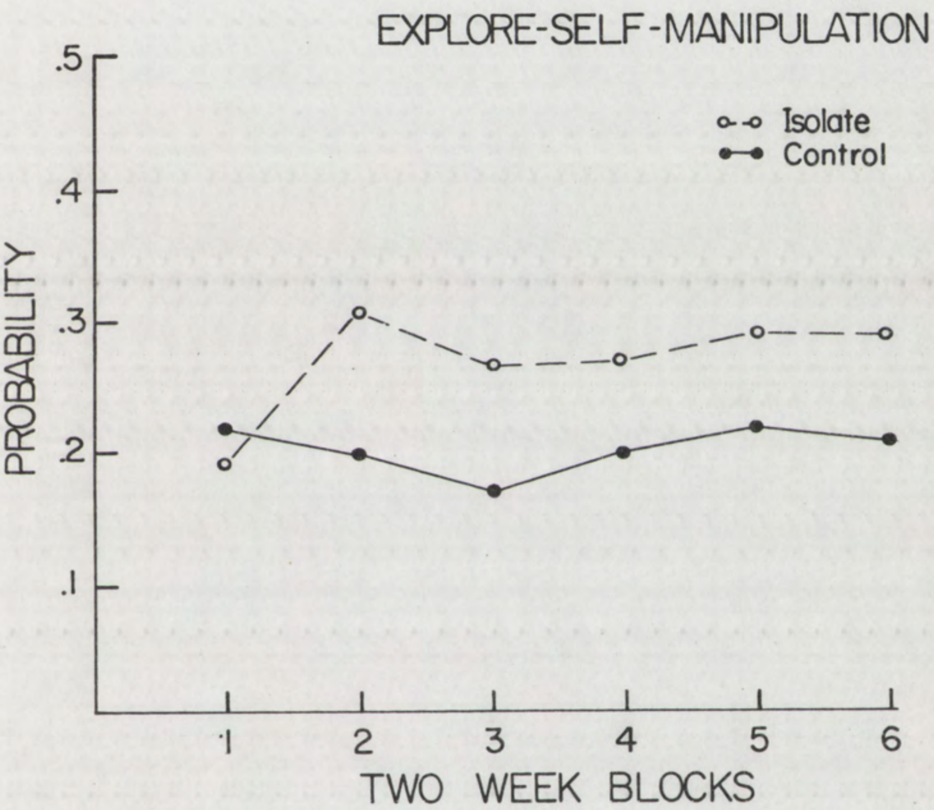

Figure 13. Changes in exploration and self-manipulation during the first 12 weeks of observation.

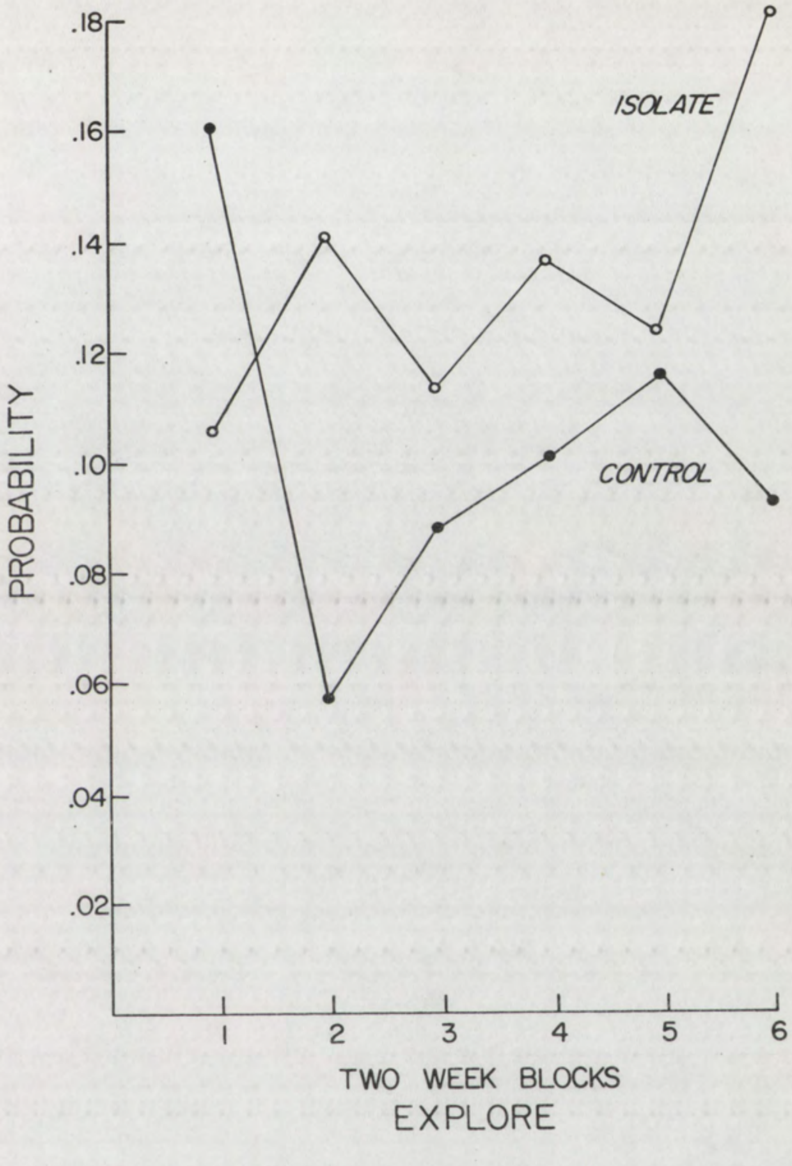

Figure 14. Changes in exploration during the first 12 weeks of observation.

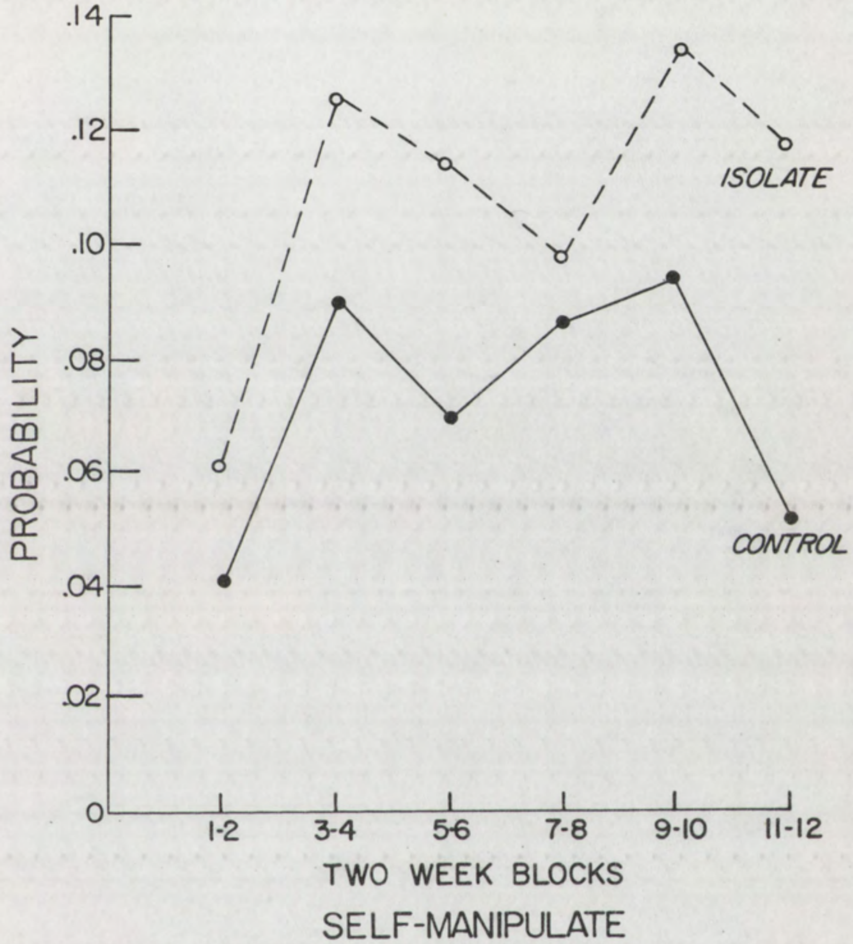

Figure 15. Changes in self-manipulation during the first 12 weeks of observation.

self-manipulate. No significant differences were found in this subcategory F (1, 11) = 1.33. Examination of Figure 15 reveals that both groups exhibited initial increases followed by a slight decrease and a repeat of that trend over the next 6 weeks. Isolates were consistently higher than controls across the 12 weeks.

Figure 16 exhibits the behavior levels of the category of eat-drink. A significant rearing by time interaction was found with isolates displaying a slightly higher level than controls, that dropped during weeks 7-8, F (5, 11) = 3.95, $p < .025$. Additionally, a significant main effect of rearing, F (1, 11) = 4.95, $p < .05$, was also evidenced.

In the category of locomotion, another significant rearing by time interaction was found, F (5, 11) = 17.43, $p < .001$. Isolates were higher than controls at all points except weeks 7-8 when isolates were lower than controls (Figure 17). In the last category of nonsocial behaviors, passive, a significant rearing by time interaction was evident F (5, 11) = 7.1, $p < .01$. Examination of Figure 18 reveals that both groups exhibited parallel functions except during weeks 7 and 8 when isolates showed a large increase.

One category, inappropriate sexual behavior, was not analyzed because it occurred less than five times.

