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Development of Dominance and Aggression in Macaques

Submitted for the degree of Ph.D.
May 1982.

Graduation: June 1982

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ACKNOWLEDGEMENTS

Acknowledgements

The author wishes to thank R. DeLizio for help in testing in the contrived dominance study, G. Cameron for help in testing in the dark study, R.E. Bowman for doing the cortisol determinations in the rank change study, and T. Molinaro for help in assessing reliability in the behavioural recording system. The following offered critical evaluations of parts of the manuscript: P.J. Baldwin, J.F. Craig, C.J. Henty, D. Lieberman, W.C. McGrew, and V.J. Nash.

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ABSTRACT

Social behaviours and 17-hydroxycorticosteroids were measured in 48 laboratory-born juvenile rhesus in old and in new quadrads for 8 days composed of animals from the same dominance position. Stress and fighting increased as a function of higher previous dominance rank but lower current rank.

When 40 macaques were tested in 4s, dominant monkeys were first to contact slightly novel objects, but a role analysis revealed better contact-order prediction than did rank-order for highly novel objects, most groups having their habitual first-contactor. When he was overtly punished or covertly trained to avoid objects, the group's response was altered. "Role" is extensively discussed.

Rhesus (36) from 3 rearing conditions were paired for 20 wk either with therapists that were (a) socially SOPhistocated 9-mo.-old monkeys, (b) 9-mo.-old partial social ISOlates, or (c) socially naive 3-mo.-old INFants. Aggression was greatest in those INF, ISO, and SOP paired with ISO and least in those paired with INF, opposite to predictions of a learning model of aggression.

Three groups of 8 infant rhesus were assigned to one of 3 ranks--Dominant, Intermediate, or Subordinate. D-monkeys were more aloof and more disturbed by novelty. D-females and S-males appeared ill-adapted to their positions, showing more disturbance and aggression. Results suggest many behaviours found in high-ranking monkeys are due to the rank and not a

characteristic of individuals.

Eight stumptailed macaques were given all social experience in DARKness or half in the dark and half in the light (CONTROLS). When tested in darkness or later in light, the DARK groups showed almost no social aggression but more self-aggression and less play than controls, and darkness reduced aggression in CONTROLS

Support was found for the hypothesis that there is some direct mechanism for the nongenetic transmission of acquired levels of aggression from mother to offspring.

Introduction

The causes of aggressive behaviours have been a subject of interest for some time. Various theories have attempted to account for the short-term development of aggression in individuals. It is possible to experimentally manipulate the early experience of individuals and then observe the effects of these manipulations on both developing and subsequent aggression. Of course the two expressions of aggression may not be correlated, and a type of early experience which might facilitate the latter might inhibit the former.

One of the constraints on the level of aggressive behaviour is dominance--the most dominant individual can be aggressive towards anyone with a relatively high level of impunity; the most subordinate individual is like to suffer retaliation if aggressive towards anyone else in the group. Dominance, like any construct, can be studied under controlled conditions, although the conclusions drawn from that situation and that population may not generalize to the wild or to semi-wild situations. Rowell (1974) goes so far as to claim that dominance hierarchies are an artifact of laboratory conditions but this is unlikely (see e.g., Deag, 1977).

This dissertation reports the results of seven laboratory studies. Briefly the first two studies look at correlates of dominance rank, two look at the effects of varying early experience upon dominance and aggressive behaviours, one looks at one way of manipulating aggressive behaviour, one looks in detail at methods of recording behaviour, and the last attempts to integrate the above studies wth others on early experience and aggressive behaviour, suggesting a new theory concerning the development of some aspects of aggressive behaviour.

The first study reviews much of the literature concerning correlates of dominance rank and behaviour in nonhuman primates. The data reflect the change in social behaviour and social status shown when laboratory-reared monkeys from stable groups of four meet unfamiliar monkeys from the same rank position in a controlled situation and form themselves into new groupings. This study also equates the prior history of the animals within a group, and looks at behavioural correlates of current and prior dominance rank during the formation of a new dominace hierarchy.

The second study also looks at behavioural correlates of dominance rank, again controlling for group size and in a clearly defined situation. This time the behaviour of interest is time to contact novel objects and its relationship with dominance rank. The study also compares a dominance rank analysis with a role analysis, critically evaluating the use of the term 'role' in animal behaviour.

The third study involves pairing animals with different amounts of prior social experience--infants with no prior experience, juveniles with no prior experience, and juveniles with extensive prior experience. In this way subjects of three types are exposed to partners which themselves exhibit different types of social behaviour. Due to age differences, dominance is also being manipulated at the same time.

The <u>fourth</u> study looks at the effects of manipulation of early experience, specifically dominance experience, on social development. Here subjects are arbitrarily assigned to dominance ranks during the first year of life by placing the subject in groups of selected monkeys. Again group size is controlled.

The <u>fifth</u> study reviews different behavioural scoring systems and describes a new behavioural category system. The study continues with an assessment of that system and compares three commonly-used time intervals using that system.

The <u>sixth</u> study is another manipulation of early experience, this time limiting visual social experience. Since visual experience is believed to be important for the development and expression of aggressive behaviour, the effects of limiting aggressive behaviour on dominance relationships and social behaviour would be expected to be considerable.

The <u>final</u> chapter is an integration of some of the above work with the literature on the effects of early experience on aggression. A new theory for the development of aggression is proposed, reconciled with the evidence, and discussed.

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CHAPTER ONE

Rank Change

In macaque groups dominance is a salient feature of social interactions. Having a high dominance position appears to be attractive in that (a) animals appear to strive for high dominance rank (Symonds, 1978), and (b) animals with a high dominance rank are attractive to others (Nash & Chamove, 1980). In some cases the more dominant animals are different from less dominant animals; they behave differently. Explaining why some animals become dominant has been the goal of some recent research. More recently the advantages of high dominance position has been investigated.

It also appears that attaining a high dominance position is a desirable goal for the macaque (Symonds, 1978). In the wild, the long-term attainment of high rank is correlated with several variables including the following: having a high-ranking mother (Koford, 1963; Hausfater, 1975; Koyoma, 1967), being adopted by a high-ranking male (Itani, 1959; Mitchell & Brandt, 1972), forming alliances with high-ranking animals (Koyoma, 1967; Maslow, 1936), and others. In the laboratory too, high position in newly-formed groups is secured through characteristics of the individual, such as physical size (Tokuda & Jensen, 1969; Mason, 1961), age (Tokuda & Jensen, 1969; Bernstein, 1981), hormonal status (Rose et al., 1974; Chamove, 1981), the ability to form advantageous alliances (Bernstein, 1968, 1981; Maslow, 1936; Leonard, 1979, 1980; Mitchell & Brandt, 1972; Miekle & Vessey, 1981; Packer, 1977; Angermeier et al., 1967; Chamove, 1981), and others (Altmann & Altmann, 1970; Singh & Pirta, 1977; Clark & Gay, 1978).

Normally in the wild the macaque develops within a stable social group composed of familiar monkeys. In adulthood, it is only on rare occasions that a situation may occur which would force females to wander alone. However, it is common for young males to leave the natal troup to wander as solitary monkeys or to form batchelor herds of unfamiliar animals (Wilson, 1975).

Encounters between such unfamiliar animals are rarely observed because they are infrequent and happen outside a group. Hinde (1976) suggests that it is only in these rare instances that those principles unique to dominance/subordinancy will be expressed in a relatively pure way, in such newly formed groups, composed of like-aged animals, all initially strangers to each other.

When unfamiliar animals meet, several variables interact to predispose the animals to behave in different ways with different consequences. Chase (1974) suggests that aggressive animals may seek out one another while the timid avoid confrontations. One explanation is that aggressive and dominant animals have an active adrenal cortex (as found by Candland & Leshner, 1973; Candland et al., 1977), although Rowell (1974) predicts just the opposite. A high baseline level of adrenocortical activity might well lead to early aggressive behaviour and rapid settling of the hierarchy which would then allow for the rapid return to the baseline adrenocortical secretion found in the dominant. The timid subordinate might be expected to show a delayed peak of agonistic behaviour and subsequently show increases due to the stress of defeat. In contrast, any dominants should show early increases in adrenocortical secretion if defeated.

More is known about the behaviour of animals occupying different ranks in stable groups than about the behaviour which occurs during group formation. Wilson (1975) summarizes a number of correlates of dominance rank order in stable wild troops. They are divided into what he calls correlates of basic rank including health, personality, and history of previous wins and losses; and correlates of dependent rank including rank of recognized kin, mother's rank, and how recently the subjects have arrived in the group.

Once the maturing individual achieves its relatively-stable rank; certain behaviours characterize that rank. These may reflect the function of occupying varying dominance ranks. This function of dominance hierarchies in certain non-human primates, as dramatized by their absence in other primates, has been a subject of continuing investigation (Butt & Fiske, 1969; Bernstein, 1980). It seems that relatively high dominance rank has two functions for the individual: priority of access to resources (McGrew, 1969), e.g., food (Southwick, 1967), to youngsters (Poirier, 1970; Hrdy, 1976; Deag, 1977), to space, to shelter, to the group, and to sexual objects (Boelkins, 1967); and an anti-stress function in competitive situations, evinced by lowered blood steroid values (Candland & Leshner, 1973; Chamove & Bowman, 1976; Sassenrath, 1970). The mechanism for this may be through a decreasing frequency of being the recipient of hostile behaviours and in an increased probability of being the recipient of positive behaviours (Sassenrath, 1970; Nash, 1982; Chamove & Bowman, 1978).

The more dominant are, almost by definition, the fittest which may eat in time of want (Loy, 1970; Wrangham, 1974, 1981; Southwick, 1976), probably the healthiest (Hausfater, 1975; but see Hausfater & Watson, 1979 who show dominants carry the heaviest parasite burden), and may more often reproduce and rear young [positive evidence--Kaufman, 1965; Struhsaker, 1967; Jay, 1963; Hausfater, 1975; Bernstein, 1976, 1981; Christian, 1970; Paterson, 1973 (DeFries, 1980 for house mice); negative evidence--Bygott, 1974; Saayman, 1971b; Baldwin, 1968; Paterson, 1973]. Other, more specific behaviours are characteristically associated with certain positions in the dominance hierarchy. For example, when comparing dominant, intermediate, and subordinate macaques in stable groups, dominant monkeys have been shown to exhibit the following characteristics: the lowest social distance scores, the highest affiliation, the most tolerance for the proximity of others, less activity (but see Stevenson-Hinde & Zunz, 1978), and lower rates of threatening and chasing (but see Buirski et al., 1973) than the other two categories (Bernstein & Sharp, 1966; Nash & Chamove, 1981, Chamove & Bowman, 1976). Sometimes the dominant acts as a 'biased arbitrator', breaking disrupting fights between more subordinate animals but supporting allies and relatives (Varley & Symes, 1966;

Massey, 1977; Oswald & Erwin, 1976; Ginsburg & Miller, 1981 on children). Surprisingly the more dominant group members do not always initiate or direct troop movement (Gartlan, 1968; Stoltz & Saayman, 1970), are less active (Nash, 1982; but see Buirski et al., 1973), and often do not initiate, or even take part in cultural innovation or transmission (Kawai, 1965; Menzel, 1966, but see Frish, 1959; and dominant rats are more exploratory, Lester, 1967)); often it is not the dominant animal(s) who acts as the arbitrator (Simons, 1965) or the procreator (Hall & DeVore, 1965; Massey, 1977). But priorities in dominant individuals may be expected to change with age in females or with time in the group in males, and the dominant males may choose a strategy of procreation early in their reign but change to one of protection of its offspring later on when their dominance is being challenged. This is not to denigrate the function of the more subordinate individual who, if male, may serve as a reserve in the case of certain changes in the dominant animal such as infirmity or age or death (see Christian, 1970), or function to increase the relative rank of the whole group (Vessey, 1971; Pirta & Singh, 1980), or may form the nucleus of new groups.

Subordinate monkeys show: the least dominance behaviour, the most submissive behaviour, and the highest activity scores (Bernstein & Sharpe, 1966; Nash, 1982; Chamove & Bowman, 1976; but see Stevenson-Hinde & Zunz, 1978). The high level of activity in subordinates might be a result of the same mechanism by which activity was related to corticosterone level in rats (Leshner, 1971; Candland et al., 1977). If this is correct, then activity as well as aggression might function to enhance the fighting behaviour that is elicited when other drives are frustrated (Vernon, 1969; Kahn & Kirk, 1968). It may account for subordinate rats being more responsive in an open-field than dominants (Chapman, Desjardins, & Brontson, 1968).

Christian (1970) suggests that there may be an optimum degree of aggressiveness. If dominance is a function of the degree of aggressiveness then this should be reflected when unfamiliar animals from the same rank are grouped together. But it may be that any frustration engendered in the grouping procedure increases the level of aggression in the formerly nonaggressive animals only, as in the rats of a study by Lagerspetz and Nurmi (1964).

Finally, past history of dominance would be expected to influence subsequent behaviour (van Kreveld, 1970). Scott (1958) has stated that one of the most effective ways to train an individual to fight is to ensure that his fighting experience is successful, although brief experience in new groups would not be expected to change stable heirarchies in monkeys (Maroney, Warren, & Sinha, 1959, as it does e.g., in bees, Free, 1961).

One important and topical question concerning dominance heirarchies and those behaviours which are related to the establishment and maintainance of these hierarchies, i.e., dominance behaviours, is the function of dominance hierarchies (Omark, Strayer, & Freedman, 1980). Lack (1966) has speculated that hierarchies reduce conflicts for a resource.

This is in agreement with Struhsaker (1967) and with Collias (1944) who state that the function of dominance hierarchies is to reduce physical aggression between individuals. Presumably the function is inferred from selecting some important consequences or sequellae of dominance hierarchies. For example, in newly formed groups of monkeys where no dominance hierarchy (as defined by unidirectional aggression) appears, there is more aggression. Certainly aggression is one of the most salient correlates of hierarchies but its reduction may not be the reason for hierarchies. Clearly it is not always correlated with hierarchies. Two examples can be cited where little or no aggression is seen when there is no hierarchy: (a) as a new male insinuates himself into a baboon troop; and (b) sometimes when a pair of macaques meet in a laboratory they do not challenge one another appearing to avoid forming a relative ranking for a long period.

Gartlan too (1968) has criticised the above assumption of function, saying that the greater rigidity of hierarchies coupled with the greater levels of aggression found in captivity argue against dominance functioning to reduce aggression. But his criticism only holds if dominance hierarchies work similarly under the circumscribed captive conditions as when under free field conditions. They almost certainly do not.

A reasonable function for hierarchies or rather the behaviours which go to make up the hierarchies would be to maximize access to desirables for individuals commensurate with the individual's ability and alliances, while maintaining

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A reasonable function for hierarchies or rather the behaviours which go to make up the hierarchies would be to maximize access to desirables for individuals commensurate with the individual's ability and alliances, while maintaining group membership and relatively low levels of stress. The function of being subordinate in the hierarchy would be the same; an individual would have the protection of the group while reproducing. At a later time this subordinate matriline could split off to form another group (Chepko-Sade & Oliver, 1979) where it would no longer be subordinate.

This experiment monitors the changes in social behaviour and social status shown when laboratory-reared animals from groups of four meet unfamiliar animals from the same rank position in a controlled situation and are formed into new and independent groupings. Four dominants (rank number 1) meet one another to form a group, four number two-ranked monkeys meet one another, and so forth. In each group one animal will subsequently become dominant, one number two, one three, and one subordinate. In such a format we can look at the expression of dominance gradients during group formation in newly-formed groups with the following additional controls: group size, home area, and past experience in specific positions of dominance.

Methods

Subjects

The subjects were 35 male and 13 female lab-born rhesus monkeys, *Macaca mulatta*, at 2-4 years of age reared with daily peer social experience and maintained on 15 hr. of light and 9 hr. of darkness daily (see Kerr, Scheffler, & Waisman, 1969, for details of rearing). The groups were chosen as available without regard to sex composition. These 48 animals were run in three successive replications. At the beginning of the experiment, the 16 monkeys of each replication had been living for the previous 9-33 mo. in four stable "original groups" (OG) of four animals, each confined in wire mesh cages, measuring .66 x .76 x 1.47 m for the older larger animals and .49 x .61 x 1.28 m for the younger, smaller ones. All had been reared individually in cages for the first year of life during which time they were given daily social experience with those three animals with which they were now housed. Animals were used to handling and blood sampling.