Weeks 11-12 vs. 13-14

During weeks 13-14, the dominant male was removed from the controls groups to determine the effects of his

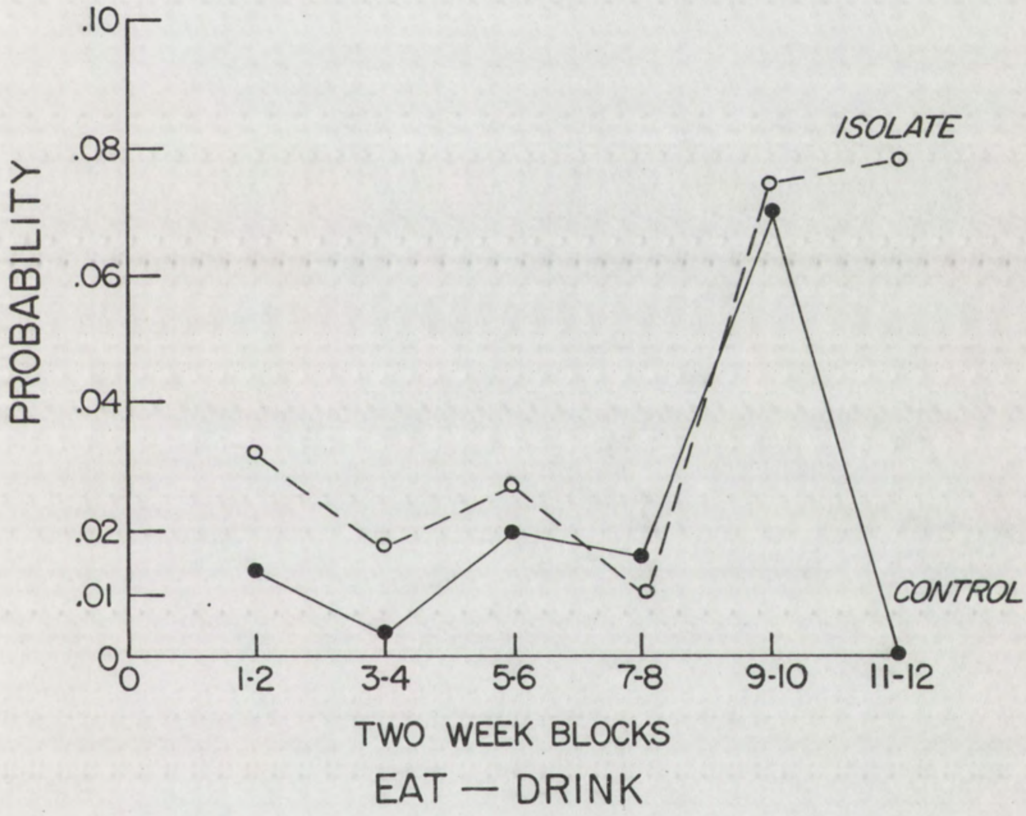

Figure 16. Changes in the category eat-drink during the first 12 weeks of observation.

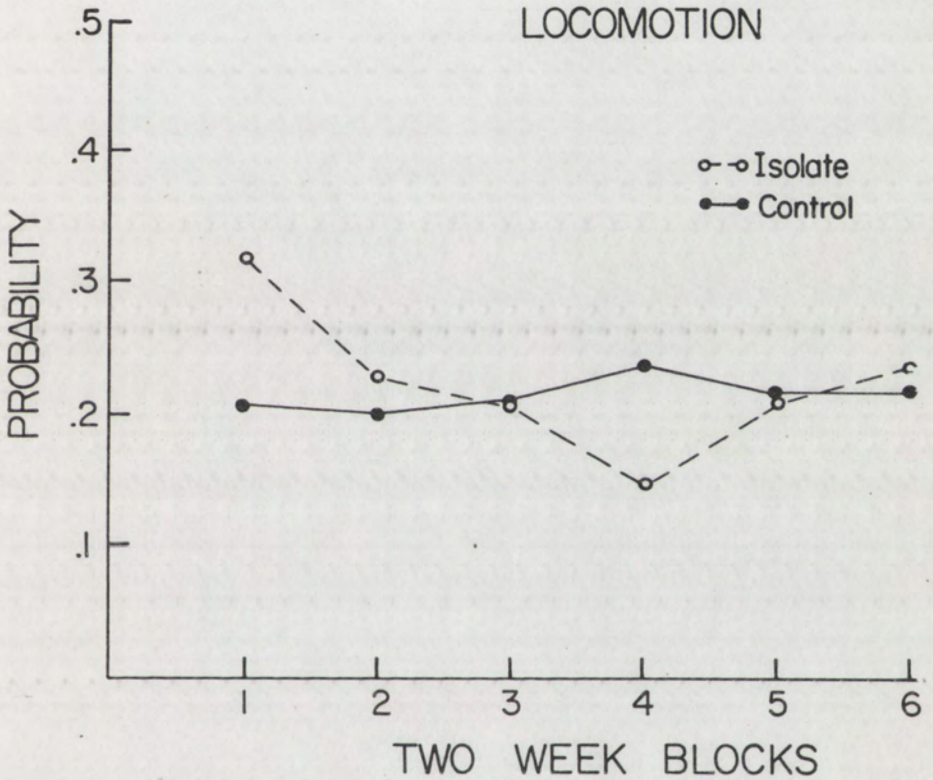

Figure 17. Changes in locomotion during the first 12 weeks of observation.

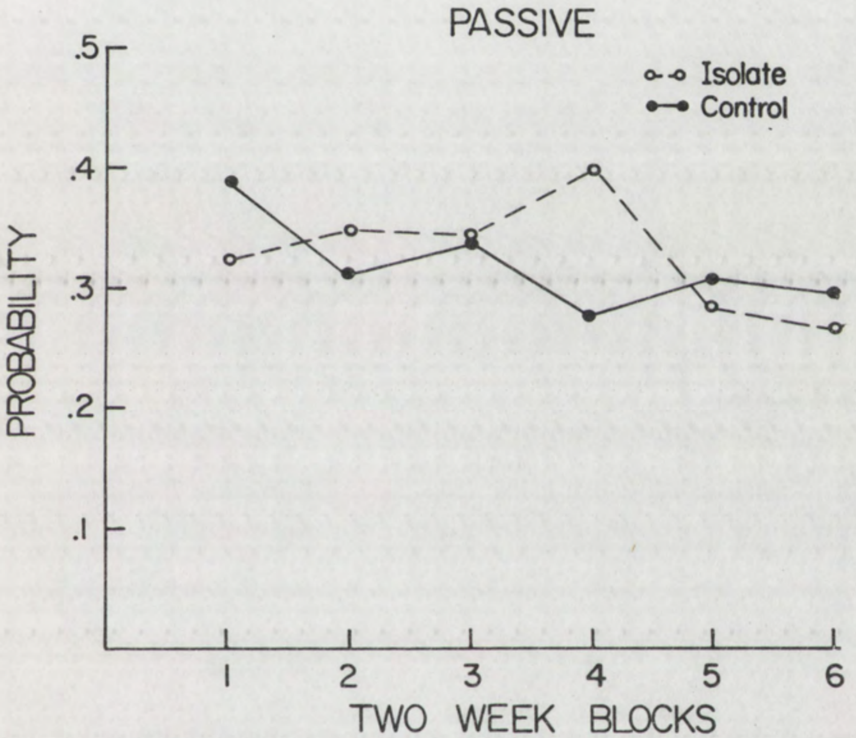

Figure 18. Changes in passive during the first 12 weeks of observation.

presence. This male was relatively asocial and frequently engaged in dominance behaviors. By removing him it was hoped to determine if his presence had reduced the level of positive social behaviors within the group. A limited analysis of between group differences over the block of weeks 11-12 vs. weeks 13-14 was performed. Examination of Figure 19 reveals a significant rearing by time interaction F (1, 10) = 10.9, $p < .01$ in social behavior. Isolates exhibited a positive trend although controls exhibited a much greater increase in social behaviors from week 11-12 to 13-14.

In the category of dominance-submission, Figure 20 displays a significant effect of time F (1, 10) = 4.8, $p < .05$. Both groups showed a parallel downward trend from weeks 11-12 to weeks 13-14 with controls exceeding the isolates. Figures 21 and 22 display the breakdown of the major category dominance submission into the two subcategories dominance and submission. Neither category, dominance F (1, 10) = .08 or submission F (1, 10) = 0 proved significant. Examination of the dominance data in Figure 21 reveals that isolates showed very low levels while controls were higher and exhibited a sharp drop between weeks 11-12 to weeks 13-14. Figure 22 displays the data from submission. Controls were higher than isolates and evidenced a sharp drop across the four week block. Isolates exhibited lower levels and a very slight drop across the four weeks.