Procedure

In each replication, the monkeys were first tested in their OG, to obtain measures of behaviour characteristic of long durations in the same group. Testing consisted of the sampling of blood at 9:00 a.m. and 3:30 p.m. for cortisol analysis as a measure of stress (Mason, 1968) and the recording of behavioural categories, as described below. This day is termed Day 0.

Dominance determination. After Day 0 the OG dominance ranks were determined from two sessions in a Water Bottle Dominance Test (WBDT). In this test subjects were water-deprived for 23 hr. to ensure high motivation (Bernstein, 1980), after which dry food was introduced and, 5 min. later, a single water bottle was introduced. The elapsed time for each animal to accumulate 30 sec. of drinking time was recorded on electric clocks and the subjects then ranked in dominance from 1 to 4 according to the order of increase of these elapsed times. Because of the low rate of spontaneous aggression, it was impractical to use the direction of aggression or relative number of animals a subject was showing aggression towards (Hausfater, 1975) as the measure of rank.

It is generally believed that dominance gives priority of access to incentives (van Kreveld, 1970). Measuring dominance hierarchies by artificially restricting incentives appears to be a good measure of a hierarchy (Syme, 1974; Boelkins, 1967; Clark & Dillon, 1973; Chamove & Bowman, 1978; Richards, 1974), especially when spontaneous levels of aggression are low. On the first WBDT only, which lasted 60 min., blood samples were obtained before (at 2:30 p.m.) and after (3:30 p.m.) the test, and behavioural observations were recorded throughout. The second WBDT was used to confirm the rankings obtained in the first.

On a subsequent Monday (Day 1), beginning at 7:30 a.m., the subjects of each replication were taken from their four OG and rearranged into four "reformed groups" (RG) each consisting entirely of strangers, and were housed in the original colony room in unfamiliar cages which were, however, identical in construction to the animals' home cages. Each of the four RG consisted exclusively of the four subjects which had held the identical dominance position in their four OG, i.e., the four OG-D (dominant in the original group) monkeys were placed together in one RG, the four OG-II (ranked two) monkeys were similarly grouped together, etc. In the OG-D group comprising the four previously dominant animals, one of the animals would be expected to become dominant (D/D), another would take second rank (D/II), a third the next rank (D/III) and the remaining animal would become subordinate (D/S). Since there were three independent replications, this meant a total of three D/D monkeys over the whole study and correspondingly, three of every other combination of four dominance ranks.*

On days 1, 2, 4 and 8 of the RG condition, blood was sampled at 9:00 a.m. and 3:30 p.m. and behavioural observations were recorded as described below. On Days 3 and 7, the groups were run in a WBDT solely to determine the RG dominance positions. For these two tests, water deprivation was not used. Instead milk, a higly desired incentive, was offered in the single bottle. This was done to eliminate any stress due to the deprivation process, and has been found to give the same dominance rankings in most situations. Finally, at 7:30 a.m. on Day 9, the subjects were removed from the RG and were returned to their original groups (ROG) and original home cages. Blood was sampled at 9:00 a.m. and 3:30 p.m. and behavioural observations (see below) were recorded as usual. On Day 10, a WBDT confirmed that all monkeys had re-established their old, OG dominance positions.

Blood samples of 0.5 ml each were obtained by allowing the monkeys in each group to enter transport cages, from which they were immediately caught, held by the hand for about one

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* As an animal has simultaneously two dominance ranks (an original or OG rank and a reformed or RG rank) throughout this study; when reference is made to rank unprefaced by one of the above notations it shall indicate reference to the subjects current rank. When referring to a combination of OG and RG ranks, the notation D/II shall denote dominant in the original group and in the number two position in the reformed group. For correlational data it should be noted that the dominant animal will be referred to as D, as 1, or as having a <u>high</u> rank.

minute during which time they were bled from the saphenous vein. Assay of blood and the results of the analysis of the cortisol data are described in Chamove & Bowman (1978) in detail.

Behavioural observations consisted of categories of the following: (a) positive behaviour, composed of social play, grooming, and clinging; (b) aggressive behaviours, including threat and approach (when accompanied by withdrawal of the other animal) which are believed to reflect low intensity aggressive behaviour, attack and pursuit which are the higher intensity behaviours; (c) fear behaviours, including fear grimace, crouch, rigidity, and submit, indicating low intensity withdrawal, and flight and scream indicating high intensity withdrawal. For each 15-sec. interval of an observation period, a single tally mark was entered in each behavioural category for which one or more instance occurred. A subject could accumulate more than one tally mark by directing the same behaviour towards more than one other monkey. The results of such a modified-frequency scoring system correlates about +.96 with true frequency of behaviour and about +.95 with true duration (see Chapter 5). In addition, distances between the subjects were estimated every 60 sec. by recording the grid positions of the subjects--each cage was divided with tape markings into a 4 x 4 x 8 grid array of cage areas. Behavioural observations for sampling times of 5 min. or more were recorded at semi-random periods between 9:00 a.m. and 3:00 p.m. and respectively totalled 24, 70, 40, 24, 24 and 28 min. for the following six experimental days: Day 0 of the OO condition, Days 1, 2, 4 and 8 of the RQ condition, and the Day 9 of ROG condition. As noted above, 60 min. of behavioral observations were also obtained during the first WBDT. For analysis all behavioural observations were converted to frequencies per 24 min., the smallest daily cumulative observation time.

Analyses of variance (ANOVAS) were used to test for group differences among the 4 x 4 factorial conditions of OG and RG dominance ranks, with behaviours, intensity, and days as correlated variables for the analysis of the behavioural observations, and both days and hours as repeated measures for the analysis of the plasma cortisol concentrations. For each of the two independent variables of plasma cortisol levels and inter-animal-distance measures, three separate ANOVAS were done, and one done on the RG condition. Also four separate ANOVAs were done, two using both the WBDT and the ROG conditions and two on the RG condition. One of each pair used the frequencies of withdrawal behaviours and aggressive behaviours and the other two used frequencies of the three positive behaviours. During the OG condition all of these behaviours were too infrequent for statistical analysis. Positive behaviours were not subdivided into the two intensity dimensions.

Partial correlation coefficients were computed using OG dominance rank (holding RG constant), RG dominance rank (holding OG constant), a.m. blood cortisol values, p.m. values, total withdrawal plus aggressive behaviour (termed agonistic behaviour), and distance. Coefficients were computed for each of the days and over all days. In addition to the original scale of dominance, I also analysed dominance rank using the actual WBDT times as an interval scale of rank. Both linear and quadratic components of rank were extracted.

Results

In summary, aggressive and withdrawal behaviours varied with differences in OG ranking on the two OG days, and with both OG and RG ranking on the RG days. In this chapter the rank interactions were the results of interest, and results not interacting with rank are not discussed. Significance was found during the four days of regroupings in the following factors: OG rank ($F=7.4$, $p<.01$), OG rank x days ($F=9.8$, $p<.001$), RG rank x behaviour ($F=14.8$, $p<.001$), OG rank x RG rank x behaviour ($F=2.8$, $p<.05$), RG rank x days x behaviour ($F=3.5$, $p<.01$), OG x RG rank x days x behaviour ($F=2.6$, $p<.01$), and OG x RG rank x behaviour x intensity ($F=5.6$, $p<.01$). The two test days when monkeys were in their original groups revealed the following: OG rank x behaviour ($F=12.8$, $p<.001$), OG rank x days x behaviour ($F=17.6$, $p<.001$), OG rank x days x intensity ($F=13.3$, $p<.001$), and finally OG rank x days x behaviour x intensity ($F=9.4$, $p<.001$).

No significance in the following important rank interactions was forthcoming--in the regrouping the OG rank x days x behaviour interaction ($F=1.2$) and in the original grouping the RG rank x days ($F=2.0$) were those approaching the five percent confidence level. The distance analysis revealed two consistencies: in the original grouping the interaction of OG rank x direction ($F=3.2$, $p<.05$) was significant and likewise for the OG rank x days ($F=5.3$, $p<.01$) during regrouping. Positive behaviour did not reveal consistent rank differences. The above summary is detailed below.

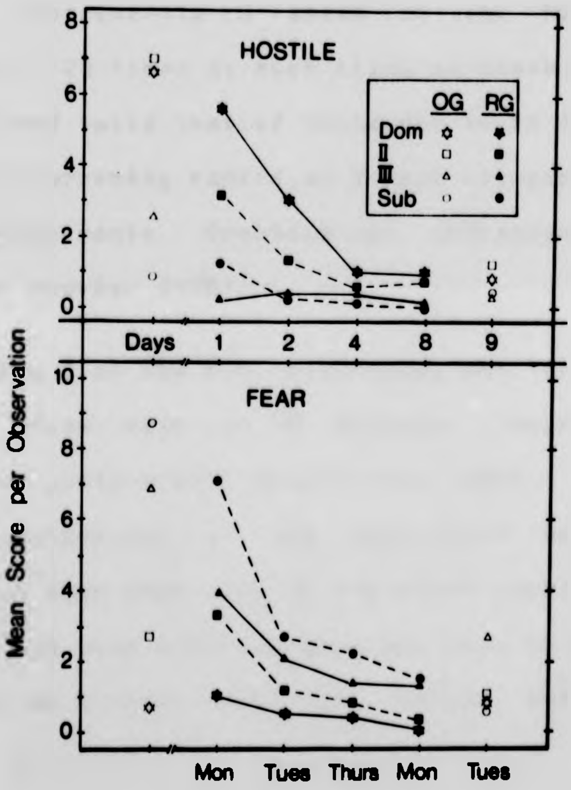

Figure 1. Behaviours as a function of current dominance rank on WBDT, the four reformed-group tests and when returned to the original group.

Original Groupings

As can be seen in Figure 1, during the Water Bottle Dominance Test a high amount of aggressive and withdrawal behaviours occurred. Here the D and II ranks were the most aggressive and showed the least withdrawal behaviour. If we look at the ranks that the animals were to attain when the groups were reformed, a different pattern emerges. Those animals subsequently S-ranked in the RG situation were exhibiting 25 times as much cling as those who were to become D or III and twice that of those due to be II. The subjects that were currently ranked as S were clinging at half the rate of the other ranks. Grooming was infrequent in all groups (see also Hawkes, 1970).

On Day 9 in the ROG, withdrawal was greatest in OG-III although also high in S animals. Aggression followed a comparable pattern with that of the WBDT. In the III's a greater proportion of the aggression was high intensity aggression than that seen in the other ranks. A high degree of cling and only a little play was seen in monkeys previously occupying an S rank, and both RG-III and S animals were grooming the most.

Over both of these days the D monkeys kept far away from the S, the III animals were far from the II and S, and the S were far from the II monkeys.

Reformed Groups

Figure 1 also illustrates the changes in the two categories of aggressive and withdrawal behaviour over the WBDT and the eight RG days, and Day 9 when returned to the OG.

Each is presented as a function of current dominance rank (p<.01). As can be seen there is a considerable concordance between the current dominance rank and aggressive behaviours. This relationship as well as the correlation with prior rank is elaborated in Table 1.

The interaction of each of the two behaviours aggression and withdrawal, with prior and current dominance ranking during the eight RG days is shown in Figure 2. It also illustrates the interaction of behavioural intensity with RG rank and the two behaviours. Similar patterns of both high and low intensity are evident over the four ranks; whereas for withdrawal behaviour there is a relatively greater proportion of low intensity withdrawal in the more subordinate monkeys.

The OG ranked D and, to a lesser extent, II are the most aggressive during the period of eight days of group reformation. On Day 1 the aggression in the three OG-D cages was more than three times that of the other groups. On Day 2 the OG-II were still more than twice aggressive as the others.

Withdrawal behaviour shows a straight line increasing function with the RG ranks over the eight days. Aggression is less linear, the S being at a level slightly greater than the III animals, although the relationship between D, II and III is quite consistent.

<u>Distance</u> changed considerably over days, being on average greatest on Day 4 and Day 1 and least on Days 2 and 8 (see Figure 3). The OG-D did not follow this pattern, but showed the greatest distance of any group and no reduction in

Linear Partial Correlation Coefficient between Aggressive plus Withdrawal Behaviours and Dominance Rank+ Holding the other Rank Constant.

Days	OG Rank	RG Rank
WBDT	-0.07	- -
1	-0.59**	-0.48**
2	-0.41**	-0.37*
4	-0.28	-0.36*
8	-0.34*	-0.20
1 - 8	-0.35*	-0.40**
9	0.08	0.28

* $p < 0.05$ and ** $p < 0.01$

\+ High dominance = 1

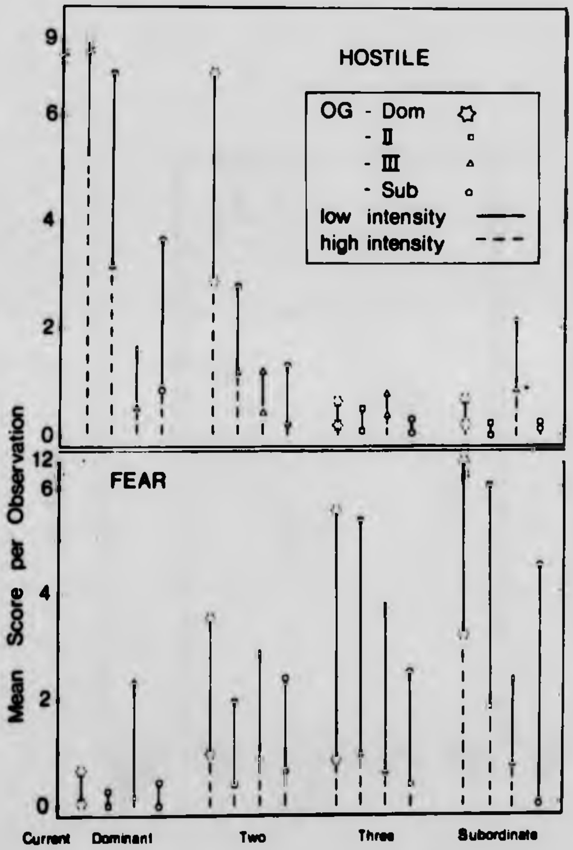

Figure 2. Cumulative frequency scores for the two intensities of aggressive and withdrawal behaviours over the four test days within the eight days of group reformation.

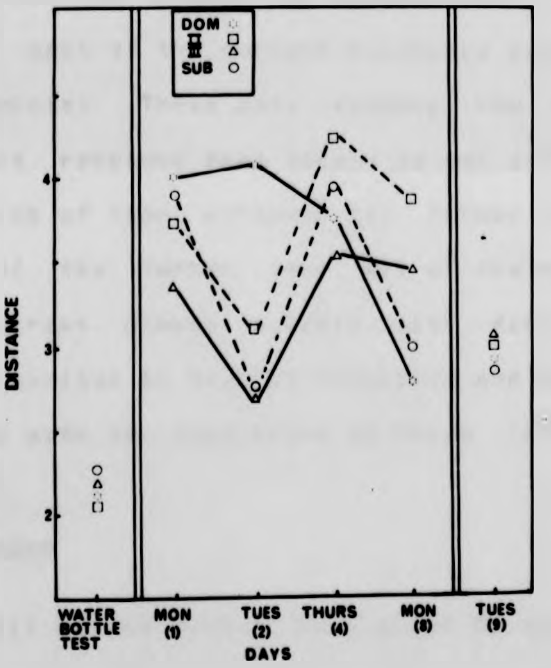

Figure 3. Distance scores on an arbitrary scale as a function of OG rank only over the WBDT, four RG days and ROG.

distance between Days 1 and 2, while exhibiting the least distance of any group on Day 8. There was a significant linear correlation between OG rank and distance of −.36 and −.48 on Days 1 and 2 respectively, which, by Day 4, was quadratic in form (r=+.35).

The change in the expression of aggressive behaviour over the whole experiment as a function of current dominance rank (solid lines, filled symbols), and prior or future rank (dashed lines, filled symbols) is plotted in Figure 4. Also illustrated is the amount of aggression directed towards animals of each of the current dominance ranks (solid lines, unfilled symbols). These data showing how much aggression some animals received from others do not differ from data on the expression of fear, although the former are on average only 66% of the latter over all of the eight days. This percentage agrees almost exactly with findings of Hawkes (1970), is similar to that of Bernstein and Mason (1963), but do not agree with the dyad tests of Maxim (1978)(see Buss & Craik, 1981).