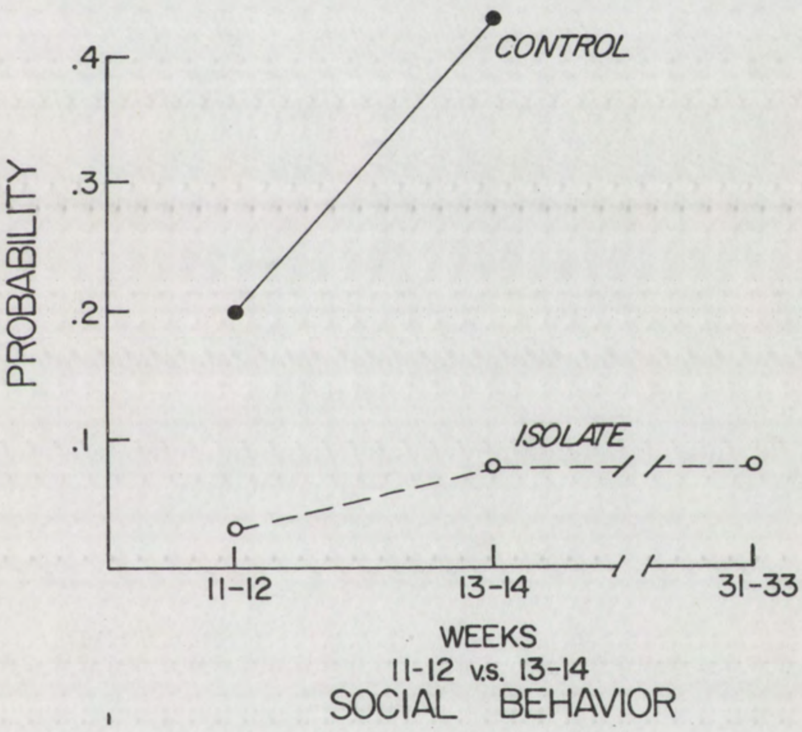

Figure 19. Comparison of social behavior during weeks 11-12 to weeks 13-14 and weeks 31-33.

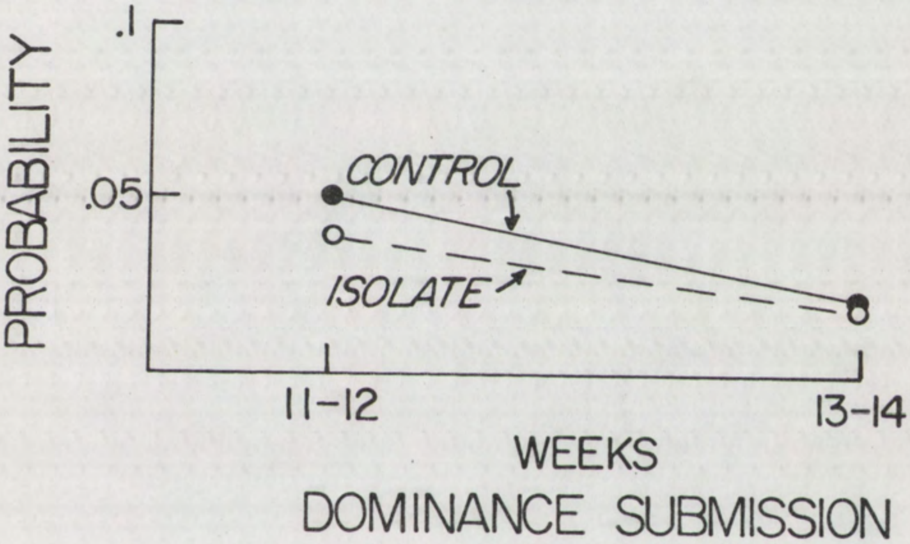

Figure 20. Comparison of dominance-submission behaviors during weeks 11-12 to weeks 13-14.

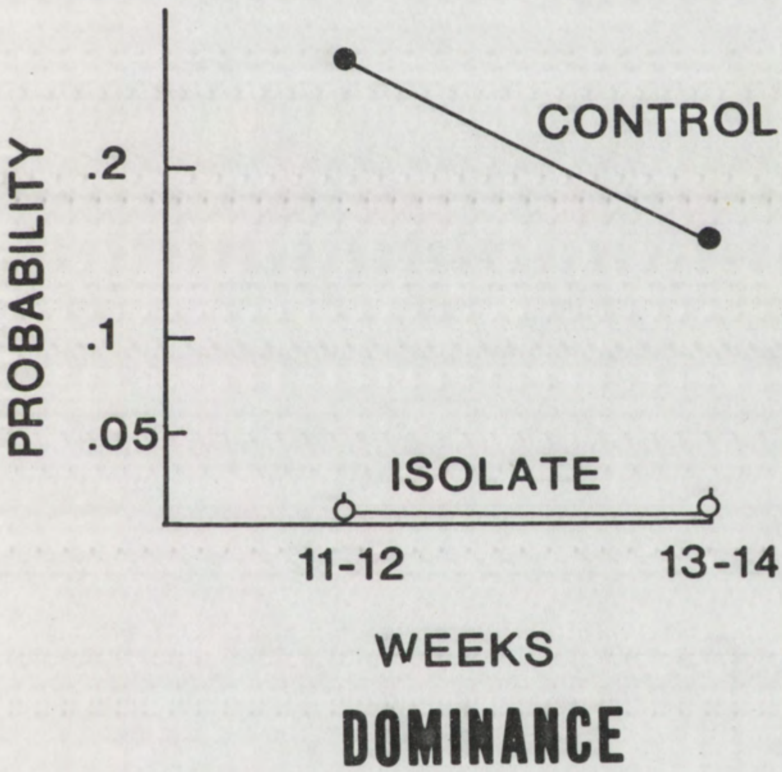

Figure 21. Comparison of dominance behavior during weeks 11-12 to weeks 13-14.

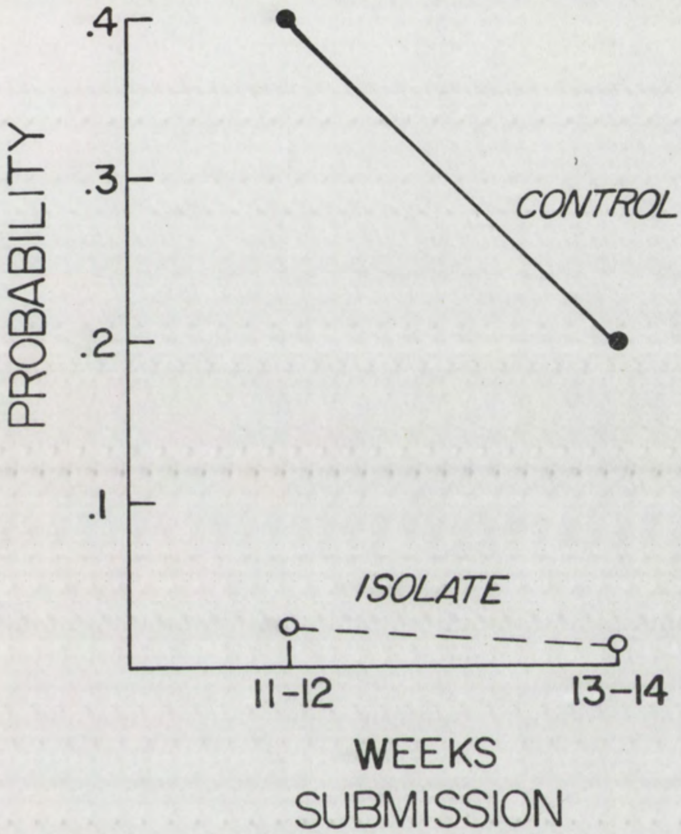

Figure 22. Comparison of submission behavior during weeks 11-12 to weeks 13-14.

In the nonsocial behaviors, several differences were apparent. Figure 23 exhibits the data from the category of passive, a significant interaction was found, $\underline{F}$ (1, 10) = 6.4, $\underline{p} < .05$. Isolates exhibited a slight increase across the 4 weeks. The controls, however, made a large drop from weeks 11-12 to weeks 13-14.

The category of explore-self-manipulate revealed no significant differences $\underline{F}$ (1, 10) = 3.2 ($\bar{X}$ for controls weeks 11-12 = 22.17, weeks 13-14 = 19.5; $\bar{X}$ for isolates weeks 11-12 = 29.12, weeks 13-14 = 29.5). Separate analysis of the subcategories, explore and self-manipulate, showed no significant differences $\underline{F}$ (1, 10) = .095 ($\bar{X}$ for controls weeks 11-12 = .095, weeks 13-14 = .075; $\bar{X}$ for isolates weeks 11-12 = .151, weeks 13-14 = .118), and $\underline{F}$ (1, 10) = 1.6 ($\bar{X}$ for controls weeks 11-12 = .065, weeks 13-14 = .076; $\bar{X}$ for isolates weeks 11-12 = .118, weeks 13-14 = .125) respectively. In the category of eat-drink, Figure 24 portrays a significant rearing by time interaction $\underline{F}$ (1, 10) = 3.6, $\underline{p} < .01$. Figure 24 indicates during weeks 11-12 isolates were frequently observed eating and controls were not. However, by weeks 23-24, a crossover had occurred and both groups were at similar levels. In the last non-social category, locomotion, a significant effect of time was found (Figure 25) $\underline{F}$ (1, 10) = 14.7, $\underline{p} < .01$. Examination of Figure 25 indicates that both groups showed decreasing functions over the four week blocks. Isolates

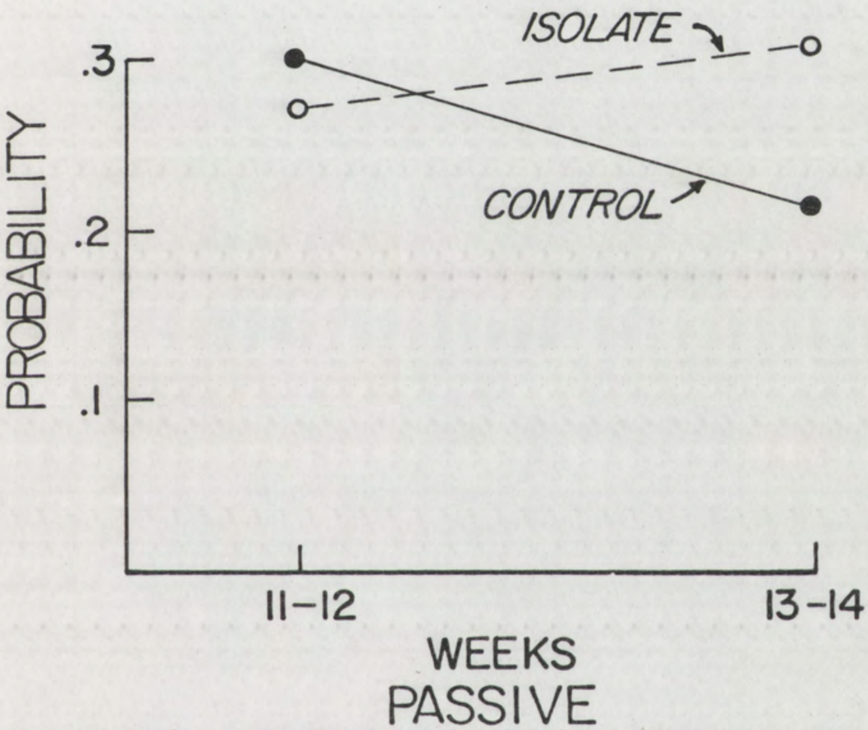

Figure 23. Comparison of passive behavior during weeks 11-12 to weeks 13-14.

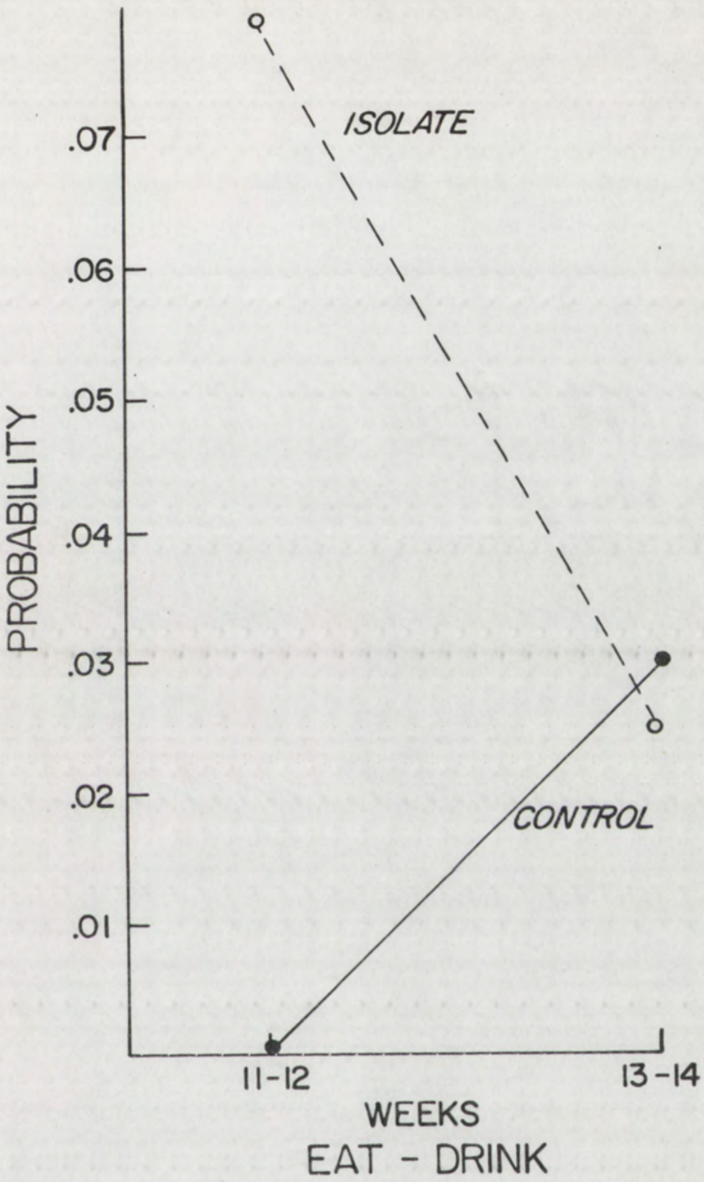

Figure 24. Comparison of eat-drink behavior during weeks 11-12 to weeks 13-14.

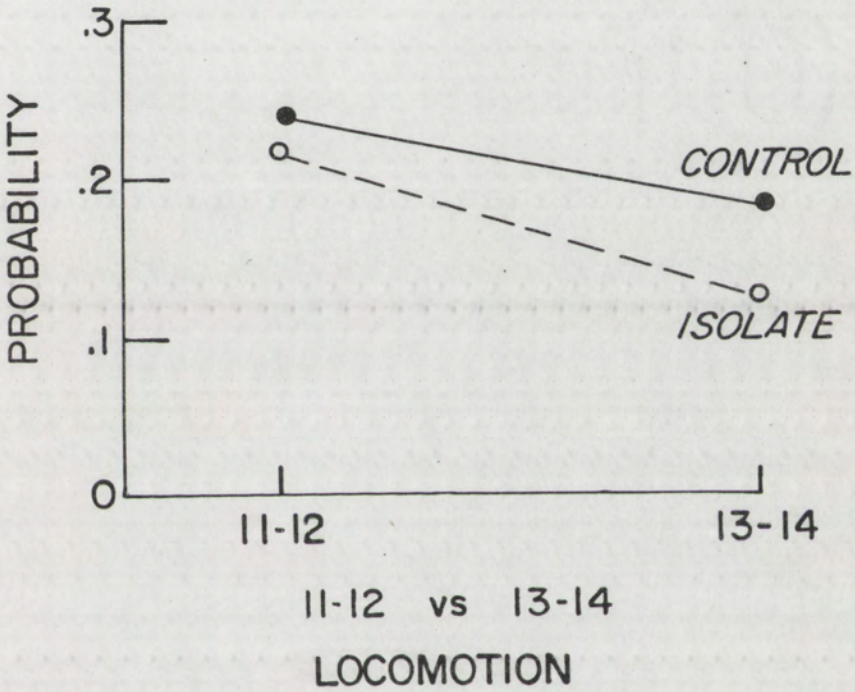

Figure 25. Comparison of locomotion during weeks 11-12 to weeks 13-14.

dropped slightly faster than controls did over that period.

In summary, removal of the male from the control group resulted in an increase in social behaviors and a decrease, although nonsignificant, in dominance and submissive behaviors. In the nonsocial behaviors, eat-drink increased with the removal of the male while passive behaviors decreased slightly. Locomotion also decreased slightly after J-90 was removed from the control group.

<u>Group Challenge Tests</u>

Data were collected on three variables during group challenge tests: order to enter the 2 foot perimeter surrounding the challenge object, duration in the 2 foot perimeter, and duration of time contacting the challenge object (or drinking or eating, whichever was appropriate for that object). Two of these measures were combined to form an overall index of dominance. Time in contact (or eating/drinking) was weighed by the order of entrance to the 2 foot perimeter surrounding the object. By multiplying the total amount of time an animal spent drinking (eating or in contact) by the number of animals in the group that had not drunk a measure of dominance was determined. Each animal was then assigned a value according to the equation and all the animals in each group were then ordinally ranked from 1 to N within their group of each test.

It can be seen that this dominance measure simply weighs the duration of contact, eating or drinking in each test by the order of the animal's first access to the stimuli. In order to allow for habituation to each testing circumstance, the analysis was based on the last challenge test of each type. Spearman Rank Order correlations were run on each group's approach-duration hierarchies across the four tests. Table 2 presents the results of this analysis. Examination of the table reveals that within the control group, knowledge of the hierarchy on one test does not allow accurate prediction of performance on the other tests. One exception to that generalization is apparent. If one is aware of the hierarchy in the water deprivation test, one could accurately predict that the hierarchy would be reversed in the novel object test, ($\rho = .714$, $\underline{N} = 7$, $\underline{p} < .05$). In the control's matrix, moderate but nonsignificant correlations were found between the hierarchy in the apple test and water deprivation test ($\rho = .32$) and in the stranger and water deprivation test ($\rho = .429$). A moderately high correlation was found between the hierarchy as measured in the apple incentive test and the stranger test. Low correlations were found between apple incentive test and the novel object test and between the novel object and the stranger test. Generally, controls seemed to react uniquely to each challenge depending upon the nature of the challenge.

Table 2

Correlation Matrix Based on Spearman Rank Order Coefficients for Controls and Isolates on Each of the Four Group Challenge Tests

Controls

	Object	Animal	Apple	Water
Object	1	-.08	.00	-.72*
Animal		1	.68	.43
Apple			1	.33
Water				1

Isolates

	Object	Animal	Apple	Water
Object	1	.88*	.34	.00
Animal		1	.17	-.26
Apple			1	.72*
Water				1

*$p < .05$.

Isolates exhibited less variability between tests. The ability to predict performance accurately in a test based on performance in a previous test was found in two cases. The novel object test correlated highly with the hierarchy found in the stranger test ($p = .875$, $N = 6$, $p < .05$) and in the water deprivation test and apple incentive test, ($p = .714$, $N = 6$, $p < .07$). Moderate correlations were noted between the hierarchy established in the apple incentive test and the novel object test as well as in the apple incentive test and the stranger test. No correlation was found between performance in the water deprivation test and the novel object test. A moderate negative correlation was found between the water deprivation test and the stranger test. Isolates, in summary, were slightly more consistent in hierarchical formation as measured by these four tests, than controls.

Pair-wise differences were assessed by using an R to Z transformation ($df = 4, 3$). Additionally, the two matrices were compared using Box's (1949) modification of Bartlett's test for homogeneity of covariance (F (10, 538) = .622). No significant difference was found between the two groups.