<u>Original Groups</u>

Since all of the animals of a given OG rank were placed with others of the same rank, and since withdrawal and aggression are highly related within a cage, the lines representing the aggressiveness of the animals as a function of prior rank during the RG phase also illustrate withdrawal behaviour in these same cages, albeit at a lower level. This same figure shows how aggression declines during group stabilization, and the high level of aggression of the former dominants on Day 1 and the former II on Day 2 is illustrated.

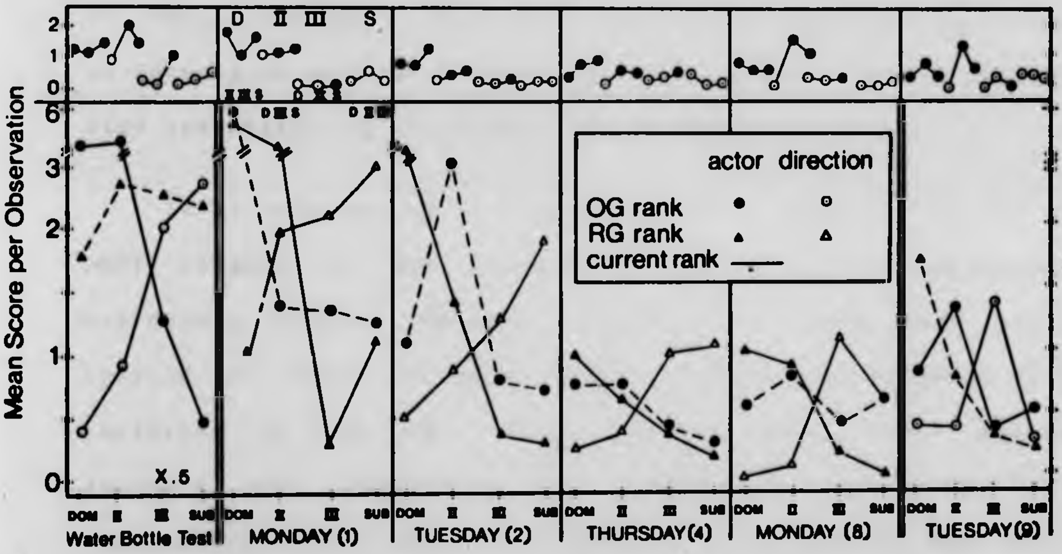

Figure 4. Aggressive behaviour as a function of OG rank and RG rank, for the actor (solid symbols) and the recipient (open symbols). The values for the WBDT are present as half those actually recorded. The top line of the figure presents the direction of aggressive behaviour apportioned to different ranks by the various ranks. In this section solid symbols denote animals subordinate to the actor, open symbols animals dominant to the actor.

The relatively large degree of aggression of both the OG-S and RG-S animals during Day 1 was surprising, particularly as the latter were less aggressive than the RG-III in their original groups.

The top panel of Figure 4 apportions the aggression by animals occupying each of the four current ranks as directed towards each of the other three animals. It can be seen that the Ds initially tend to be more aggressive towards the II and S monkeys, then shift back to the S and III, and finally back to the II monkeys. This shift back to II-directed aggression is correlated with an increase in aggression, of relatively high intensity, by II towards III on Day 8.

It is interesting the degree to which behaviour in the OG WBDT relates to the position to be held in the subsequent regrouping phase. Several consistencies were seen which centred on those animals which were to hold either D or S positions in the RG. Those animals which later became dominant were exhibiting the least aggression in the WBDT (dashed line first panel of Figure 4), they received the most high-intensity aggression but little low-intensity aggression, and they were the recipients of the least withdrawal behaviour. Those to become subordinate exhibited the most withdrawal, three times that of the others, and a disproportionately great amount of high-intensity withdrawal, twice the amount of cling, more than twice the amount of grooming; and were the recipients of the most aggressive, withdrawal, grooming, and cling behaviour.

Day 9 behaviour upon reunion was clearly affected by the prior regrouping procedure. Upon return to their original groups those animals which had so recently occupied dominant positions were the most aggressive, showing a relatively large amount of high intensity aggression, over four times that of the others, and the least withdrawal. The lower the RG rank, the greater the withdrawal. behaviour during the ROG day. The RG-subordinate monkeys were the least playful (6x), the most clinging (4x), and, together with the RG-III, showed the most grooming (3x) in comparison with the other ranks.

<u>Positive behaviour</u> was unstable. During the reformed-group phase, play gradually changed so that going down in the hierarchy there was less initiation of play and less receipt of play. This was maintained, although not so distinctively, on Day 9. Cling and its receipt which, during the WBDT, was a decreasing function of rank, was a U function on Days 1 and 8 and an inverted U function on Days 2 and 4. Cling was a linear increasing function of rank upon return to the OG, low-ranked subordinates clinging the most. Grooming, and those to whom it was directed, both maintained the U function during most of the RG and on Day 9. The Ds groomed the most during RG, and groomed in order the IIs and Ss. The RG-II groomed III primarily during RG and the OG-II groomed D and S in the ROG. The OG-III groomed S and D in that order during ROG. The S groomed D almost exclusively in the RG, which was interesting considering the high amount of aggressive behaviour directed by the D towards the S; and the S and D groomed the D and II in the ROG in that order.

<u>Blood cortisol</u>

Although results other than the correlation coefficients are reported in greater detail elsewhere (Chamove & Bowman, 1978), mention should be made here of the stress of dominance on hierarchy formation. Significant effects were forthcoming from the RG analysis of blood cortisol level: RG rank, RG rank x days, and OG rank x time of blood collection (see Figure 5). OG rank x day and OG x RG x day closely approached significance. The highly ranked OG-D were most stressed of the OG ranks. Although the two blood values correlated +0.6, this a.m./p.m. effect of rank was only significant using the morning blood values.

The blood cortisol levels during the RG period closely paralleled the results of the direction of aggressive behaviour and therefore also the level of withdrawal behaviour for the current RG ranking in agreement also with the earlier results of Chamove and Bowman (1976). When holding withdrawal behaviour constant, the partial correlation between aggressive behaviour and plasma cortisol level was low (r=0.05); when holding aggressive behaviour constant, on the other hand, the partial correlation between cortisol and withdrawal behaviour was high, 0.86.

In the stable OG group there were correlations of the quadratic component of rank with resting levels of a.m. blood and p.m. blood of -0.29 and +0.29 respectively. Blood plasma cortisol levels measured just before the Water Bottle Dominance Test showed a linear correlation with rank of -0.25 and after the test of +0.26, the latter just significant with 40 d.f. Disappointingly the magnitude of all the blood correlations is increased only an average of about 0.06 by

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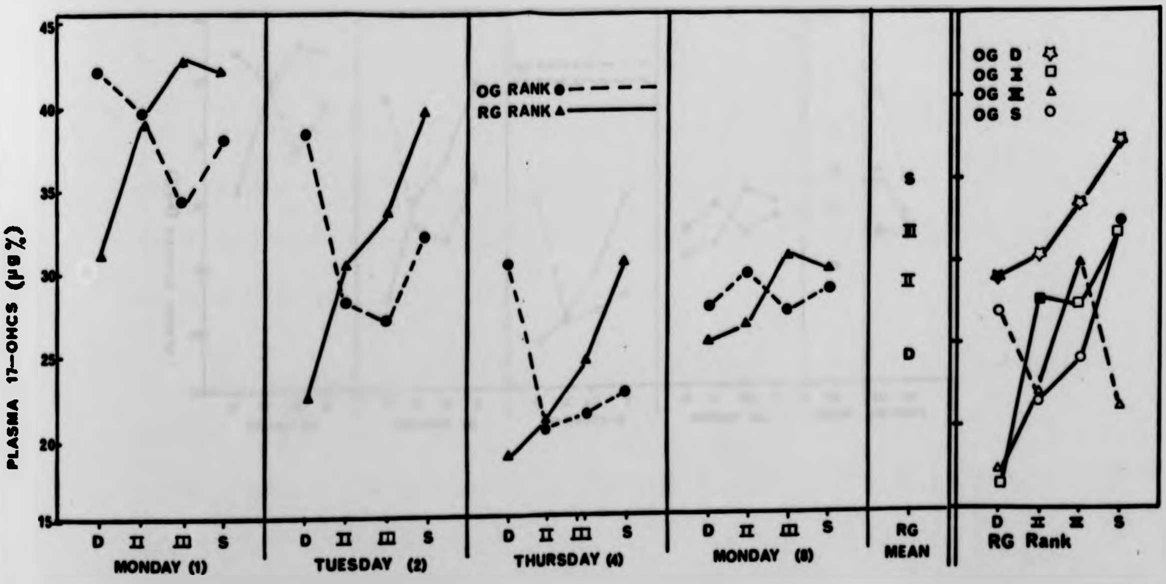

Figure 5. Plasma cortisol response as a function of OG and RG rank for the four days; and the interaction of OG and RG over the four RG days (right section). In the latter the solid symbols emphasize those subjects whose OG and RG ranks did not change.

using the actual Water Bottle times as a continuous measure of rank rather than the rank order of Water bottle times as is commonly done.

Discussion

During competition, in stable groups, and in newly formed groups composed of animals with similar histories, rank was found to be correlated with the expression and receipt of aggressive and withdrawal behaviours, when rank is defined as priority of access to a defined incentive. In general the higher the current rank the greater the amount of aggression expressed and the less aggression received, the less frequent the expression of withdrawal behaviour, the less stress measured, and the more withdrawal shown by others. The overall relationships were tempered by the age of the newly-forming group and the past history of the monkey subjects. Animals previously occupying dominant positions showed more aggressive behaviour, more positive behaviour, were spatially more distant, and were more stressed than prior subordinates.

These results confirm other findings (Bernstein & Mason, 1963; Bramblett, 1978). They also support Chase's suggestion (1974) that aggressive or dominant animals rapidly engage in aggressive interaction and show early cortisol increases indicative of stress (Table 1). Although it appears that subordinates are slower to engage in aggressive behaviour, it is perhaps more accurate to suggest that over the course of a meeting between unfamiliar animals in neutral territory, subordinates become more exclusively the objects of aggression.

These data support former results which suggest that a history of success in aggressive encounters leads to persistence and high levels of aggression in subsequent encounters, e.g., Scott (1958); van der Molen and van der Dennen (1981); Clark and Gay (1978).

Results shown in the right panel of Figure 5 suggest that any reduction in rank is accompanied by an increase in stress whereas an increase in rank is less stressful when compared to remaining in a former position. The two exceptions to this are emphasized with dotted lines.

Several suggestions of consistencies emerge if we attempt to predict the future rank of unfamiliar animals housed together, from the behaviour exhibited in a WBDT. Potential subordinates are characterized as more fearful, clinging, grooming animals. Potential dominants differ only in that they show relatively little low intensity aggression. This suggests that the former may be more emotional, the latter more calm animals.

Prior dominants were initially very aggressive upon regrouping, whereas OG-II were at their most aggressive on the second day. While current rank was being simultaneously decided, this RG rank formation appeared to proceed in a series of confrontations between pairs of animals. At the beginning the RG dominants were attacking the II and S while the RG-II were attacking primarily S, D, and II. On the second day the relationship between D and II appeared settled, and the Ds directed their aggression toward the S animal. On Day 4 the D asserted their dominance over III and S, while the fighting between D and II was reduced even more. By Day 8 the D were stably dominant over the III and S showing little assertive action at all. The II animals were now overtly aggressive towards the III and also toward the S group member. This plus aggression between D and II is suggestive of the formation of alliances between D and II (see also Leonard, 1979, 1980).

The prolonged aggression between ranks II and S and especially ranks II and III, was reminiscent of behaviour in the WBDT, naturally with different group members, and was seen also upon reuniting the original group on Day 9. As grooming, clinging and play were directed by D and II primarily toward each other, and clinging and play were directed by III and S primarily toward each other in the OG (III grooms S but S grooms D), perhaps the instability between II and those lower, resulted from the formation of multiple sub-dyads within the group of four. An examination of Day 8, with the hypothesis that some of this sub-group formation might have already occurred, reveals support for this suggestion in the play category and some support in cling and groom. The D was clinging to S, and the II while grooming the former played with the latter; II was clinging to and played with D but groomed III; III was clinging to and grooming S; and S was clinging to and groomed D and III. For the most part the interaction between ranks II and ranks III and S were aggressive, perhaps redirection as a result of the aggression directed by D to II as they formed their alliance.

On the return of animals to their original groups after the relatively brief group formation, prior dominance makes animals more aggressive and prior subordinance makes them more withdrawing, more clinging, more grooming, and less playful.

This study has shown the high degree to which current and prior dominance rank is a governing principle in social behaviour during the formation of a social group. Both affect behaviour and thereby affect the stress level of the individual.

CHAPTER TWO

Novel Objects

Hall in 1965 suggested that role is more important than hierarchical status in understanding social relationships, and some support for the usefulness of role has been found with respect to group control in capuchin and rhesus monkeys (Bernstein, 1966; Bernstein & Sharpe, 1966), although role has not been adequately defined (but see Hinde, 1974). The present chapter investigates response to novel objects which may differ in the degree to which subjects approach them using different social groups composed of hierarchically-stable macaques of similar ages. It attempts to answer the question "does the rank of an animal determine its response to novel objects, or is a role analysis a better in describing the subject's order of response?". The chapter goes on to examine the function of novel-object contact.

It will be argued that the order that animals contact slightly frightening objects reveals a social role and that this role fits the following criteria: this role (a) has the attribute of expectancy, (b) involves relationships between individuals, (c) has complex social consequences, (d) involves behaviours unique to a few individuals, (e) has a low genetic component, (f) is a specialised role limited to a small class of individuals, (g) has an important function for the group.

Method

Subjects

A total of 80 laboratory-born macaques were tested. Thirty-six were rhesus macaques (Macaca mulatta), 6 were pigtailed macaques (M. nemestrina), and the remainder were stumptailed macaques (M. arctoides). All except 12 rhesus and 4 stumptailed macaques were separated from their mothers within the first week of life and reared alone in cages for the first year of life, as described in Chapter 1. During this time, the 64 individually caged monkeys were given daily social experience with peers starting when 3 mo. old and were continuously housed with these same animals in groups of four at one year of age, thus ensuring relatively normal social development. The main group of monkeys was composed of eight quadrads of rhesus macaques and six quadrads of stumptailed macaques, aged between two and four years at the time of testing and having been housed continuously together in peer groups of four for a minimum of 12 mo. prior to testing. All rhesus groups except for two were exclusively male; these two had three males and one male respectively. All of the stumptailed groups except for one was composed of one male and three females; the remaining group was sex-balanced.

In an attempt to generalise the findings to other species and other social conditions the following supplementary groups, also mostly in quadrads, were tested: (a) a sex-balanced group composed solely of pigtailed macaques, (b) a group composed of two female pigtails and a male (dominant) and a female (no. 2) stumptailed, (c) three groups of four rhesus raised and tested with their parents in nuclear family groups, and (d) one group of four stumptailed infants reared with their mothers. The rearing and testing of the pigtailed and mixed groups were similar to those of the animals described above. The testing of the 12 rhesus however, [part of an ongoing study by M.K. Harlow (1971)], and the mother-reared stumptailed group necessitated a change in procedure. Each of these rhesus monkeys was raised in one of three four-unit playpen devices, each pen containing four families--one mother, father, and juvenile. The stumptailed monkeys were reared in a single enclosure with one adult male but were tested in individual pens with the male absent. The juvenile monkeys were able to leave or return to the enclosure containing the adult male and female at any time through a small opening in the mesh of the home unit, to enter or leave a central play area in which only, but all of, the four juveniles could interact. As most of the device was mesh, all parents and four juveniles comprising one group could see and hear one another clearly at all times. These 16 subjects averaged 12 mo. at testing, and these 3 sex-balanced groups of 4 juveniles had been housed continuously with the same neighbours and had daily social interaction with one another from birth.

Apparatus

Group testing of both the main group and of the supplementary group monkeys and individual testing of the former was conducted in their home cages. These cages were bare with no other objects or toys. In the case of all monkeys except those with mothers present during rearing and testing, this was a stainless steel wire mesh cage measuring 1.3 x .66 x .76m or one 1.25 x .75 x .75m. The testing area for those rhesus juveniles with parents was over twice as large, 1.8 x 1.2 x 2.0m (see Harlow, 1971).

The novel objects used for group testing consisted of 18 objects plus an additional 4 objects for individual testing and 3 'dangerous objects' i.e., shock-producing (see below). All of these objects had been selected from a larger pool of stimulus objects which had been rated for their inferred novelty value by placing them in the home-cages of four individually housed year-old rhesus and recording the elapsed time before physical contact was made, thereby scaling the objects. Of course, the time to contact the objects may reflect characteristics other than novelty, e.g., the attractiveness or some mix of novelty and fear (Humphrey, 1972, 1974). Nine 'slightly novel objects', touched within five min. by the four animals, and nine 'highly novel objects', touched after ten min., were thus ordered with respect to novelty. Within these two categories objects were ranked in terms of degree of novelty using the mean contact time of the animals. In order of increasing novelty the slightly novel objects used were as follows: an irregularly cut wooden block, a square cut wooden painted block, a snake shaped wooden block painted with stripes, half a brown brick, a large black stove bolt, a red wooden cube with nails partly embedded into the top surface, a white hair brush, a mesh cylinder, and a small clock (ticking). The highly novel objects used were the following: a piece of brass pipe, a black rubber wheel, a length of black rubber tubing, a pair of vice grips, a large pair of tin snips, a black scrubbing brush, a small plastic turtle, an oil can, and a toy robot.

These 18 objects were used for testing all groups and were used in the above order alternating between slight and high novelty. The lighter objects were fixed with a short length of brass chain clipped to the door of the test cage. Recording of time until first contact with the object was done with a stopwatch. Only one object was used each day.

Procedure

Dominance position was assessed prior to testing in all but the family groups by means of three water-bottle dominance tests. In this test, following 24 hr. of water deprivation, animals were given simultaneous access to one water bottle. The time spent drinking was recorded on a bank of five standard electric timers, and each animal given a rank based upon the number of seconds elapsing before it had spent 30 sec. drinking from the bottle. The monkey accumulating 30 sec. of drinking time first on two consecutive tests was termed the dominant or no. 1 animal; the next monkey to complete 30 sec. of drinking was the no. 2; and so forth. This has been shown to be a reliable measure and to correlate well with the outcome of avoid/approach interactions as detailed in Chapter 1.

In the nuclear family groups, dominance postion was ascertained by an independent experimenter who had observed and tested these monkeys daily from birth (J. Ruppenthal, personal communication). The pigtail, mixed, and family groups were tested in the group condition for a total of only eight days, using eight novel objects.

Individual testing, performed on main group, pigtail and mixed group monkeys, was carried out before main group testing. All animals in the group to be tested were removed from the cage and one was replaced for the test period. The test object of the day was then put in and left in the home-cage until contacted or until 30 min. had elapsed; no other behavioural measures were taken.

Group testing procedures were the same as those for individual testing except (a) subjects were not removed from the cage prior to testing and (b) the object of the day remained until all monkeys had touched it or until 30 min. had passed. Again only time-until-contact was recorded for each animal.

Finally, a series of four dangerous-object tests were run to ascertain whether the behaviour of the first contactor or others towards the objects influenced the subsequent behaviour of other group members. Two tests were run using two additional objects rated as highly novel, one on each of two days after all the other testing was complete. Only the main group monkeys were tested. The objects used were two abstract scrap metal forms on a wooden base, the first quite flat, the second taller. A wire connected these objects with an electrical source. The first animal touching these objects with its hand was given a brief shock originating from a cattle prod for the duration of contact. The time until contact, as before, was recorded for all animals, and the test was terminated after 50 min. if all group members had not touched the stimulus object. Order of testing for the pairs of objects was randomized for each group.

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The third and fourth dangerous object tests were undertaken to determine whether non-response in the group situation, in contrast to an avoidance response in the prior two tests, by the first contactor or others would alter the behaviour of the remaining group members. A week following the previous tests all animals were withdrawn from the home-cage and the most probable first-contactor introduced. While alone in the cage, a highly-novel object, a metal lampshade, was placed in the cage facing upwards. The animal received a mild shock whenever contacting it. This procedure was repeated on the following day, and if an animal did not contact the object within 5 min., grapes were placed into the centre of the shade to encourage a punished contact. This procedure had the effect of ensuring that the trained animal would not contact the object when retested with its group members present. One hour after this second training session the intact four-membered group was tested with the object now disconnected from the shock source.

One week later the same procedure was followed using a large metal funnel. This time one of the other animals was used. On half the remaining tests the dominant monkey was given this pretraining; on half, one of the two remaining monkeys was used (see Wechkin, 1970).

Preliminary analysis on duration-until-contact scores was performed for the main group monkeys using two repeated-measure analysis of variance. The first evaluated the individual testing, the second the group testing. The factors in these analyses were dominance rank (four levels), degree of novelty (two levels) and days (five levels).

Subsequent Fisher's Least Significant Difference (LSD) (Li, 1966) tests were used to answer more detailed questions subsequent to F values with a probability of less than .05. All tests were two-tailed.

Results

As a function of dominance

As enumerated in Table 2, for all subjects tested in groups of four, the animal most likely to touch the slightly novel object first was the dominant (No. 1) animal (probability= +.42), the animal most likely to touch it second was the second-ranked animal (p= +.31), then the No. 3 and finally the most subordinate (No. 4) group member. This class of object was contacted on average after 28 sec. This pattern of contact is as one might expect, and it parallels the type of behaviour in response to food--the dominant animal controlling the source until surfeit and then the next most dominant taking control, and so on. Analysis of response to the more highly novel objects, however, yielded a different ordering. The No. 1 monkey only rarely touched this object first (p= +.19)(also found by Menzel, 1966), and instead the No. 2 animal most often touched it first (p= +.50). The second animal to contact this object was most likely to be the dominant group member, followed by the No. 4 touching it third, and then the No. 3 monkey, touching it last. This was revealed by a significant rank x novelty interaction (F=6.99, p<.01) in the analysis of variance. Neither interacts significantly with days although there appears to be some amelioration of the highly-novel effect with repeated testing.

Table 2. Results of rhesus group-testing in probability (X 100) of contacting objects as a function of dominance rank, order of contact, and degree of novelty

Order of Contact	Slightly novel object				Highly novel object			
	Dom.	2	3	Sub.	Dom.	2	3	Sub.
First	42	29	13	17	19	50	25	6
Second	33	31	26	11	48	21	13	19
Third	14	23	40	24	14	19	28	42
Fourth	12	18	24	47	21	9	35	34

Although there was a most common pattern in the ordering of contact with the object, it was not a universal one. This most common pattern for contacting the slightly novel object was monkey No. 1, 2, 3, 4 and for the highly novel object was animal 2, 1, 4, 3.

As a function of role

From the results it appeared that there was some contradiction in the relationship between degree of novelty and the order of contacting the objects in varying dominance positions. Inspection of the data revealed that, when high-novel objects were used, the same animal contacted the objects first within any one group. This led to the possibility that it was fulfilling some role. Probabilities of contact were then estimated post hoc, i.e., in the category of interest, that subject showing the greatest amount of that behaviour was first selected and then the probability of that animal exhibiting the particular behaviour was calculated. Table 3 presents comparative data examining role and rank contact probabilities. It must be stressed that role probabilities were estimated post hoc, i.e., the subject showing the greatest degree of that behaviour in the category of interest is selected. It is clear when doing this, higher probabilities of contact are obtained using role vs. rank as a selector. In 74% of cases, the first animal to contact the objects in the group is the same animal on repeated tests. Using high-novel objects raises this value to 81%, whereas using low-novel objects it is only 69%. If low-novel objects are redefined as those objects most quickly contacted in the actual test situation instead of the *a priori* scaling

Table 3. Probability (X 100) of contacting the objects in a group test as a function of rank (dominant) or role (contactor)

Order of Contact		Novel Object Category			
		Slightly	Highly	All	All*
Dominant animal	1st	42 (30)	19 (30)	30	25
Dominant animal	2nd	33	48	40	43
1st contactor	1st	69	81	69	74
2nd contactor	2nd	56	64	56	59
3rd contactor	3rd			59	62
4th contactor	4th			66	69

Note - those probabilities in parenthesis were ascertained by recategorising the objects as determined by time to first contact, all those greater than the mean (48 seconds) being defined post hoc as highly novel and those contacted first more quickly than average being slightly novel. The asterisked category utilises data from all monkeys in addition to main group animals, using both degrees of novelty.

evaluation, the probability value of low-novel objects being contacted first by the same individual is only raised by +.06 to +.75 and lowered by +.02 to +.79 for high-novel objects.

Individual testing did not reveal any significant rank effects on time although there was a slight tendency for the two most dominant animals to touch the objects before the others (F=1.20, p>.05). The probability of this happening was only +.44. It should be noted that both analyses of variance performed showed the expected highly significant days and novelty main effects, which did not interact with each other or, in this individual analysis, with rank. Comparing socially mediated order of contact with contact in the individual test situation suggests that the social ranking is not merely a reflection of the monkeys' individual ability to perform the task.

During individual testing, one particular animal had the lowest latency to touch the object when tested alone with that object on three out of four tests in four of the groups and one animal had the lowest latency twice in another four groups. In none of the four former groups was this animal the most common first contactor in the group tests; the individual test first contactor held dominance ranks of 2, 3, 4 and 4 in their respective groups. The probability of the group's first contactor also touching the objects first in the individual test was only +.32. This lends only the slightest support to the idea of individual differences when housed alone but rather suggests that contact time and contact order is a function of the interactions of individuals rather than of characteristics of the individual. We have no evidence that it is some genetic or developmental aspect of bravery or curiosity, or at least not bravery when alone, which induces or allows the first-contactor to contact novel or fearful objects first. Rather there appears to be different processes at work in the individual and the group tests. There is some process, related to group structure or membership which singles out a monkey to instigate the handling of moderately novel objects.

It is interesting to note that in all cases except for one, the first contactor contacted the object sooner when in the group situation than when alone. Of course, the objects were different, but the level of novelty was approximately the same, as determined by the pretest measures.

In the rare circumstances when neither the normal first contactor nor the dominant animal was the first to contact the object, the latency to first contact was over 20 times as long as when touched by the normal first contactor.

Results of the first two tests using the <u>dangerous novel objects</u> were clear cut. Not surprisingly although the intitial shocked responses were within the normal duration for the highly-novel objects, the subsequent post-shock contacts were of much longer duration. The subject shocked did not recontact the object. Although, on the first day using shock, the first monkey to contact the object prior to any shock was that member who characteristically contacted most highly-novel objects in prior tests, the second animal to contact it, subsequent to the shock of course, was rarely (only once) the normal, second contactor. This second contact was not punished.

On Day 1 of the dangerous-object test 46% of the monkeys never touched the object in 50 min., and 62% of those not touching it first, i.e., not shocked, never contacted it. This compares with a normal non-contact rate of 4% over the rest of the tests. The probability of the dominant group member touching the object at all after anyone was shocked was +.42 but was only +.28 for his touching it second under that condition. The probability of the dominant animal contacting the object after anyone <u>other than himself</u> received a shock was +.60 and was +.40 for his touching it in the second position. This suggests that seeing the first-contactor shocked, considerably reduces the chances of the dominant animal contacting the object at all, but if the dominant animal contacts it at all, the chances of this animal contacting it in the second position are not markedly reduced.

On Day 2 of the dangerous object test, only 60% of group members contacted the object, surprisingly with about the same average time and order pattern to first contact. After it had been first contacted and shock had been administered no dominant animal touched it, whereas 55% of all remaining animals did. On Day 2 (only) one group had no members contacting the object at all.

In all except one of the 14 quadrads comprising the main group, there was a single individual who contacted the high-novel objects first on a minimum of 80% of tests. One might expect that in the one 'leaderless' group, objects would not be contacted as soon as in other groups which have a first contactor. Two-tailed Mann-Whitney U tests on both low and high-novel objects supported this expectation ($p<.01$).

These 13 groups were those used in the third and fourth dangerous object test. Although the time to first-contact using this dangerous object was within the range for high-novel objects on the first day in the individual training period, on the second, refresher day, the first contactor had to be encouraged (with grapes) to contact it. When group tested, 10 of the 13 (77%) groups took longer to first-contact the object (now no longer shocking) than to contact any non-dangerous-object before. On all but one of these three occasions the normal first-contactor behaved unusually and fearfully towards the object which had so recently shocked him. Some threatened it, some screamed, some ran around banging the sides of the cage.

In the three groups that contacted the object within the range of their normal contact time, two were at about one standard deviation above the overall mean for highly novel objects. In the third a fight erupted and one animal hit the object (apparently unintentionally) sending it clattering and inverting it. It was not contacted soon again. The normal first-contactor did not contact the object in any group.

In the fourth and final dangerous object test, when animals other than the first-contactor were pre-shocked with the object, these pre-shocked subjects did not contact the object and their behaviour did not influence the latency to first contact, second contact, or third contact the objects.

Discussion

It appears that in response to novel objects two aspects of the social environment interact: a more dominant animal may expropriate an object in which he is interested, but certain group members characteristically investigate objects in such a way that the fears of other group members appear to be allayed. Visual exploration does not do this, but contact and manipulation do. The response of these investigators is closely observed by the others. If the response subsequent to contact is one of fear or pain, then some of this information is retained and used by the others. Even if other animals then contact this 'dangerous object', the behaviour of some of the rest of the group is altered as a function of this first-contact reaction. There is support for the idea that the other members of the group 'expect' their champion to ascertain the nature of these strange objects. When this first-contactor does not show this behaviour (or when the group has no member who shows this behaviour) the investigation and use (e.g., for play) of novel objects is curtailed. But can we term this behavioural constellation a role?

Despite considerable use of the term "role", definitions are not easy to find. Social psychologists suggest that *roles refer to consistent patterns of expected reciprocal behaviour (and perhaps attributes) between two or more individuals: these patterns are recurrent in interactions of consequence to them in a specific context* (Sarbin, 1954). When dealing with animals, however, this definition does not enable one to decide whether a behaviour constellation can be termed a role (Sarbin & Allen, 1968), or whether labelling it as a role helps us to tackle particular problems (Hinde, 1978). Similar problems arise when trying to decide if animals exhibit culture (McGrew & Tutin, 1978).

There are several important aspects of these definitions. One is the idea of <u>expectancy</u> (Benedict, 1969; Sarbin, 1954). In animals we can but infer expectancy. We infer it if animals act as though they expect a particular behaviour in another animal, e.g., a more dominant animal to approach and take food; if animals alter their behaviour in the absence of role behaviour, e.g., milling around in the absence of a leader; or if they show surprise when their expectancies are not fulfilled.

The second important aspect to this definition is that of <u>interaction</u> (Jones, 1975). The very idea of expectancy of roles implies at least two animals and often involves interaction between the two. Nadel (1957; and Reynolds, 1972) has stated that roles materialise only in an interaction setting. But the idea of interaction does not imply that roles are seen only when individuals are interacting. Rather, sometimes interaction is inferred, e.g., the role of sentinel where it is out of sight of other group members, or that the role of the adult male is that of the focus of the troup even when such interaction is not obvious (Burton, 1972). What is observed is some relationship between individuals, one of which may not be interacting with the other. For example, animals receiving a large number of friendly approaches have distinct social roles according to Gartlan (1968). But is it the role of the infant to receive behaviour from the mother? If receipt of behaviour can be termed a role, then an individual can have a role thrust upon it. At the extreme, a role can involve no contribution from the individual at all. So can one speak of the role of a dead infant or the role of the scapegoat (Maxim, 1978)? If roles are specialised expected behaviours and dead infants are not behaving, then they do not have roles although they may have a function in the group or have an effect upon the behaviour of others. Also, the behaviour of animals may not involve choice, and roles may imply choice. Hinde (1975, p.21) states that "a peripheral male may act as a 'watchdog' because he is excluded to the periphery, not because he strives to fill that role".

In some cases high levels of interaction lead to problems in the definition of role. Is there a role of infant or only that of mother? Is there a role of scapegoat or only of bully? Is there a role of leader or only follower? When interaction between two individuals is essential for the existence of a role, the separation of role attributes between those interacting is difficult in some circumstances. When the performance of a role involves the exclusive interaction between two individuals, such as the role of the male and female of a consort pair or mother and infant, the problem becomes even more difficult.

Another important aspect is that of roles being patterns of behaviour. In the statement "the major role of the alpha monkey is repression of intra-group aggression", the implication is that repression involves some patterns of behaviours. If we substitute the word "behaviour" for that of "role" in that statement, we see how the functional connotation of role implies more than some simple behaviour, and we also see how the term "role" implies patterns of behaviour to some degree unique to the subject that is performing the role.

I would support the idea that roles must involve patterns of behaviour, that "it is not a category at the data level with absolute properties..." (Hinde, 1978, p.33). It is difficult to conceive of a role at the data level, and the usefulness of "role" is when that item or pattern has complex social consequences. Role involves interpretation of the simplest behaviour.