Table 3 presents the data from the number of displacements noted across all tests in both groups. Examination of the table reveals that isolates exhibited fewer displacements than controls.

Table 3B presents displacement activity during the group challenge tasks. Examination of the table reveals that displacement activity was divided into 3 measures. Measure A constrasts the average number of displacement encounters occurring across all the challenge tests in both groups. A t-test performed on the results demonstrated that controls were significantly higher in the average number of displacements occurring across the challenge test than isolation reared animals ($t = 2.64$, $p < .05$).

Measure B contrasts the average percentage of the total group encountered in displacement bouts during the group challenge tests. Controls encountered 92.7% of the group during the challenge tests. The majority of controls encountered at least 5 out of the 6 possible monkeys in the control group during the challenge tests. Isolates in contrast encountered only 60% of the possible animals during the challenge tests. Thus, isolates had, on the average, displacement bouts with only 3 out of the possible 5 monkeys during the challenge tests.

Measure C reveals that only 15% of the isolates encountered every other isolate during the challenge tests. In contrast, 71% of the controls either displaced were were displaced by every other members of the control group during the challenge tests.

Table 3

Displacements Across All Tests

Isolates	12	22	8	8
Controls	40	26	43	32

Table 3B

Three Measures of Displacement During

Group Challenge Tests

Displacement activity	Isolate	Control
(a) Average number of displacement encounters during tests	16.6*	38.14
(b) Average percentage of the total group encountered by individual members	60.00%	92.71%
(c) Percentage of the group which encountered <u>all other</u> group members during tests	14.00%	71.00%

*$p < .05$.

Discussion

The results clearly indicate that the effects of early social isolation endure. Isolation reared monkeys evidenced very low levels of social behavior. In fact, the only type social behavior observed in isolation reared monkeys was an increasing, but nonsignificant, trend in the category of social passive. Thus, isolates spent more time in the general proximity of each other, but did not initiate active social behaviors, as time progressed.

Sexual behavior was nonexistent in the isolation reared monkeys with the exception of a few presents noted in the female isolates. In contrast, the controls produced two live births as a function of their group housing. The low level of sexual behavior noted in the isolates was unexpected. Mitchell (1968) reported that although isolates were aberrant sexually, some improvement was apparent with age. The reliability of this age trend was not supported by the present study.

These findings generally parallel those typically found using early total social isolates. As Mitchell (1968) reported, isolates were generally aberrant in social behaviors and sexual behaviors. Fittinghoff et al. (1974) found a similar trend in partial isolates at age 13. In both of those studies, as well as the present study, isolation reared monkeys exhibited high levels of bizarre behaviors which maintained and become more idiosyncratic with time. Fittinghoff et al. (1974) reported that as isolates aged, the variety of behavioral abnormalities exhibited by each animal decreased. Each animal developed its own unique repertoire as it aged and would utilize only one or two unique bizarre behaviors as an adult. The overall frequency of bizarre behavior remained high as an adult. In the present study, isolates exhibited significantly higher levels of bizarre behaviors than controls. Although the category was not subdivided into particular motor patterns, observers reported that like Fittinghoff et al., each animal had one or two unique bizarre behaviors which accounted for the majority of their bizarre behavior.

In contrast to previous work (Fittinghoff et al., 1974) no significant differences were noted in negative social behaviors. Isolates were not hyper-aggressive, nor did they exhibit significantly higher levels of submission behaviors. Mitchell (1968) reported an interaction with age in fear behaviors. As isolates got older, they exhibited fewer fear behaviors. The present research extends and supports Mitchell's findings. Isolates proved to be no more submissive than normally reared controls. Within the present study, the majority of animals exhibited few fear or submission behaviors. It is noteworthy that one animal, E-15, accounted for the preponderance of submission and fear behaviors noted within the isolate group. She exhibited the typical picture of the young fearful isolate, consistently crouching and huddling in a corner.

Mitchell (1968) also reported that the diminution of fear behaviors in isolates was replaced by an increase of agonistic behaviors. Such a trend was not apparent in the present study. Isolation reared monkeys proved no more aggressive than controls. In summary, it appears that limited changes occur over time in the positive social behavioral repertoire of social isolates, but negative social behaviors appear to interact markedly with age. Not only does the level of the behaviors drop, but the quality changes as well.

Nonsocial behaviors comprised the majority of the isolation reared monkeys' behavioral repertoire; however, isolates and controls showed few differences. Work with young isolates has rarely examined nonsocial behaviors. Mitchell (1968), in one of the few studies examining non-social behaviors, found that young isolates were markedly depressed in the levels of nonsocial exploration they exhibited. In the present study, isolates engaged in significantly higher levels of environmental exploration-self-manipulation. Thus, there appears to be an interaction with time in the category of exploration-self-manipulation in isolation reared monkeys. The increase in exploration-self-manipulation would seem to git well with the decrease in submissive and fear behavior observed here. Clearly, if the animals are spending less time huddling and avoiding, and social contact is not increasing, then increases in behavioral categories such as exploration, self-manipulation, locomotion, and passive might be expected. In the present study, the only one of these three behaviors to show a significant main effect of rearing was exploration-self-manipulation.

Isolates have previously been reported to eat and drink more than controls (Gluck, 1971; Miller, Caul, & Mirsky, 1971). Typically, workers have reported elevated water consumption alone. From this research, it is impossible to determine which specific factor is elevated. The overall elevation supports findings of both Miller, Caul, and Mirsky (1971), which reported elevated water consumption, and by Gluck (1971), who found high food consumption in isolates in a dense schedule of food reinforcement.

The removal of the dominant male from the control group produced a clear increase in social behaviors. While he rarely engaged in social behaviors himself, his presence clearly inhibited the participation of other animals. Concurrently, there was a decrease, although nonsignificant, of dominance-submission behaviors as a general group. The removal of this male clearly increased the levels of positive social behaviors seen within the group. The significant increase of grooming and the positive trend in sexual behaviors seemed to be directly attributable to the absence of the previously dominant male. Typically, this male would interrupt any social behavior by walking toward the participants displacing both of the actors. With the removal of the male, social behaviors were not interrupted, allowing the rate to increase. The profile for weeks 13-14 of the control group probably reflects a more accurate estimate of group behavior in normally reared monkeys than the previous data. However, the first 12 weeks of data still bear critical relevance. The fact that a male, with normal early socialization, did manifest such behaviors indicates that the profile had ethological relevance.

The results of the group challenge tests were somewhat surprising. Earlier work done by Anderson and Mason (1974) had suggested that young partial isolates maintained more rigid dominance hierarchies and had fewer reversals in dominance pairings than controls. The present work suggested no differences in the levels of reversals between isolation reared monkeys and controls. Furthermore, as measured by reversals, control dominance hierarchies proved no more rigid than those of isolation reared monkeys. The difference between these two findings cannot be clearly resolved. Two factors may have influenced the results. First, there was the presence of the extremely dominant male in the control group. His behavior increased the number of submissions within the control and, therefore, probably tightened their dominance hierarchy within that group. Anderson and Mason (1974) reported that many reversals were observed in their socially experienced group. Thus, the presence of the dominant male in our control group may account for the difference between the two studies. However, the results of a fourth water dominance test run after the male was removed dispute this argument. Fewer displacements were seen on that test than any other test. In other words, with the dominant male removed, displacements decreased. The differences between present results and Anderson and Mason's (1974) results does not appear to be due to the presence of a highly dominant male in the control group. A better explanation is that fewer displacements and reversals were seen in the present study because of changes which occur as a function of aging.

One last consideration is the nature of the differentially reared groups used by Anderson and Mason. Their isolates were reared with surrogates in adjoining pairs for the first 4 months of life. During months 5 through 11, they lived in single cages in the more typical partial social isolation paradigm. The controls were reared with mothers only until 6 months of age when they were grouped together and housed until 11 months of age. The effects of their rearing cannot be clearly interpreted. Such an early experience manipulation has rarely been used and its effects are not clear. It is possible that their results were unique to their rearing. It is more likely, however, that the rigidity of their dominance hierarchy is specific to the social measures they based it upon while the hierarchies found in the present study are based upon nonsocial measures.

Examination of the displacement data indicates that despite the failure to find reversals in the control group, the displacement data indicate that isolates interacted with only a few members of their group, adapting strict patterns of interactions. Controls, in contrast, routinely interacted with the majority of the members of their group. Thus, controls exhibited more complex social strategies as Anderson and Mason reported.

The correlation patterns found in the matrix based upon the hierarchies derived from the 4 challenge tests support Anderson and Mason's findings. Controls showed a variety of strategies in dealing with each challenge test. Each test was handled by the controls uniquely. Isolates, in contrast, exhibited 2 basic strategies for approaching the challenge tests. Isolates dichotomized their behavior according to the nature of the challenge test. In those challenge tests which utilized apples or water, isolates reacted with one specific order. In those tests which utilized nonnutritive stimuli, a completely different hierarchy developed. Thus, isolates exhibited 2 basic strategies which stand in marked opposition to the controls behavior.

The results of the challenge tests failed to support Mason's 1961 work. Mason paired partial isolates at 3 years in 16 dyadic, competitive situations in which raisins were presented. The animal that consistently retrieved the raisin was considered dominant. Isolates produced unstable hierarchies with over half the pairs failing to determine a consistent dominant animal. Feral controls, in contrast, maintained clear dominance hierarchies in all pairs from the first pairings. Thus, the generalization made earlier, that as isolates age they become rigid, appears apt. Clearly, the difference between the present findings and Mason's work with young isolates supports such a hypothesis.

The failure to find significant group differences in the challenge test group comparisons and in the pairwise comparisons is not unexpected. With the small N available for comparisons in the two groups, only the most robust effects could have demonstrated significance. The failure to find significance, of course, indicates the need to consider group differences with caution, however, it does not forbid cautious optimism concerning the indications of the results.

Summary

In summary, fully mature, early total social isolates do not appear to be either hyperaggressive or overly fearful. Rather, they appear to be asocial, spending the majority of their time engaged in nonsocial or bizarre behaviors. Prolonged housing with similarly reared peers does not produce a significant improvement in social abilities although slight improvements were noted. Additionally, sexual behavior remains aberrant into complete maturity in early total social isolates. Age clearly modifies the repertoire of the early isolates. It is inappropriate to assume that young isolates' behavioral profiles will persist in full maturity unchanged. Age interacts with behavior, and, early social isolates are no exception.

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APPENDICES

APPENDIX I

REVIEW OF THE LITERATURE

Early civilizations attributed behavior to divine causes. As time passed a gradual transition occurred with thinkers like Descartes emphasizing external causes of behavior in animals. But in humans, behavior was seen as being mediated by a "soul" which was influenced by divine factors. The presence of the soul separated man from beast. Darwin's 19th century revelation that man and ape were related on a biological continuum followed by Freud's emphasis upon the effects of early experiences upon later behaviors produced a new trend in the thought of the day. The trend has evolved until today the counter-intuitive effects of early experience are generally accepted. A wide variety of social experiences are now seen as being necessary for the production or retardation of many adult behaviors.

Experimental examination of the variables which affect adult behavior has proven very difficult in humans. Ethical factors have made research using humans virtually impossible. Over the years many stories have been passed down concerning humans reared in isolation or by animals. Kasper Hauser (Wasserman, 1928), a Bavarian prince, was placed in a single room dungeon as a very young child and saw no other person until shortly before puberty. In the few years he lived Kasper was reported to have functioned normally. But, tragically, he was murdered several years after his release from captivity.

Folklore has it that Romulus and Remus were reared by wolves. Romulus apparently suffered little intellectual or social damage as he later became emperor of the Roman empire. Many other stories are told of children reared by canines (Bettleheim, 1959; Foley, 1940a, 1940b; Singh & Zinn, 1942), but most seem highly unlikely.

Interest in the effects of early social deprivation upon later behavior was given an impetus by Spitz, who reported that children reared in restricted environments as typified by two very inadequate orphanages developed marasmus (Spitz, 1946) and hospitalism (Spitz, 1945) which were dramatized by disturbed and distorted personality development and significant developmental loss.

The ethical considerations involved in systematically manipulating the pertinent variables involved in early experience research have resulted in workers in the area turning to infrahuman subjects. Mason (1968) has argued the validity of this approach. Mason stated that the implications that may be gained from cross-species generalization under closely controlled circumstances in infrahuman species outweigh the possible pitfalls of this type of research as long as experimenters are aware of limitations arising from infrahuman studies.

The majority of research in the early experience area is aimed at delineating the effects of early exposure to either enriched or deprived environments. Subjects reared in enriched environments are typically placed in groups or with at least one other conspecific. Extra stimuli are usually available in the rearing chamber. These stimuli may range from geometric toys to climbing or activity apparatus. The deprived environmental enclosure is smaller than the enriched rearing chamber. The deprived chamber is void of any extra stimuli and the animal is reared alone.

Several variations of the deprived rearing condition exist. Partial social isolates are reared in wire cages which allow the subject to see and hear conspecifics but not touch them. Total social isolation allows the animals to hear other animals but not to touch or see them (Gluck & Harlow, 1971).

Mason (1960) reported that monkeys reared in wire cages (partial social isolation) from birth fought more and groomed less than feral reared monkeys. In tests of gregariousness the partial isolates made fewer social choices and fought more frequently following a social choice than did pairs of feral monkeys (Mason, 1961). Mason and Green (1962) found partial social isolates would crouch, suck their thumb and toes, clasp themselves, engage in rocking or other stereotypic movements while normally reared animals rarely exhibited the behaviors.

The effects of total social isolation were reported by Harlow, Rowland, and Griffin (1964). Shortly after birth, Harlow et al. placed rhesus monkeys into one of four groups. Group 1YI spent 12 months in total social isolation, group 6 ME spent their first 6 months of life in total social isolation, group 6 ML spent their second 6 months in total social isolation and group PI, the controls, spent their first year in partial social isolation. The subjects were tested in a variety of social and learning tests at the end of their first year. The results in the behavioral categories indicated that the monkeys that had spent 12 months in total social isolation were characterized by inactivity, fear, withdrawal, and almost complete absence of play and exploration, and inability to avoid aggression from the partial isolate controls. The 6 ME group was also inadequate at the beginning of testing but showed improvement during the course of the testing but failed to reach the levels of socialization of the partial isolate controls. The 6 ML initially displayed high levels of disturbance behaviors but gradually the 6ML isolates' socialization improved until they dominated the partial isolate controls. One year of early social isolation completely destroyed the animal's ability to engage in social interaction. Six months of early isolation produced behavioral deficits that improved with experience. Late isolation also produced abnormal behavior, but 6ML animals were capable of engaging in some positive social behaviors.

Harlow, Dodsworth, and Harlow (1965) reported that the effects of three months of social isolation were debilitating but reversible. If the three month isolates were allowed to interact with normally reared controls, they gradually developed normal social behaviors. The authors furthered Harlow et al. (1964) reporting that six month isolates adjusted adequately to agemates in the playroom, had low levels of autoerotic behavior, and low levels of threat behavior. In contrast, the 12 month social isolates showed high levels of stereotypic behaviors, rocking and huddling, and an absence of autoerotic behavior. Harlow et al. reported a follow-up study by Mitchell with three-year-old social isolates. Mitchell found no play, no aggression, almost no sexual behavior, high levels of fear behaviors to adults, infants, and agemates. Six month isolates showed more variety with two showing some aggression; the other two six month isolates showed no aggression. Sexual behavior was diffuse or absent in the six month isolates.

In terms of social behavior an apt generalization would be the longer the social isolation the greater the social deficits arising from the isolation. Furthermore, the more restricting the isolation, the greater the deficit.

Learning

In terms of learning, to date, few deficits have been found as a result of early social isolation. Rowland (1964) found no differences between 6 month early isolates, 12 month isolates and partial isolates on two choice discrimination problems. Rowland also found no differences in avoidance learning in a shuttlebox, although 12 month isolates required more trials to begin avoiding. In delayed response tasks no differences were found with up to five second delays (Harlow, Schiltz, & Harlow, 1969). In one of the few learning differences reported, Gluck, Schiltz, and Harlow (1973) reported that partial social isolates performed at lower levels than monkeys in enriched environments on complex oddity tasks. The authors supported previous work which had found no differences on two choice discrimination problems between social isolates and normally reared controls.

Lichstein and Sackett (1972) found that monkeys reared in social isolation would tolerate higher levels of mouth shock in order to receive a drink of water when they were water deprived than normally reared monkeys. Along these same lines Frank, Gluck, and Strongin (1976) found that early social isolates marginally suppressed responding to the CS in a CER task while normally reared monkeys totally suppressed responding to the CS.

Little work has been done in operant analysis of early social isolation effects. Gluck (1970) found early social isolates took more time to take food from the magazine, more time to make the initial lever press but did not differ from normally reared controls in acquisition once the first lever press had been made. When placed on an alternating extinction-reacquisition schedule isolates were found to emit more responses in extinction than normally reared controls. In the only work done using basic operant schedules, Gluck (1971) tested isolates on CRF, progressive FI and progressive FR schedules. Isolates were found to respond at higher levels on CRF and at lower levels on intermittent schedules as compared with normally reared controls. Gluck reported that isolation reared monkeys were slower to adjust to new contingencies of reward as compared to controls.

Sackett (1968) allowed isolates and controls to interact with a variety of stimuli ranging from a swinging T-bar to a stable perch. The stimuli were seen as offering a continuum of proprioceptive complexity. The isolates preferred the most simple stimuli while the controls, reared with mother-peer access preferred the most complex stimuli. Earlier, Sackett (1965) measured the amount of time isolates and controls oriented to visual stimuli ranged on a continuum. Again, isolates oriented toward the most simple stimuli and avoided the most complex.

Normally reared monkeys oriented toward the most complex stimuli.

Dominance

Mason (1961) paired partial isolates with other feral reared animals. Mason offered raisins to the paired animals and assessed dominance by which animal received the majority of the food. In the feral group dominance hierarchies remained constant across pairings. In the restricted group dominance hierarchies varied between sessions; in only two pairs did the same partial isolate remain dominant. Mason concluded by saying, "the data emphasize the importance of social learning in the establishment and maintenance of dominance relations."

Rowland (1964) tested dominance relationships among total social isolates using the order of access to a water bottle following water deprivation as an indication. He found monkeys that spent their second 6 months of life in total social isolation were dominant over monkeys that had spent their first 6 months in isolation. Both these groups were dominants over monkeys that had spent the first 12 months of life in isolation. Rowland inferred part of the dominance hierarchy because the 6 month late isolates tended to be very aggressive toward the 12 month isolates causing pairing to be stopped.

Anderson and Mason (1974) formed six member social groups composed of either young feral reared animals or young partial isolates. The groups were allowed to live together for a total of 30 intermittent days; after 20 days, the groups were broken up for 3 months, and then reformed for 10 final days. In this seminatural testing environment, Anderson and Mason reported that between the first forming of each group and the reforming of the group, dominance relations remained constant in the feral-reared group but were reversed in many instances in the deprived group.