If we again substitute the word behaviour for role in the following sentence, we can see how role has at times been unjustifiably used to imply more than simply behaviour: "the major role of the mother is to feed and protect her infant". "Used in this way 'role' is equivalent to behaviour and thus a redundant concept..." (Hinde, 1978, p.34). This example shows how the degree of exclusiveness of a role is important. In these examples we can also see how as the time an individual is involved in behaviours associated with its role increases the less valuable the concept of role is in that context. The role of the group member is of less interest than that of a mother, and a mother less than that of a control animal or group leader.

Another measure of exclusiveness is the degree to which roles are unique and this is reflected in the interest people have in different roles. For as the number of individuals exhibiting a behaviour decreases (e.g., eating behaviour, infant behaviour, maternal behaviour, group leaders), the greater the interest in the behaviour/role and the more likely it is to be called a role.

Wilson (1975), among others, suggests that the specialization of group members is a hallmark of advance in the evolution of social behaviour. Co-ordinated specialists are more efficient than an equal number of generalists. It seems reasonable that one of the effects of roles is to make groups efficient; if everyone exhibits the behaviour then it is not a role. We do not speak of roles that are as general as that of the eater or the breather, but some speak of the role of the copulator and the social interactor (Benedict, 1969; Burton, 1977, p.6).

Another dimension which influences interest in certain behaviours or roles is that of the degree of genetic control. In primate behaviour, investigators seem more interested in roles which appear to be under only indirect physiological control (e.g., group leader, control animal, aunt, arbitrator) as opposed to the more essential but more directly physiological role such as the role of the mother, infant, juvenile female, and so on. And some go so far as to say that fulfilment of basic roles is not biologically determined (Burton, 1977).

Nadel (1957) stresses two attributes of roles: (1) role behaviour and (2) role name. If a particular animal leaves the troup for a few minutes and then returns, we can describe this behaviour. If we can also describe the functional significance of the behaviour, say, initiating movement or some vigilance function, then we may term this behaviour part of a role (see also Bernstein, 1974). This does not mean, however, that the function of a group of behaviours and the role name by which we describe these behaviours are interchangeable, although the words "role" and "function" often seem to be used to mean the same thing. Sarbin (1954) feels that role theory is compatible with an interactional or functionalistic framework of social behaviour.

Also, there is the minor problem of the time scale of roles. If one of the roles (or functions) of the infant is to promote group cohesion, as the infant grows this ability gradually decreases. Does the role gradually decrease also, or does the role change its nature?

Crook (1971, p.247) defines roles "in terms of the relative frequencies... with which individuals perform certain behavioural sequences. When the behaviour set of an individual or class of individuals is distinct, the animal is said to show a 'role'"; so too does Reynolds (1970). Such a definition can enable one to detect roles by either beginning with a certain class or subgroup of individuals on the basis of some interaction of physiological traits, e.g., age, sex, or parity, and describing their behaviours which are to some degree statistically unique to them; or starting with their behaviours and seeing if they are distributed non-randomly, as are most social behaviours.

The first strategy leads to a myriad of roles as the selection of the class can vary from the general to the specific. Using varying levels of classes, writers discuss the role of the monkey (Benedict, 1969, p.206), the role of the mating monkey (Benedict, 1969), of the adult, of the peripheral male, of the dominant animals, the adult male, the male infant caretaker (Bernstein, 1974), the father, the uncle, and the control animal, the alpha male, or beta male. Certainly the more narrow the class the more valuable the concept of role (Rowell, 1972, p.168).

The less common strategy, looking at the distribution of behaviours (Gartlan, 1968), leads to the assignment of most behaviours to different classes of individuals, each with different probabilities (Reynolds, 1972). Whether the classes are based on age/sex categories or on more individual labels seems not to influence the effectiveness of role analysis. When roles are more individual, more specialised, however, the chance that certain groups will not have a member playing a specific role will increase. Presumably there are roles which may or may not be used in a group. After the death of the sentinel, it is possible that no animal would take up the role and that animals would not alter their behaviour in the absence of a sentinel. If group B does not have a member using the .control role, how does control work in group B and is the control role an important innovation? (Hinde, 1971, 1978 discusses other problems of roles) The role of the consumer in human society or sentinel in some ungulates is an extreme example: many individuals occupy the role; if one individual does not fulfill its role, this lack does not necessarily lead to changes in the behaviour of others. Its presence does not lead to greater efficiency; its absence doesn't lead to an appreciable increase in inefficiency. In many ways the role of the solitary male is similar (Sarbin, 1954).

The two strategies used to detect the existence of role have another effect, an effect on the importance of the behaviours making up the role. The role of mother, alpha male, or core female is composed of an association of behaviours, any one of which may be missing, especially if that missing behaviour is supplied by another animal.

Another problem of both these strategies is that of the definition of age/sex classes. The problem goes beyond that of the lack of agreement as to the boundaries of classes and as to which classes are important ones. If one begins by looking at classes or by assigning behaviours to classes, this precludes the possibility of assigning roles which are operated by individuals from more than one class. For example, if both adult males and females act as group leaders, defining roles as exclusively occupied by either males or females will cause one to omit "leader" as a role. It also means that individual specialised behaviour within a class is not recognised as a role.

One way to escape from the difficulties posed by the two strategies to define roles is to use factor analytic techniques on interaction data (Fedigan, 1976; Chamove, 1974; Chamove, Eysenck & Harlow, 1972). This avoids answering the questions; (1) Does every behaviour at every second function as part of a role? (2) Does every animal have one or more roles? The advantage of this approach is that it gives adequate descriptions of roles without getting into endless subdivision of classes into individual descriptions of behaviour. The disadvantage is the need to use many groups and that factor analysis is designed to detect clumps of behaviours and not single behaviour patterns such as "control role".

How do the results of this experiment fit with a role analysis? Although it appears that dominant monkeys are less liable to be the first to contact feared novel objects than more subordinate ones, the difference in order of response to novel objects is more predictably due to the role of one group member as 'first-contactor'. Once first contact has been made, the dominant animal may then expropriate the object for itself or its own use. We may hypothesise that this hesitancy gives the dominant monkey the opportunity safely to test this new object--if it induces fear or avoidance in the initial contactor, the dominant has the opportunity to so observe. It may then act on this information. The results of the three punitive-object tests indicate that the dominant animal might engage in such a chain of behaviour.

Finally, I argue that the role of the first contactor fulfills the seven criteria I have set. (a) The animals expect an individual to contact a novel object. (b) If it does there are consequences based on its response, namely further contact by others if it is safe and no further contact if it is dangerous. (c) If it does not there are also consequences, namely delay in contacting the object. (d) The role involves relationships between individuals. (e) The role appears to be fulfilled by only one individual, (f) and it is specialised in the sense that some rare groups do not have an individual who fills the role. (g) And there appear to be no obvious correlates with the behaviour of individuals when isolated from the group.

The role of first contactor has obvious benefit to the group and to the dominant group member, but what benefit does it bring to the first contactor? Perhaps, at some risk to the first contactor, it allows preferential access to potentially desirable resources. If so, then one might predict that the first contactor would not be the dominant who already has the option of access to the resource or a close friend of the dominant nor be either an enemy of the dominant or very subordinate where its contact of objects might evoke retaliation by the dominant after its first contact had been made.

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CHAPTER THREE

Therapy

The behaviour of animals reared under varying degrees of isolation is often quite bizarre. The permanence and extent of these patterns has been shown to depend upon the particular behaviour measured, the duration of isolation, the age at which isolation is begun, and the phyletic level of the subjects (Bronfenbrenner, 1966). He reports that total social isolation of insects or fish from birth to maturity produces no detectable irreversible social deficit. However in birds, rodents, dogs, and primates, social isolation has been shown to damage the animal permanently. Total social isolation for over three months produces longlasting but circumscribed debility in rhesus monkeys, whether started at birth, three, or six mo. Longer periods--9, 12, or 14 mo.-- when started at birth, have drastic and presumably permanent social effects. Partial social isolation, allowing monkeys to see and hear but not physically interact with others, produces less of an effect than total isolation (reviewed by Mitchell, 1970).

Work with both forms of isolates has in the main been descriptive and evaluative rather than rehabilitative, but suggestions as to possible rehabilitative procedures are evident. These experiments most commonly grouped various types of isolates with age-mates of either greater, equal, or lesser social experience. A study by Rowland (reported by

Mitchell, 1970) tested monkeys daily in a playroom subsequent to removal from isolation. He tested four control animals, which were 1-year partial isolates, with four 1-year total isolates in groups of four. He also tested four additional 1-year isolates with four 6-mo. 'late total isolates (6-12 mo. of age). It is important to note, as Rowland neglected to do, that his two 'control' groups, the eight 1-year partial isolates, showed behaviour patterns divergent from one another as a function of the behaviour of their total isolate partners. The extreme aggressiveness of the 6-mo. late total isolates can account for the high-level, negatively-accelerating function of disturbance and mirrored low-level of social approach in the 1-year partial isolate controls. Similarly reared 1-year partial isolate controls tested with the fearful, disturbed, unassertive 1-year total isolates showed low and negatively decelerating disturbance scores from the very beginning of testing and high positively accelerating social approach scores, as well as a great deal of aggression. Because of the high level of aggression, testing was terminated at 10 and 12 weeks respectively.

A subsequent study by Pratt (also reported in, Mitchell, 1970) briefly tested 9-mo. total isolates with sophisticated age-mates and/or 9-mo. partial isolates both in triads and quadrads, observing each subject's responses differentially to the type of partner. He found social fear higher, but nonsocial disturbance lower, when either type of isolate was paired with the social sophisticates. Levels of nonsocial play, social threat, and social explore were not a function of partner type.

A final type of evaluative study is typified by Mitchell (1970) who briefly paired monkeys of varying rearing histories with socially sophisticated adults, age-mates, or younger juvenile stimulus monkeys. When comparing 1-year total isolates to animals reared with maternal and peer interaction, he reports that play and hostility were primarily directed toward the younger juvenile stimulus monkeys by the isolates but directed toward age-mates by the mother-peer group. The absolute levels of these behaviours further differentiated these two groups.

Chamove (1973b) tested six 11-mo. partial isolates with an infant, younger juvenile, or adult in a similar situation to that described above. Aggression increased with the age of the stimulus animal.

Therapy of isolated monkeys has been reported by four experimenters. The first was Harlow (1962) who placed a sex-balanced group of 18 monkeys, 3- to 4-year old partial isolates, on a monkey island for 2 mo He reported some positive behaviours after an initial period of "misunderstanding", social grooming and pair bonds developed but there was no sign of normal sexual behaviour even after the introduction of their "most experienced, most patient, and most kindly breeding male".

Arling (1972) found no improvement in the behaviour of inadequate isolation-reared motherless-mothers toward their second infant above that which could be accounted for by age in these now more-experienced mothers.

In an attempt to treat one of the symptoms of the total isolate--the reluctance to physically contact other monkeys--isolates were successfully trained to avoid shock by sitting on a small platform in contact with another monkey in a shuttle-box. But subsequent play-room testing did not reveal any stable improvement in the isolates' contact scores (Sackett, 1968a).

Another study was theraputic in design. Four 6-mo. total isolates were first paired and then grouped with socially sophisticated monkeys 3 mo. their junior. The authors report almost total recovery within 9 mo. (Harlow & Suomi, 1971) in that the isolates did not differ from the therapists, the only control group used.

Novak observed the development of 12-mo. total isolates put with 2-mo. old infants and noted improvement in the isolates' behaviour. No controls were used (Novak & Harlow, 1975).

One purpose of this present study was to pair monkeys suffering from a moderate level of social deficiency with one of two types of rehabilitative agents. The first type was the 3 mo. infant, at an age when social play is beginning its rapidly accelerating development in terms of both frequency and complexity but too young to challenge the dominance of the older and larger isolate monkey. The second type was the socially sophisticated age-mate, of an age when play is complex and frequently exhibited and having sufficient experience to cope with any aggressive behaviour in the isolate subject. It was expected that with the infant, both the therapist and partial isolate patient could develop together; whereas with the socially sophisticated therapist the patient would be rewarded when affiliative but punished when agonistic. A third group, partial isolates paired with partial isolates served as a comparison group. The effects of being a therapist were also assessed by using a complete factorial design. Infants reared with juvenile isolates would be compared with infants reared with nonaggressive infants and relatively nonaggressive sophisticated juveniles. The behaviour of sophisticated juvenile monkeys would be compared after months of experience with infants, juvenile isolates, or peers. In addition, rather than evaluating the results by comparing the groups on some global measure of adequacy, groups would be assessed as a function of changes in the individual behaviours.

Method

Subjects

Twelve 9-mo. old rhesus monkeys formed the Patient group. They were separated from their mother at birth and reared in bare wire cages as described in detail by Blomquist and Harlow (1961). During the first 9 mo. of life, these monkeys had visual and auditory but no tactual contact with other animals. After 9 mo. of partial isolation rearing in a colony room each of these 'patient' subjects was assigned to one of three 'therapy' conditions: (a) Four of the previously isolated subjects were paired daily with the 3-mo. old infant 'therapists' and these were termed the Patient-developmental subgroup; (b) four of the partially isolated animals were paired daily with socially sophisticated age-mate therapists and were designated the Patient-sophisticate subgroup; and (c) the four remaining monkey isolate patients were paired with socially naive age-mate therapists, i.e., other patients, and these were termed the Patient-patient subgroup.

The therapist monkeys mentioned above were animals of three types: (a) four were 9-mo. old socially sophisticated monkeys which had been housed in changing pairs from 1 mo. of age (see Chamove, 1973b), (b) four were 3-mo. old infants which had as yet no social experience (called developmental), and (c) four were 9-mo. old socially naive patient monkeys, which were also used as experimental subjects. All were separated from their mothers at birth and reared in bare wire cages until the start of their experimental treatment. To assess changes in the therapists as well as the patients, a factorial design was used pairing independent subgroups of each of the three types of monkey groups with one of each of the other types. This meant that not only were four patients put with infants (Patient-developmental), four with patients (Patient- patient), and four with sophisticates (Patient-sophisticates); but also four infants were put with infants (Developmental-developmental), four with patients (Developmental-patient), and four with sophisticates; and similarly for the 12 comprising the sophisticate group.

Table 4 gives the design for the three patient subgroups. The designs for the infant and sophisticate groups are identical so that from each of the three groups of 12 animals, four subjects were paired with developmental infants, another four with patient, and the final four with sophisticated 9-mo. old monkey therapists, a 3 x 3 design with four subjects

THERAPY & TESTING PROCEDURE FOR THE PATIENT GROUP

		Monkeys of other treatment conditions with which playroom tested	
Patient subgroups (1) (2)	N (3)	During first 10 test sessions (4)	During final 10 test sessions (5) (6)
Patient-sophisticate.......	2	Sophisticate	Patient-developmental
Patient-sophisticate.......	2	Sophisticate	Patient-patient
Patient-developmental......	2	Developmental	Patient-sophisticate
Patient-developmental......	2	Developmental	Patient-patient
Patient-patient............	2	Patient	Patient-sophisticate
Patient-patient............	2	Patient	Patient-developmental

Table 4. Columns 1 and 2 denote the subgroup name; column 1 is the rearing condition; column 2 is the therapy condition; column 4 is the type of animal with which the patient was grouped for the first 10 playroom test sessions; columns 5 and 6 describe the type of animal with which the patient was tested for the second 10 test sessions. The format for the other two groups, i.e., Sophisticate or Developmental rearing condition, is the same when the capitalized words 'Sophisticate' or 'Developmental' replace the word 'Patient' throughout.

per cell and utilizing a total of 36 rhesus macaques. Sex was randomized in that animals were assigned to groups as they were born with no regard as to sex except that many of the males were removed for use in other biochemical studies. As a result there were only two males in the Patient group and three in both the Developmental and Sophisticated groups.

Apparatus

Beginning at 9 mo. of age, monkeys were reared and given therapy for 20 weeks in their home cages located in a colony room. It was hoped that this small cage size and familiarity would prevent the avoidance response commonly seen in a larger playroom (Baum, 1970). These cages were wiremesh measuring .46 x .61 x .61m. Monkeys were social tested in Playroom II (shown in Figure 6 and described in detail by Sackett, 1968a). This irregular hexagonal room was 2.2m in length and had a floor area 7.7m^2. An enclosed plywood shelf and four mesh platforms added 2.3 and 2.6m respectively to the level area of the room. The plywood walls were painted dull yellow, the shelf red, and the concrete floor grey. The experimenter sat outside the test chamber and observed the subjects through a two-way window. Test sessions were divided into 5-min 3periods by the signal of a synchronous-motor-microswitch apparatus.

Recording of behaviours and their duration was performed by the simultaneous use of a one-pen event recorder and a check sheet. The experimenter observed each subject for three periods of five minutes, continously recording the behaviour of that subject within each 5-min. 3period, so that duration values for the behaviours were obtained. The apparatus for

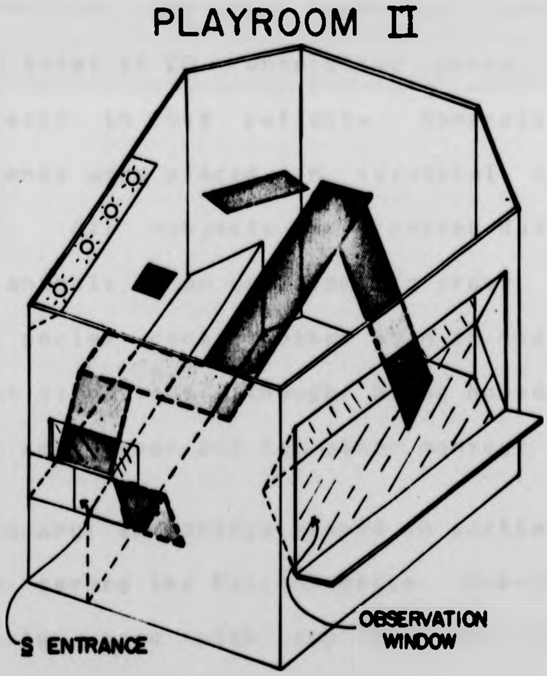


Figure 6. Playroom II used for social testing.

recording is described in more detail in Chapter 5. The behaviours recorded were as follows: socially directed withdrawal, explore, play, and hostility, and the same behaviours nonsocially directed. Whether monkeys were in physical contact with each other was also recorded. Detailed definitions and rationale for choice of behaviour categories is given in Chapter 5 and in Chamove, Eysenck and Harlow (1972) respectively.

Procedure.

Therapy. Beginning at 9-mo. of age, animals were given therapy for four continuous hours daily between 10 a.m. and 2 p.m. for a total of 20 consecutive weeks. Therapists were either placed in the patients' homecage, or, on alternate days, patients were placed in identical cages housing the therapists. All subjects were paired daily with one of the two other animals in an unsystematic order. Animals received no other social contact other than in the daily therapy and weekly test situations although, being housed in the colony room, they could hear and see other monkeys.

In summary, 12 monkeys reared in partial isolation for 9 mo. were termed the Patient group. One-third of these were paired daily, each with one of two infants, and were designated the Patient-developmental subgroup; one third, paired only with sophisticates, were called the Patient-sophisticate subgroup; and in the final four, each was paired with one of the four patient monkeys and called the Patient-patient subgroup. In addition, those four infants or Developmental therapists paired with patients were called the Developmental-patient subgroup; those four monkeys from the

9-mo. sophisticate rearing group that were paired with patients (i.e., given the patient treatment) were termed the Sophisticate-patient subgroup.

The experiment was designed to run for longer than 20 weeks but unfortunately it had to be terminated for reasons outside the experimenter's control, as the animals were assigned to a biochemical experiment. The isolates were part of this experiment from birth which was the reason for their isolation rearing.

Testing. Social testing, in weekly hour-long evaluation sessions conducted in the playroom, began after the first week of therapy and continued for the total period of 20 weeks. During the first ten weeks of testing, a given animal was tested once a week with its two therapists plus one other animal from its rearing condition who was also paired daily with the same two therapists. This particular combination was chosen in the belief that using familiar therapists would facilitate social interaction. However, this was not always the case. Hence, in the second ten week period all animals were tested once a week in a group of animals all from the same rearing condition. Therefore in the first half of the testing period an isolate Patient-sophisticate would be tested with one other Patient-sophisticate and two Sophisticate-patient monkeys; in the second half that same Patient-sophisticate would be tested with three other isolates, the same three other isolates throughout the ten weekly sessions (as detailed in Table 4).

A total of nine analyses of variance, three for each group, were performed on duration scores collected during playroom testing. Behaviour categories were combined into six behaviours called social explore, nonsocial explore, social play, nonsocial play, fear, and hostility. The categories were paired for analysis, the first analysis called explore having social and nonsocial direction as a correlated variable in the analysis. Combining of categories functioned to help retain alpha per experiment by reducing the number of analyses (Li, 1966). The second analysis utilized social and nonsocial play. The third analysis was called agonistic, and fear and hostility were used as the behaviours. The ten test days of each half were collapsed into three blocks: block one, was composed of the first three days, block two of the next four, and block three of the final three days of the half. The analysis of variance used on each group was therefore a 3 (subgroup) x 2 (halves) x 3 (blocks) x 2 (behaviours) analysis containing repeated measures in the halves, blocks, and behaviours dimensions. Subsequent Fisher's Least Significant Difference (LSD) tests were employed to make finer comparisons between the means that were significant beyond p=.05. All results reported are significant unless otherwise stated.

Results

Isolate

Those partial isolate patients paired with sophisticated peers showed the most normal development of social behaviour of all the isolates, and those isolates paired only with other isolates showed the least normal development. The analysis of play behaviour yielded a significant subgroup x halves x behaviour interaction, F=8.01(2,9) p<.05. A subsequent

Fisher's LSD test showed that the sophisticate-paired isolates exhibited both significantly more socially directed (LSD=2.1) and nonsocially directed (LSD=6.0) play than the other two groups in the first half of testing (see Figure 7). The significantly greater amounts of social play by the infant-paired isolates in half 1, block 1, when compared with the isolate-paired isolates, the subsequent reduction in play, and its partial recovery in half 2 is unexplained. During the second 10-weeks of testing isolate-paired isolates showed significantly less of both types of play and the Patient-sophisticate showed significantly more social play than did the other isolates. The significant drop in nonsocial play in half 1, block 2 by the Patient-developmental partial isolates seems related to the high level of agonistic behaviour seen in this group in that particular block. The Patient-patient subgroup show significantly less nonsocial play than the others by the final block of testing.

The analysis of agonistic behaviours revealed a significant subgroups x halves x blocks effect, F=4.60 (4,18)p<.01, as illustrated in Figure 8. Interpretation of this interaction was that fear behaviour was significantly greater both in block 3 of the first half of testing in the Patient-patient subgroup than in the two other subgroups (LSD=3.7) as well as throughout half 2. Hostility differences showed a developmental parallel to that of fear with the two following exceptions: hostility was significantly less in infant-paired isolates in the second half of testing. Patient-patient monkeys were significantly more hostile to other Patient-patient monkeys in the second half of testing

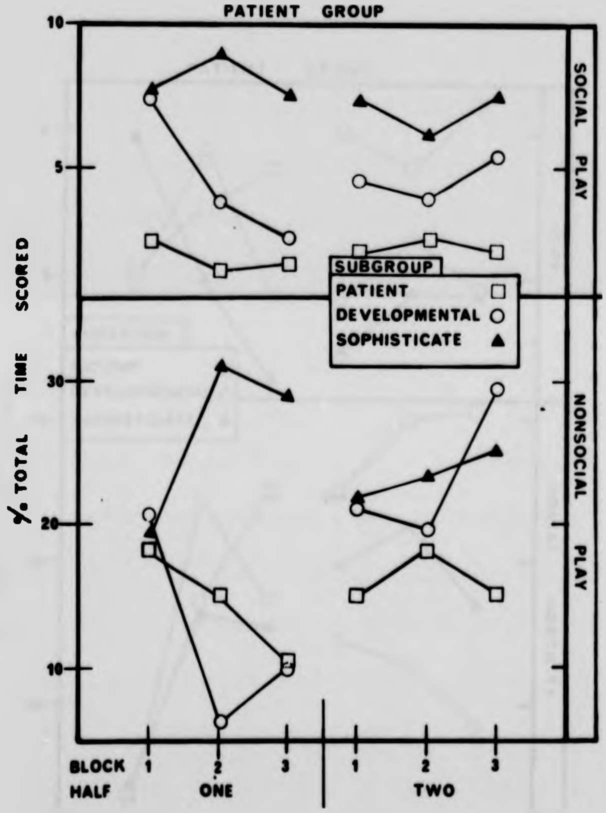


Figure 7. Play behaviour of the isolate patients socialized with either isolates, infants, or sophisticated peers. Halves are subdivided into three blocks as in the analysis.

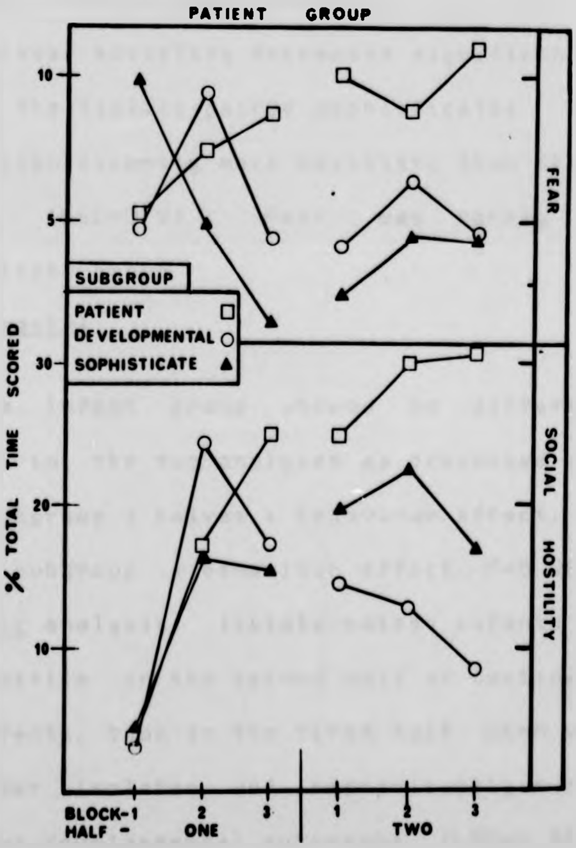


Figure 8. Agonistic behaviour of the patient monkeys in each of the three subgroups—socialized with isolates, infants, or sophisticates.

than were the other Patient subgroups (LSD=7.4).

Sophisticate

The Sophisticate monkey group showed only one significant subgroup effect. That was a subgroup x block x behaviour interaction, F=3.58(4,18)p<.05, in the agonistic analysis (depicted graphically in Figure 9). Hostility doubled in all sophisticate monkeys between the two test halves but, as this did not interact with subgroup, it is not shown. Within the test halves, hostility decreased significantly for all groups except the isolate-paired sophisticates. Also, this subgroup showed significantly more hostility than the others throughout testing (LSD=3.9). Fear was rarely exhibited in the sophisticate group.

Developmental

The infant group showed no differential effects of pairing in the two analyses as presented in Figure 9. There was a subgroup x halves x behaviour effect, F=9.19(2,9)p<.01, and a subgroup x behaviour effect, F=5.28(2,9)p<.05, in the agonistic analysis. Isolate-paired infants were significantly more hostile in the second half of testing, when tested only with infants, than in the first half, when with both infants and older isolates and significantly more hostile than the other two developmental subgroups (LSD=0.59). In the play analysis significant effects were seen in the subgroup x behaviour and in the subgroup x halves x behaviour interaction, F=5.26 and 5.89(2,9)p<.05 respectively. Social play was significantly less frequent and nonsocial play significantly more frequent in Developmental-patient subjects in half 2 than in Developmental-developmental and

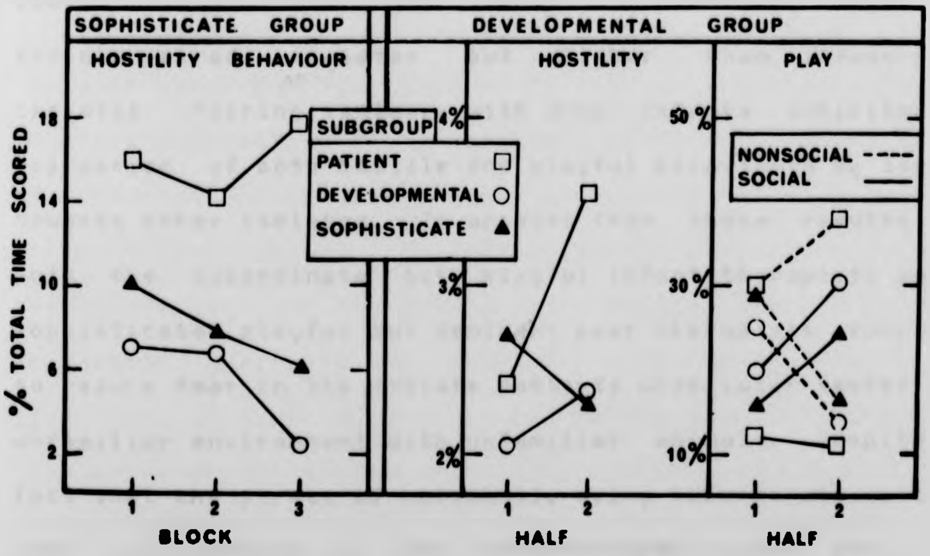


Figure 9. Significant subgroup interactions in the sophisticate and infant developmental groups.

Developmental-sophisticate infants (LSD=11.1).

No differences were detected by the <u>exploration</u> analysis in either Developmental, Sophisticate, or Patient monkeys, all groups exhibiting this behaviour roughly 25% of the time.

<u>Discussion</u>

When tested in a playroom, it was found that daily pairing of fearful or hostile 9-mo. partial isolates with other isolates was found to produce progressively increasing levels of fear and hostility and an inhibition in the development of play behaviour. Pairing partial isolates with sophisticated peers leads to the highest levels of play, the lowest levels of fear, and levels of hostility lower than isolate-paired isolates but higher than infant-paired isolates. Pairing isolates with 3-mo. infants inhibited the expression of both hostile and playful behaviours by isolates towards other isolates. It appears from these results that both the subordinate but playful infant therapists and the sophisticated playful but dominant peer therapists functioned to reduce fear in the isolate patients when later tested in an unfamiliar environment with unfamiliar animals, despite the fact that the stress of constantly being subordinate must have been considerable in the Patient-sophisticate group (see Chapter 1).

Unfortunately these results did not enable one to evaluate most of the different models of aggression production (Eron, Walder, & Lefkowitz, 1971). The Catharsis model, primarily concerned with aggression in the adult, predicts the least aggression in animals paired with infants, and this was found. The Modeling model, primarily concerned with aggression as it develops in the infant or juvenile, predicts the greatest aggression in animals paired with isolates, and this was found. The Frustration-aggression model predicts least aggression in infant-paired animals, and this was also found as described above. However, a learning or instrumental model, assuming an infant would positively reinforce aggression and a sophisticate would negatively reinforce it, predicts higher levels of aggression in animals paired with infants than in those paired with sophisticated peers. The reverse was found. This will be discussed more fully in Chapter 7.

The homecage behaviour of the isolates towards other isolates was one of increasing fear in the subordinate and increasing hostility in the dominant partner. Hostility was the predominant initial behaviour toward the infant. Despite the prolonged periods of infant vocalisation these monkey therapists were not injured by their partial isolate partners, the latter appearing to soon tire of their nonresisting companions. Other isolates, when paired with isolates, fared less well, emerging from their four hours of therapy with bruised eyebrows, tails, and digits. This agrees with reports of isolates subsequently housed in groups by Chamove (1973b) and isolates only tested in groups by Rowland described above. Isolates paired daily with sophisticated therapists were, as predicted, quite subordinate to them, withdrawing at first from even playful encounters in the close quarters of the homecages. Later however, rudimentary play patterns were seen to be developing.

In the playroom there was a significant increase in positive contact behaviours similar to that reported in chimpanzees but also an increase in total interaction unlike the chimpanzee results (Turner, Davenport & Rogers, 1969). Upon closer analysis the increase in total interaction of the partial isolate rhesus was found to be mainly a result of a large increase in noncontact behaviours. Their contact behaviour increased in parallel with that of other groups, while their noncontact behaviour increased at a more rapid rate.