Permanence of Isolate Behaviors

Rowland (1964) found that social isolation for 6 or 12 months had a debilitating effect upon subsequent behavior. He reported isolate monkeys were fearful, highly disturbed, and sexually abnormal when observed 12-20 months after birth. Mitchell et al. (1966) performed a follow-up study on Rowland's monkeys when they were 28-44 months of age. Mitchell paired 8 of Rowland's isolates with sophisticated controls in brief cross-sectional pairings with 12 stimulus strangers: 4 adults, 4 agemates, and 4 juveniles. The isolates were characterized by infantile disturbance, low environmental orality, high levels of fear, high aggression, low sexual behavior, low play and by idiosyncratic bizarre movements. The 12 month isolates were primarily fearful and nonaggressive at this age, yet they threatened many attacks. The 6 month isolates were both fearful and physically aggressive. Thus, the effects of early isolation, even as little as 6 months, last until puberty in rhesus monkeys.

Mitchell (1968) again surveyed the behavior of Rowland's isolates which were then 4 1/2 years of age. The females were cycling and the males' testes had descended, but the canines of the males had not completely grown out. The isolates were still socially inactive, fearful, and disturbed.

Rowland (1964) reported that fear was the predominant behavior in the young isolates. As they matured, at about 5 years of age, fear became associated with hyperaggressiveness but the hostility was suppressed or delayed by fear when the duration of isolation was severe (Mitchell et al., 1966). When the increased aggression became obvious, both the quantity and quality of the aggression were abnormal. Mason (1961) reported isolates fought longer and more frequently than controls. Attacks against huge adult males or beatings of infants were not uncommon (Mitchell et al., 1966). Mitchell (1968) found that despite their hyperaggressiveness, Rowland's isolates were submissive to controls in dominance tests.

Fittinghoff, Lindburg, Gomber, and Mitchell (1974) found that self-punishments, stereotypes, bizarre movements, and autoeroticism persist into the thirteenth year in rhesus monkeys reared in partial social isolation.

Therapy

To date, all the attempts at rehabilitation of animals who have spent their first six or more months in social isolation have fallen into two main classes. These two classes of therapeutic intervention are separated by a simple distinction, whether the rehabilitating agent was a social organism or not; in other words, alive or inanimate. In the chronology of rehabilitation attempts the nonsocial interventions generally preceded the social attempts, so we will deal with the nonsocial attempts first.

Nonsocial Intervention

Before reviewing the nonsocial rehabilitation attempts, it may be helpful to review quickly the theories which attempt to account for the effects of early social isolation. Two theories have been given special credence by primatologists, emergence trauma (Fuller & Clark, 1966) and the critical period theory (Scott, 1962). Emergence trauma theory states that the aberrant behaviors displayed by early social isolates results from the trauma which occurs upon entering a more complex environment after spending long periods in the simple isolation environment. The post-isolation environment is seen to literally overwhelm the organism. Emergence trauma, as a significant factor in the creation of deviant behavior displayed by social isolates has largely been disregarded today due to two key factors: (a) If emergence trauma is a causal agent in producing the bizarre behavior displayed by social isolates, as the animal adapts to the complexity of the postisolation environment, some amelioration of the isolates' behavior pattern should occur. As mentioned earlier, the behavioral pattern established by social isolates is persistent and does not improve with time. (b) Secondly, if emergence trauma is a key to social isolates' behavioral patterns, experimenter induced pacing of the complexity of the environment the organism meets as it emerges should result in a decrease in the isolates' atypical behaviors. D. Clark (1968), among others, attempted just such a program and found no reduction in the aberrant behaviors of monkeys reared in social isolation.

This is not to say emergence trauma does not exist. Most recently, Novak and Harlow (1974) reported that upon release from total social isolation, which had lasted twelve months, rhesus monkeys exhibited higher levels of deviant behaviors than they had during the isolation period. The elevated levels of aberrant behavior lasted for about two weeks and then descended to the same frequency observed during the isolation period.

A second theory concerning the cause of social isolate behavioral deficits postulates that animals that spend the first few months of life in social isolation display atypical behaviors as a result of missing a "critical period" for social interaction. After missing the critical period there is no way to induce improvement. The length of the critical period was originally thought to be a minimum of about six months (Harlow, Dodsworth, & Harlow, 1965). These two theories, the emergence trauma theory and the critical period theory, have received the majority of attention from researchers. The critical period hypothesis has been tacitly accepted by most workers in the area.

The earliest attempts at reducing the effects of early social isolation through nonsocial manipulations used surrogate mothers which were cylindrical objects composed of wire mesh and had a semicircular head. Occasionally the wire mesh of the surrogate was covered with cloth, making it more attractive to the infant (Harlow, 1958). Alexander and Harlow (1965) raised monkeys from birth to six months of age in wire cages which allowed them access to wire surrogates. Alexander and Harlow found access to cloth surrogates during the isolation period did not diminish the level of aberrant behaviors typical of partial social isolates. They did note some improvement in the levels of social behaviors exhibited by the partial social isolates over the course of testing in social groups. The authors notes ". . . contact with non-peer-deprived monkeys might be essential for deprived monkeys to learn social skills which other peer-deprived monkeys do not possess." Despite the optimistic ending note, no real rehabilitation had occurred.

Pratt (1967) attempted to reduce the effects of total social isolation by introducing the closest thing possible to social stimuli but still really using nonsocial stimuli. He exposed his subjects to pictures of monkeys engaged in various social activities such as threatening, playing, and copulating during the isolation period. At the end of the isolation, gradual adaption preceded a series of social tests. Despite his pains to adapt the monkeys gradually to the postisolation milieu, picture isolates proved to be as socially devastated as total social isolates. Thus, neither presentation of pictures during isolation or gradual adaption to the postisolation environment ameliorated the effects of early social isolation.

Gene Sackett (1968) attacked the rehabilitation problem from a different angle. Sackett conditioned social isolates to avoid a shock by sitting on a perch in contact with a stimulus monkey whenever a light flashed. Sackett was successful in conditioning the isolates to avoid the shock; however, he found no transfer of the conditioned behavior to different social situations unless specific cues were provided. Young juvenile animals, Sackett reported, had longer contacts with the stimulus animals than the older animals. Aside from the very limited success with younger animals, Sackett concluded that his attempt at conditioning social contact was largely a failure.

Few attempts have been made at rehabilitating social isolates through the use of drug therapies. In chimpanzees, which exhibit isolation effects analogous to rhesus monkeys, several varieties of drugs have been administered to isolates without notable behavioral improvement. Among those drugs which have failed to produce improvements in chimps were: trifluoperazine, dextroamphetamine sulfate, oxazepam, and lysergic acid diethylamine (Menzel, Davenport, & Rogers, 1963a, 1963b; Turner, Davenport, & Rogers, 1969). Despite these failures, McKinney, Young, Suomi, and Davis (1973) did obtain some evidence of rehabilitation in rhesus monkeys. McKinney and his colleagues regimented partial social isolates on a therapy of chloropromazine which acts as an antipsyhotic drug in humans. During chloropromazine administration the investigators found significant decreases in levels of self-directed behaviors such as self-mouth, self-bite, and stereotypic behaviors. McKinney and his co-workers failed to find a commensurate increase in appropriate social behaviors; thus, this would be classified as a case of partial rehabilitation.

The fifth instance of nonsocial therapeutic intervention has been the most successful of any of the nonsocial interventions and actually uses social agents as well as nonsocial agents. S. Suomi (1972) reared rhesus monkeys for the first six months of life in total social isolation. At the end of six months the isolates were observed for two weeks and then placed with heated surrogates for two more weeks. Four weeks after being removed from isolation, two isolates of the same sex and their surrogates were placed in a common living cage. Suomi reported that the social isolates showed marked increases in locomotion, exploration, partner contact, and play. The isolates showed decreased levels of self-directed behaviors. Although Suomi reported an amelioration of aberrant behaviors compared to normal agemates, the social isolates were still deficient, especially in play behavior. Suomi attributed the failure of the isolates to attain normal play patterns to their lack of interaction with monkeys exhibiting normal play patterns. The only playmate the social isolates had during the course of the experiment was another social isolate, equally deficient in social behaviors. The cloth surrogate, while capable of providing contact and comfort to the young isolate, could not provide social interactions. Suomi stated that what was needed for adequate social development was a social agent which reciprocated social interactions.

The Suomi study marked a turning point in rehabilitation studies in that Suomi combined both nonsocial and social therapeutic methods. Looking at rehabilitation methods as a dichotomy between social and nonsocial interventions the social technique employed by Suomi was actually quite sophisticated and falls rather late in the chronology of social intervention techniques. Earlier rehabilitation attempts using social agents had led researchers to believe that that avenue held little promise.

A second mode of social rehabilitation did not originally begin as an attempt at rehabilitation. In the mid-'60s Seay, Alexander, and Harlow (1964) decided to investigate what the effects of rearing a monkey in social isolation without a mother had upon their maternal behavior as adults. These monkeys, who became known as motherless mothers, proved to be grossly inadequate mothers themselves. They were often indifferent or even brutal to their infants. Despite the maternal battering, the infants developed normally, differing from normally reared monkeys only in increased levels of aggression. The main finding of interest to this paper concerned the fact that motherless mothers tended to provide normal material care to their second infant. Although the motherless mothers were better mothers to their second infant, the levels of aberrant behaviors displayed by the motherless mothers remained very high. The motherless mothers seemed to be another case of partial rehabilitation. However, this apparent rehabilitation was questioned by Arling, Ruppenthal, and Mitchell (1969) when they reported that eight year old nulliparous female monkeys exhibited less aggression toward infants than did younger nulliparous monkeys. The improvement in the motherless mother's maternal behavior could be as easily attributed to age as to having borne an infant.

In the chronology of social therapeutic measures the next occurrence was the Suomi heated surrogate, isolate paired with isolate study related earlier in this paper under the nonsocial intervention section. As was indicated in that section, Suomi felt that what was needed to produce more complete rehabilitation was a reciprocating social agent. Along with H. F. Harlow, he conducted such a study (Suomi & Harlow, 1972). Suomi and Harlow paired six month social isolates with three month peer reared infants two weeks after the isolates were released from isolation. Three month infants were used because young monkeys will cling to almost any object. At three months the clining reflex is still present which meant that the young "therapist" monkeys would constantly seek and contact the older isolates. Furthermore, in typical three month old rhesus monkeys aggressive type responses have not yet matured; thus, the isolates would not fall victim to the younger monkeys. Three month old infants seemed to offer the ideal reciprocating social agent that Suomi predicted would be required for full rehabilitation.

Suomi and Harlow reared their monkeys for the first six months of life in total social isolation. At the end of six months the monkeys were individually housed to assess the effects of the isolation. Two weeks later they began a regimen which allowed eight hours per week of interaction with the three month old therapist monkeys. As the therapists developed, the social isolates also developed. When the therapist clung, the isolates clung back; when the therapist played, the isolates played back.

By the end of the therapy period the isolates were indistinguishable from the therapist monkeys in terms of the levels of social and nonsocial behaviors they displayed. At the end of the therapy period the isolates showed few behavioral differences when contrasted to the therapist monkeys except higher levels of self-clasping, but even self-clasping had decreased from its original baseline level and was continuing to descend at the conclusion of the observations. Suomi and Harlow felt their results supported the notion that the aberrant behaviors resulting from isolation occur not because of emergence trauma or a missed critical period but due to a learning deficit during the isolation period. The therapist monkey according to Suomi, Harlow, and Novak (1974) has a two-fold purpose: (a) to reduce or eliminate patterns of self-directed behavior typically seen in social isolates, and (b) to replace such patterns with normal social activities in a gradually increasing sequence. The reduction of self-directed behaviors occurs as a product of the clinging reflex of the therapist; it is difficult for the isolate to engage in any self-directed behaviors with, literally, a monkey on its back. Secondly, as the therapist matures it will initiate play in the appropriate developmental sequence, also taking the isolate through that sequence. Speaking loosely, the therapist monkey causes the social isolate to stop directing behavior toward itself and then takes the social isolate through a second "monkeyhood."

Evidence to support Suomi and Harlow's notion that a young monkey with clinging reflexes still intact must be used as the therapist monkey came from Maple, Brandt, and Mitchell (1973). Maple and his co-workers reported that pairing eight month social isolates with a preadolescent monkey produced some improvement in the social isolate's behavior. However, a follow-up study of the social isolates at approximately three years of age indicated the improvements found in the earlier study were only temporary and were no longer evident (Erin, Maple, Mitchell, & Willot, 1974).

Suomi and Harlow, as reported earlier had successfully rehabilitated six month social isolates but the roughtest test remained. Monkeys reared for one year in total social isolation are more devastated, both quantitatively and qualitatively, than six month social isolates. Novak and Harlow (1975) attempted to rehabilitate a group of twelve month social isolates. Because twelve month isolates are more affected by the isolation period, several extra steps were taken such as allowing the isolates to self-pace the amount of stimulation they received immediately following their release from isolation. Novak and Harlow found that species-typical behavior could be rehabilitated in twelve month social isolates; their results were, overall, very successful.

Novak and Harlow elaborated upon the learning deficit hypothesis first suggested by Suomi and Harlow (1973). The critical period hypothesis, they felt, had been permanently put to rest by their results. In its place they proposed the environment-specific learning hypothesis. According to this hypothesis an animal will acquire a behavioral repertoire reflecting the interaction between the animal's basic needs and the ability of the environment to satisfy these needs. When the environment fails to provide for the needs of the organism, the organism will make adaptions. An infant in social isolation has a need for contact-comfort. When the environment fails to provide this, the infant generates its own, resulting in the typical self-directed behaviors seen in isolates.

The failure to display species-typical behaviors after emergence from isolation occurs because the animal did not have an opportunity to learn the behaviors at the time they are usually learned. Novak and Harlow felt that the infant rhesus monkey is predisposed to develop patterns of play, grooming, and rudimentary sexual behavior but reciprocal and consistent stimulation is required to maintain these behaviors.

With the rehabilitation of twelve month isolates only one more crucial step remained to have secured full scale rehabilitation of social isolates, that being the rehabilitation of social isolates some time after their release from isolation. Gomber and Mitchell (1974) paired a 15 year old male partial isolate with a one month old female rhesus infant. The partial isolate, before the pairing, had a behavioral profile typical of an animal which had experienced early partial isolation, high levels of self-directed behaviors, no social behaviors, and little or no sexual behavior. Following a gradual adaption period, allowing both animals to acclimate to each other, high levels of aggression were evidenced by the partial isolate toward the infant. After a short period the hyperaggressive levels decreased and some improvement was seen in the partial isolate's aberrant behaviors. Higher levels of physical contact, play, and appropriate threatening were observed in the partial isolate. Despite the improvement in social skills the partial isolate continued to evidence high levels of self-directed behaviors.

Timothy Strongin (1975), at the University of New Mexico, performed a similar manipulation. Strongin paired a three and one-half month old rhesus with an eleven year old nulliparous, total isolate female. Strongin's results paralleled those of Gomber and Mitchell in that he found increased levels of social interaction but no decrease in bizarre or self-directed behaviors.

APPENDIX II

Table 4

Subjects' History

	ID	Sex	DOB	Place of Birth		*Macaca mulatta* Rearing History	Last known assessment of social behavior
Socialized Control Subject Pool:							
1.	E3	M	7/64	Univ. of Wisc.	0-9 mo.	Mother and peers	3rd & 4th yr.
2.	G44	F	5/66	"	"	Housed singly since rearing	"
3.	G49	M	6/66	"		"	"
4.	G66	M	7/66	"	"	"	"
5.	J90	M	7/68	"	"	"	"
6.	Cindy	F	'67-est.	-	Feral	Housed singly since 1970 with infant 1974-75	unknown
7.	Mona	F	'64-est.	-	"	Housed singly since 1970	"
8.	Tess	F	'64-est.	-	"	Housed with infants periodically	"
				Totals	N = 8 Male = 4 Female = 4	Age Range 7-13 (est.)	
Deprived (Isolate) Experimental Subject Pool:							
1.	E7	F	8/64	Univ. of Wisc.	0-9 mo.	Total Isolation/Housed singly since rearing	3rd & 4th yr.
2.	E8	F	8/64	"	"	" " "	"
3.	E12	M	9/64	"	"	" " "	"
4.	E15	F	9/64	"	"	" " "	"
5.	K2	M	7/68	"	"	" " "	2nd year
6.	K6	M	7/68	"	"	" " "	"
7.	K9	F	7/68	"	"	" " "	"
				Totals	N = 3 Male = 7 Female = 4	Age Range 8-13	

APPENDIX III

Table 5

Statistical Summary -- Comparison of Weeks 1-12 between Groups

Category	Variable	F-Value	Category	Variable	F-Value
Social	R	19.62*	Social Initiator	R	U=0** (Mann Whitney-U)
	T	.54			
	RxT	1.1			
Social Recipient	R	2.90	Social Passive	R	9.25**
	T	3.1		T	25.1 **
	RxT	3.9 *		RxT	4.6 *
Play	R	.17	Aggression	R	.79
	T	2.5		T	1.3
	RxT	.65		RxT	.72
Dominance-Submission	R	3.77	Dominance	R	.43
	T	1.66		T	.58
	RxT	.39		RxT	.2
Bizarre	R	12.58**	Self-Manipulate Explore	R	4.87*
	T	.53		T	.27
	RxT	.35		RxT	3.3
Self-Manipulate	R	1.34	Explore	R	1.17
	T	.2		T	1.2
	RxT	1.8		RxT	1.7
Eat-Drink	R	4.9*	Locomotion	R	.06
	T	3.9*		T	17.4**
	RxT	5.0*		RxT	10.7**
Passive	R	.01			
	T	3.6			
	RxT	7.1**			

*$p < .05$
**$p < .01$

R = Effect of Rearing
T = Effect of Time
RxT = Interaction RxT

Table 5 (continued)

Weeks 11-12 vs. 13-14

Category	Variable	F-Value	Category	Variable	F-Value
Social	R	37.1**	Dominance Submission	R	.104
	T	24.3**		T	4.8*
	RxT	10.9**		RxT	3.5
Dominance	R	.08	Submission	R	0
	T	.3		T	4.4
	RxT	1.6		RxT	1.4
Passive	R	.617	Explore-Self-Manipulate	R	3.2
	T	2.1		T	.27
	RxT	6.4*		RxT	.45
Explore	R	4.5	Self-Manipulate	R	1.6
	T	1.8		T	.37
	RxT	.41		RxT	.02
Eat-Drink	R	3.6	Locomotion	R	1.3
	T	.99		T	14.7**
	RxT	10.6**		RxT	1.02
Sexual Mann Whitney Test. (within group)		U=0*			

*$p < .05$.
**$p < .01$.

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