Although the ever-lowering aggression of partial isolate patients paired with developmentally naive infant therapists lends some support to a cathartic explanation of aggression reduction, hostility toward socially isolated age-mates (see Rowland above and Chamove, 1973b) appears to persist undiminished over a period of weeks until the combatants are separated. The hostile partial isolates appear to engender similar hostile patterns in sophisticates and also in developing infants, hostility suppressed in the infants when with the partial isolates but emerging when the infants are later tested with peers. As the expression of fear, militates against play behaviour, it is not surprising that those Patient-sophisticate isolates, while showing lowest fear scores, also played the most. The close relationship between hostility, fear, and play can relegate hostility scores to a limiting role in their relation to social play and fear to limiting both hostility and play. But, we have also seen that varying partner type can alter these behaviours independently.

So we may conclude that forced contact leads to behaviour change, the greater change occurring in the least sophisticate monkeys. The data here suggests that the partial isolation syndrome may be due more to interference from emotionally-based responses during or soon after isolation than to the more commonly suggested absence of learning critical skills during critical periods.

CHAPTER FOUR

Contrived Dominance

Attempts to study dominance using experimental manipulation of group members have been restricted to removal, separation, and reintroduction of animals (Vessey, 1971; Nash, 1982; Saayman, 1971a; Tokuda & Jensen, 1968); changing the behaviour of an animal within the group setting, e.g., through anesthesia or electrical stimulation of the brain (Delgado, 1970); or the pairing or grouping of animals of unknown history (Tokuda & Jensen, 1969; Rose, Bernstein, & Gordon, 1975) or with a history of similar positions in dominance rank as shown above (Chapter 1). That above study grouped together dominant animals, intermediate animals, or subordinate animals, forcing these animals into new dominance positions in a factorial design. In none of the above studies, however, did the experimenter randomly assign rank to the subjects. This study proposes to do just that. A rank will be imposed upon a subject for the first year of life by placing it in groups of selected monkeys.

Method

Subjects

Thirteen male and 11 female *Macaca mulatta* were separated from their mothers at birth and reared as previously described (Kerr et al., 1969). They were housed in individual cages in a colony room although given extensive social experience as described below. They were fed milk every four hours until 300 days of age when chow feedings were begun. A soft cloth was continuously available until 21 weeks of age. These monkeys were also used as control animals in a study of physical growth and learning ability.

An additional 15 stimulus animals were used as described below. Eight of these were socially naive infants reared in similar conditions to the 24 experimental subjects; another six were 9-mo. old juveniles, 3 male and 3 female, and one was an adult male. The juveniles and adult had extensive social experience and were chosen for their placid friendly nature.

Apparatus

The infant monkeys were housed in cages measuring .68 x .38 x .49 m high from birth until 21 weeks of age, at which time they were rehoused in larger .61 x .61 x .46 m cages. The size of the cage used for social testing was .38 x 1.22 x .48 m until the monkeys were 5 mo. old, at which point the size was increased to .71 x .79 x 1.56 m.

Subsequent preference for other monkeys was evaluated in the Sackett Self-Selection Circus (described in detail in Sackett 1968a & 1970). This is essentially a hexagon within a larger hexagon; only the centre hexagon and five adjacent sections of the outer hexagon were used. Perspex restrained the animals within their section and yet allowed the subjects to see one another. When one of three subjects was in the centre section or one of two of the outer sections, it could position itself so as to see only one of the other two subjects. Opaque 1.5m T-shaped structural pieces at the juncture of the three occupied sections made it impossible for any subject to see the outer two subjects simultaneously. Three blank outer sections, one adjacent to each of the sections occupied by a monkey, served as an area of retreat and "no choice" was recorded when the subjects were in this area. Recording of relative preference for other animals was carried out using two banks of 9 clocks and counters, each bank manually activated by 9 microswitches.

The *novel objects* used were the following, in order of ascending novelty: one red and one black rubber nipple, one blue and one yellow .09 m^2 plastic cube, one brown and one black-and-white toy dog standing .12 m at the shoulder.

Procedure

The experimental subjects were raised so that they would occupy the same dominance position in several different three-membered groups until one year of age. This was achieved by manipulating the ages and prior social experience of the group members (see *Dominance manipulation*). Throughout the experimental manipulation of dominance rank, the subjects' social behaviour was recorded. After the experimental manipulation, and up until 18 mo. of age, subjects were tested for their preference for partners of different dominance histories. This was done by recording their responses to each of three stimulus animals which themselves varied in age. Before and after the experimental manipulation the subjects were tested for responses to novel objects and for their general activity level. Finally, the dominance rank of the subjects was changed and the behavioural responses to that change recorded.

<u>Novel object testing</u>. Results of Chapter 2 has shown that spontaneous dominance position affects the responses to novel objects. On Weeks 11 and 50, i.e., when the subjects were 11 and 50 weeks of age, each animal was tested on three consecutive days with one of the three novel objects, <u>alone</u> with the objects. The objects had been rated for novelty by measuring the amount of time it took 10 1-year old monkeys to contact the objects, the greater the time the more novel the rating. The objects were placed just inside the door of the subject's cage, the door closed, and testing begun immediately. Testing lasted 12 min. unless the subject did not contact the object. In that case, the subject was observed with the object for a further 8 min. but only to ascertain the time at which it first touched the object. The objects were presented in ascending order of novelty, beginnning with the nipple and ending with the dog. The behaviour categories used during this test are described below.

During Week 51 and 52 each animal underwent further <u>group</u> novel object tests. The objects were colour variants of the original objects. After 30 min. had elapsed in a social grouping, one of the three novel objects was placed into the test cage. The time to first contact the object was recorded and the animal touching the object was noted. Three tests were administered using three novel objects and a random selection of animals with the restriction that no animal was tested twice with the same animal and an attempt was made to have all animals of the same sex in any one test. These three tests were done only to evaluate time to contact, and no other behaviours were recorded.

Activity testing. If subordinates are constrained in their behaviour in groups, one might expect changes in activity when free from these constraints. When the subjects were 9 and 48 weeks of age they were briefly observed when in their homecages every hour on the hour between 7 a.m. and 11 p.m. for two consecutive 5-day weeks. Using a checksheet, a record was made when the subject appeared to be (a) asleep, (b) awake but inactive, (c) awake and moving, or (d) playing. When more than one behaviour was occurring, the most active category was recorded.

Dominance manipulation. The first four males and four females born were assigned to the dominant group (D). They were reared in individual cages until Week 12, when hour-long sessions of social experience were started. Two 1-mo. old stimulus infants were placed in the homecage of each 3-mo. old D infant. Because of the age discrepancy and the advantage of being in their own homecages, the D infants were dominant over the younger infants. This triadic social grouping was repeated at least four days per week for 40 weeks for periods between 60 and 90 min.

After 1.5 mo. had elapsed from the birth of the four D infants, the next four male and four female infants born were assigned to the intermediate-ranked group (I). Due to the spacing of births, the mean age difference between adjacent groups was 8 weeks. When the I group had reached 3 mo. of age, their social experience was begun. One I infant was placed into the homecage of a D animal, now about 8 weeks its senior, and a new 1-mo. old stimulus infant was added to form the triad.

After a period of 1.5 mo. from the birth of the last infant, the subordinate group (S) was begun. Because of a shortage of female infants, this group consisted of five males and three females. As the members of this group became 3-mo. of age, they were gradually substituted for the stimulus infants in the above groupings, forming the youngest member of the triad. Social groupings utilized the test cage as much as possible, but primarily took place in the homecage.

Because there is evidence that giving infant rhesus monkeys all of their social experience with the same peers (Chamove, 1973b), or four peers or less (Chamove, 1973a; Goldfoot, 1977; Chamove, Rosenblum, & Harlow, 1973; Kerr, Chamove, & Harlow, 1969) leads to abnormal social behaviour, an attempt was made to vary the composition of the triad groups as much as possible. All of the animals had experience with 16 other animals of both sexes, but always in groups of three and always in the same dominance position. The composition of the groups changed every day. The sex of partners was unsystematically ordered. Some of the infants, because of what appeared to be their "assertive nature", were temporarily restricted in the membership of their groupings following the slightest suggestion of incompatability.

During social grouping the infant monkeys were only observed for the first few minutes and then at intervals throughout grouping to ensure establishment of the predetermined dominance position. Dominance was assessed by noting the direction of aggressive and withdrawal behaviours. If the desired hierarchy was not immediately evident, due to illness or undetermined causes, immediate removal and regrouping of subjects took place. It was always possible to predict this abnormality by observing the physical and social posturings of the monkeys when first placed in the cage. Because social experience was begun as early as 12 weeks of age, the effects of prior isolation rearing was minimized; and because animals had only brief periods of daily social interaction, rather than being continuously housed together, there were no effects of daily separation subsequent to social interaction.

Social testing. Social testing was similar to social grouping except that it was always done in the test cage. The social behaviour of the monkeys was tested at least once a week for 45 min. per test beginning at 12 and ending at 52 weeks of age. During the social test two experimenters continuously observed the behaviour of one of the three animals, each experimenter recording behaviour from one of the three for 5-min. 3periods. The categories used are described below. Whereas the composition of the social grouping was balanced, the composition of social testing was randomized as much as possible within the constraints of compatibility. It should be noted that the manipulation meant that the relative ages of social partners would differ between the three groups; the subordinate or S groups members were always the youngest. Similar confounding influences might be expected in the wild. The data recorded from the groups were taken at staggered intervals so the subjects were all the same age.

Nevertheless, it was of interest to see how members of the three conditions would respond to similar stimulus monkeys.

<u>Stimulus testing</u>. When the animals reached 1-year of age they were paired with each of the three types of stimulus animal in an order designed to maintain their dominance rank as long as possible. The subjects of the D, I, and S groups were tested with a 1-mo. old infant, a 9-mo. old juvenile of the same sex, and an adult male; a juvenile, adult, infant; and an adult, juvenile, infant in that order respectively. It was hoped that different stimulus animals would evoke different types of behaviours and different types of aggression (Blanchard & Blanchard, 1977).

To do this the test cage was divided in half by transparent perspex, and the stimulus animal and subject animal placed on either side of the cage for a period of 3 min. The divider was removed and testing immediately begun. The subject was observed for two 7-min. periods separated by a 1-min. interval, after which it was returned to its homecage. After two days of the normal grouping procedure, the second stimulus animal test took place, and similarly for the third.

In this way the behaviour of all subjects, D, I, and S were observed when these animals were dominant with the infant stimulus animal, when subordinate with the adult male, and when with a playful, younger like-sexed juvenile.

<u>Intragroup testing</u>. After stimulus testing at Week 52, the subjects continued daily social grouping through Week 62. When the average group age was 60 weeks and again when 64

weeks, within-group testing was undertaken in order to observe behaviour when confronted with peers with the same dominance history as themselves, e.g., all D or all I. In addition, it was then possible to observe the groups as dominance position changed. Three animals from the same group, and same sex when possible, were social tested in the test cage. The procedure was the same as that used for social testing except for the behaviour categories used (see below). When three D animals were tested together, one animal remained dominant, one became intermediate, and one was subordinate in rank. The test of the final two animals necessitated reusing one of the animals from a previous intragroup test that had not retained its old dominance position.

The three resulting dominant animals were then tested together for a final test. A similar procedure was carried out in the I and S monkey groups. In this way the behaviour of formerly D monkeys could be observed when all monkeys (except for one) were now intermediate or subordinate ranked. Only data from the first test at 60 or the first at 64 weeks of age when the subject's rank was first changed was used in the analysis.

Preference testing. When the average age of all 24 subjects was 62 weeks, one subject from each original group was selected randomly so that all were of the same sex, placed in the self-selection circus, and the three were observed by the two experimenters for 15 min. They recorded the duration of time the subjects spent closest to either of the two perspex doors separating the monkeys. When an animal was equidistant from each, the direction of orientation was recorded as the measure of relative preference for the other subjects. Each animal was tested three times, with three different but randomly chosen partners.

After all of the tests were completed, a further three preference tests were begun. These were a replication of the first three, but, instead of the subjects being tested after a period of individual housing interspersed with social grouping as was done in the first three tests, the animals were housed together in triads for a week immediately prior to testing. The test animals were not the animals with which they had been housed.

Behaviour categories. The notations below in brackets indicate whether that category was used in novel object testing (No), social testing (So), stimulus animal testing (Sa), or intragroup testing (Ig); the symbols d and f set apart from the test by a stroke denote the recording of duration and/or frequency of the behaviour.

Positive contact (Sa/d)--included socially directed exploration, play, grooming, and clinging in which the subject contacted the object of its behaviour; negative contact (Sa/d)--was defined as social aggression with physical contact; contact (No/f,d)--contact of any sort with the novel object; asleep (No/f,d)--scored when a subject appeared to be asleep; thumb suck (No/f,d)--sucking of any digit; immobility (No/f,d. Sa/d)--a withdrawal of the subject from an inanimate object or from no specific object into an immobile position; appropriate withdrawal (Sa/d)--an attempt to flee from or stop the aggression of another animal by the display of submissive behaviour; inappropriate withdrawal (Sa/d)--fleeing or otherwise submitting to animals who are exhibiting withdrawal, explore, or play behaviour; social withdrawal (Ig/d)--a combination of the above two behaviours; social explore (No/f,d. Sa/d)--tentative or visual exploration of other animals; social play (Ig/d. No/f,d. So/d. Sa/d)--interactive play with another animal; social aggression (Ig/d. No/f,d. So/d. Sa/d)--behaviours in which the subject tries to dominate or attack another animal; nonsocial play (Sa/d)--play not directed toward any other animal and including both object play and solitary play; cling (So/d. Sa/d)--social cling behaviour; vocalization (No/f)--cooing and screaming. Those social behaviours, when used in novel object testing, were used to record behaviour directed toward the test object. In the intragroup test and the social test, the direction of the behaviour was also recorded.

Analysis. The unequal ns analyses of variance test was utilized to evaluate mean differences. Whenever possible, behaviours were evaluated in one analysis as a correlated variable so as to maintain alpha per experiment (Li, 1966). The data used in analyses was, whenever possible, that collected when all animals were the same age.

Factor analysis. During the stimulus animal testing, an experienced tester was present who was not familiar with the animals. As part of another experiment designed to assess the reliability of various measurement techniques, he rated each animal on a 7-point scale after each test using the following six scales: (a) Sociability was rated as a measure of how much the subject was judged to like other animals as opposed to disliking other animals; (b) Extraversion was an estimate of how socially interactive the animal was judged to be as opposed to withdrawn; (c) Assertiveness was a rating of the subject's assertiveness in response to the assertiveness of others; (d) Social emotional was a rating of how socially reactive the subject appeared to be; (e) Nonsocial emotional was a rating of the subject's emotionality towards the nonsocial environment; (f) Stability was a rating of how variable the behaviour of the subject appeared to be.

The factor analyses followed the method used in Chapter 5 below and described by Chamove, Eysenck, and Harlow (1972), and involved subjecting the data to a principal components analysis rotated to oblique simple structure. The rating data were included in the factor analysis because this type of datum has not been reported before in factor analyses of animal social behaviour together with other types of data.

Results

Homecage activity

Before the experimental treatment it was reassuring to see that there were no differences between the three groups in homecage activity. When approaching 1-year old, however, the D were the most active but least playful and the I were the least active but most playful in the homecage. A significant group x age x behaviour effect ($F=6.12$, $p<.01$) attests to the stability of homecage activity. No other group effects or group interactions were significant.

Novel object test

There were no group differences in behaviour in responses to the three novel objects when tested before being given any social experience. After 38 weeks of social testing, only two of the five behavioural analyses revealed significant group differences. There was a group x sex x age interaction (F=4.16, p<.05) for the behaviour category of disturbance indicating that, when almost 1-year of age, the S females were less disturbed by the objects than any of the other five subgroups. There was a significant reduction in disturbance behaviours, i.e., sleep, thumb suck, and withdrawal, with increasing age in all subgroups except for the D females who showed no such reduction, the greatest improvement being in the S females. There was a nonsignificant tendency for the males at 11-weeks of age to be the most disturbed.

The time to contact analysis also showed stable group differences (group x sex x housing x age, F=5.61, p<.05). Prior to social experience there was no group difference in the time elapsing until the infants contacted the objects; after 9 mo. of social experience the S female monkeys, followed by the D male group, were the first to contact the objects when tested singly. The slowest to contact the objects were the S males followed by the D females. But when grouped for testing the D monkeys were the first to touch the objects and the S the last to show physical contact.

Some results which only approached significance support the general conclusions and are mentioned here. The analysis of object-directed aggressive behaviour in the presence of novel objects showed a tendency for aggression to increase with age in the females, while decreasing in males. In contrast, self-aggression increased with age in I and S males. There was a tendency for S animals to vocalize the least at 9-mo. of age and for D animals to vocalize the most. Positive behaviour at 9-mo. of age was least in males and most in females overall, but least of all in D females.

Preference

The D and I monkeys were seen to prefer to remain nearer to others with a relatively high (nearer one) as opposed to low dominance rank (see Table 4), whereas S animals showed no such preference (group x direction, $F=18.85$, $p<.001$). A significant interaction of housing condition with measures, which did not, however, interact with groups, suggested that after the normal individual housing the overall frequency of preference response of the animals was greater than after the newly-introduced group housing while the duration of response showed the opposite effect. The preference of animals for specific ranks is not predicted by other studies which have shown that animals prefer categories of stimuli with which they were reared (Salzen & Cornell, 1968; Candland & Milne, 1966; Pratt & Sackett, 1967; Chamove, 1979; Chamove & Harlow, 1975). One exception to this prediction and a caution as to my interpretation is the work of Strayer et al (1975). They compared preferences in a free social situation with those in an unfamiliar choice test using squirrel monkeys. In the latter the subjects did not choose their normally-preferred partner, but seemed to prefer higher ranking partners. Strayer interprets this as suggesting that subjects prefer the protection of higher ranking group members in a dangerous situation.

Table 4.
Preference Test Results Subsequent to Individual and Group Housing

		Housing					
		Alone			Group		
		Direction					
		Dom	I	Sub	Dom	I	Sub
Duration (seconds)	Dominant		320	194		700	176
	Intermediate	442		243	476		421
	Subordinate	319	224		368	488	
Frequency	Dominant		37.0	33.8		17.8	17.5
	Intermediate	41.2		38.0	20.5		18.7
	Subordinate	48.9	45.1		21.5	22.4	

Note: Maximum duration score = 900

Social testing

Analysis of social behaviour revealed two basic trends. The two sexes showed behavioural differences, and the three groups showed differences, but the two did not interact to a significant extent until the highest level of interaction (as can be seen in Figure 10) over all major social behaviour categories--play, cling, withdrawal, and aggression. . The D animals showed the lowest scores, interacting the least with other animals (main group effect; F=5.20, p<.05). This effect was more marked for males. The main effect of sex (F=4.25, p<.05) showed males interacting less than females over all behaviours. The sex x behaviour x direction effect (F=4.15, p<.01) indicated that females played less with the dominant group members than did males. Males played primarily with the dominant peer whereas females played with the intermediate and dominant peer in that order and played with both of these less than did the males. In the aggression behaviour category, females directed over twice as much aggression as did males towards the intermediate and subordinate ranked peers. The females clung primarily to the subordinate peer and clung twice as much to these animals as did males who clung less overall and the least towards subordinate peers.

Many of the group interactions were significant (group x behaviour, F=77.9, p<.001; group x behaviour x direction, F=40.12, p<.001; group x behaviour x age, F=6.62, p<.01; group x behaviour x direction x age, F=3.82, p<.001; and highest level of interaction--group x sex x behaviour x direction x age, F=3.10, p<.01). In general the D showed the

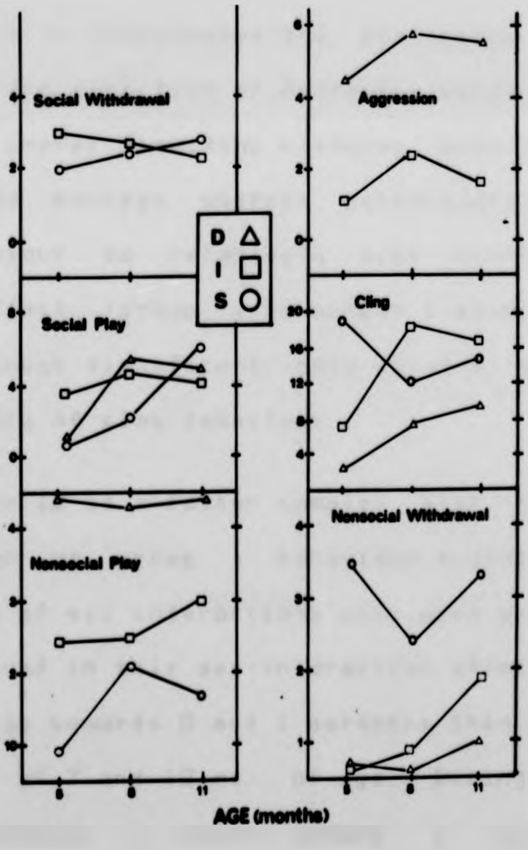


Figure 10. Group differences in behaviors over the 9 months of social testing ($p < .01$).

most play and aggression and the least cling and withdrawal; the S showed marginally the most withdrawal; the rest appeared not to differ. The first three figures of this chapter show these interactions in more detail. Figure 10 shows the change in behaviour over the three 3-mo. blocks. Aggression, naturally never seen in the S, is considerably more frequent in the D as is solitary environmentally-directed play while social withdrawal and cling behaviour is lowest in this group. The I show the most cling and the S the most socially-directed withdrawal behaviour.

Figure 11 illustrates the preferences that the groups show for the direction of different behaviours. All subjects appear to prefer directing clinging behaviour to relatively subordinate monkeys whereas particularly the males, direct play behaviour to relatively high ranking monkeys. This latter effect (group x behaviour x direction x sex, F=2.51, p<.05), though significant, only shows a sex interaction in the category of play behaviour.

Figure 12 is a rather complex plot of the significant interaction of group x behaviour x direction x age with an indication of sex interactions only when present. In general it was found in this sex-interaction effect that males showed greater play towards D and I partners than did females between the ages of 7 and 12 mo. of age. During the first 3 mo. of social testing, I males showed a greater nonspecific withdrawal than did I females, and D males were less aggressive towards I and S peers than were D females. The sex interaction within cling behaviour is more complex, but is shown at the top of Figure 12.

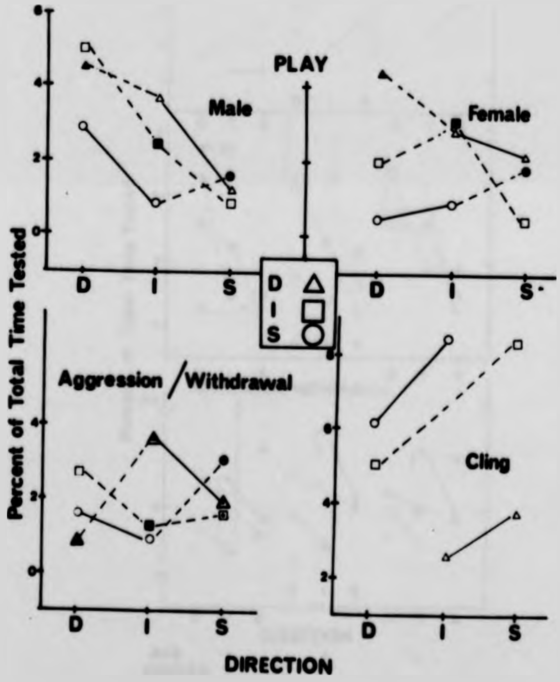


Figure 11. Group differences in the direction of behaviors ($p < .001$). The solid symbols indicate the amount of nonsocially-directed behavior. Aggressive behavior towards subordinates is indicated by symbols with a dot in their center; the other symbols indicate withdrawal behavior towards animals of more dominant rank.

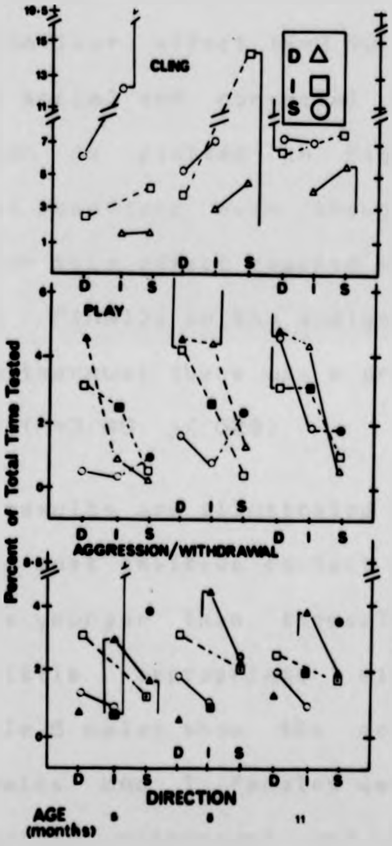


Figure 12. Group differences in the direction of behaviors as a function of age ($p < .001$). Solid and dotted symbols are as in Figure 11. The vertical lines indicate the degree of divergence of the mean of the male scores from the combined mean of male plus female scores.

Stimulus animal testing

Three of the four analyses showed significant group interactions. The analysis using nonsocial withdrawal, aggressive, and noncontact socially-directed exploratory behaviour showed a significant group x sex x stimulus x behaviour interaction (F=2.71, p<.025). A significant group x stimulus x behaviour effect (F=3.90, p<.01) was revealed in the analysis of social and nonsocial play behaviour. This same interaction is plotted in Figure 13 for positive and negative contact behaviour even though none of the group interactions for this effect reached statistical significance (F=2.49, p>.05). Finally in the analysis of appropriate and inappropriate withdrawal there was a group x sex x behaviour x stimulus effect (F=3.48, p<.025).

The above results are illustrated in Figure 13. The S monkeys show the most positive contact and nonsocial play with stimulus animals younger than themselves. S females show relatively little appropriate withdrawal i.e., from aggression, while S males show the most of this behaviour pattern. I males and I females were high in the level of their inappropriate withdrawal and environmental withdraw respectively. D males, too, were high in the level of environmental withdrawal but low in aggressive behaviour. D females showed little inappropriate or nonsocial withdrawal but a large amount of appropriate withdrawal.

Intragroup testing

The analysis of behaviour occurring during the within group triad testing revealed two interesting effects. The

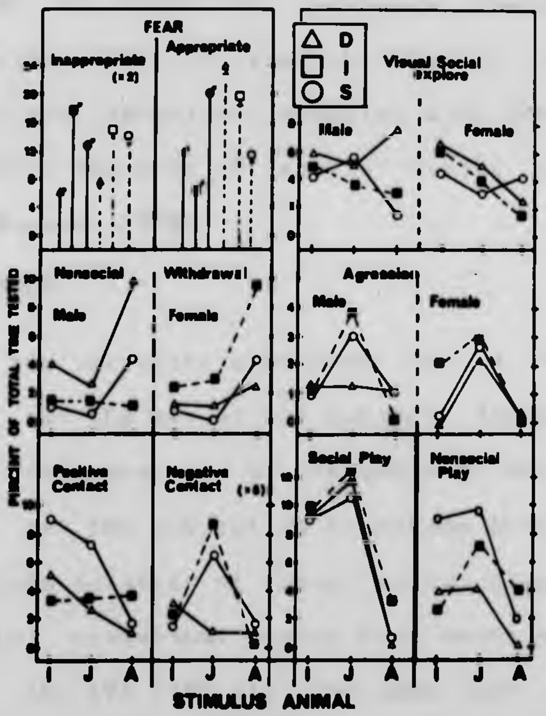


Figure 13. Group differences in behavior towards infant, juvenile, or adult stimulus animals (p <.025).

first, sex x behaviour (F=4.01, p<.05), suggests that females show three times as much aggression as do males. The significant group x sex x behaviour interaction (F=7.27, p<.01) is shown in Figure 14. Here we can see that male D monkeys, when grouped together and forced to lower their dominance position, show the most withdrawal and least play of all the experimental groups; female D monkeys show considerably less withdrawal than D males but the greatest amount of aggression of all; whereas I male and S female monkeys seem to adapt to dominance change with the least stress as evidenced by their exhibiting the least withdrawal and the most play behaviour, agreeing with the findings taking direct cortisol measures of stress during dominance change (Chamove & Bowman, 1978).

Factor analysis

Twenty two variables were used for a factor analysis. These were (1) the sex of the subject, female = 1 and male = 2; (2) the dominance rank of the subject, S=1, I=2, D=3; (3) the weight of the subject in kilograms when 8 mo. old; (4) (5) (6) (7) the duration of cling, social play, nonsocial play and nonsocial withdrawal during four weeks of testing when 3 mo. of age; (8) (9) (10) (11) the same four behaviours when 11 mo. old; (12) (13) (14) the duration of social withdrawal, aggression, and social play during the intragroup test; (15) the total duration of social choice during the preference tests; (16) a relative preference score made up from the sum of the ratios of the preferred monkey over both monkeys; and the six personality ratings described above.

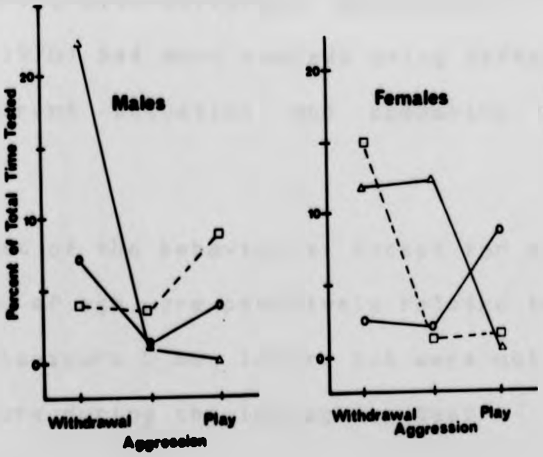


Figure 14. Intragroup test results ($p < .01$).

The intercorrelations between variables are presented in Table 5. These results show that high dominance rank is associated with a high level of solitary play at 3 and 11 mo., low levels of nonsocial withdrawal and cling at 3 and 11 mo., and high levels of aggression and social withdrawal and low levels of social play behaviour during intragroup testing at 15 mo. of age. This is in general agreement with the results of Smith (1977). Dominant animals are rated as being more extraverted during stimulus-animal testing. The high intercorrelations of all six of the ratings, within the triangle in Table 5, suggests that they are not reflecting different orthogonal attributes. They do however correlate differently with different behaviours. Stevenson-Hinde and Zunz (1978) had more success using different rating scales in a different situation and comparing them only with one another.

Most of the behaviours, except for social play, recorded at 3 mo. of age were positively related to the levels of these same behaviours 8 mo. later, but were not related to the same behaviours during the intragroup test.

The results of the factor analysis (see Table 6) agree with the results of other such analyses (Chamove, Eysenck, & Harlow, 1972; Chamove, 1974). Two factors with eigenvalues above unity were extracted correlating relatively little with one another (r=+.29). Factor 1 is strongly related to high rank and solitary play during the stable experimental period at one extreme and loads heavily on social play at 11 mo., cling at 3 mo., and social play during the relatively stressful intragroup test at the other extreme. One extreme

PRODUCT-MOMENT INTERCORRELATIONS (X 100)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	
	-63	17	-77	76	-26	-25	-55	-35	31	52	-4	-5	-13	34	13	38	42	49	25	87	-14	(1) PLAY-ns
		-36	84	-51	42	2	9	29	-6	-46	-16	10	35	-43	-42	-50	-54	-52	-46	-65	8	(2) WITHDRAWAL-ns
			-37	-11	0	-14	21	27	-16	-1	-6	25	-5	21	32	23	35	12	17	6	16	(3) PLAY-s
				-60	41	12	27	31	-17	-39	2	11	36	-20	-16	-26	-38	-42	-27	-82	5	(4) CLING
					-57	-13	-40	-50	45	52	-14	-8	-18	9	5	20	26	20	13	86	-38	(5) PLAY-ns
						-34	-2	24	-25	-12	18	29	55	-23	-30	-27	-30	-15	-44	-51	6	(6) WITHDRAWAL-ns
							13	0	10	1	8	-34	-34	31	32	30	27	-2	32	-22	18	(7) PLAY-s
								32	8	-26	1	23	27	-12	-3	-20	-28	-36	2	-44	-25	(8) CLING
									-4	-67	-12	35	12	6	11	5	-1	-4	12	-41	17	(9) PLAY-s
										-11	-2	23	12	-6	-22	-1	2	-16	-17	40	-22	(10) AGGRESSION
											8	-15	1	13	16	23	19	21	16	50	-25	(11) WITHDRAWAL-s
												12	-8	34	18	24	43	27	18	-10	5	(12) BODY WEIGHT

		(22)	(21)	(20)	(19)	(18)	(17)	(16)	(15)	(14)
SEX-M	(22)									
RANK-D	(21)	21								
SOCIABILITY	(20)	22	20							
EXTRAVERSION	(19)	36	45	66						
ASSERTIVENESS	(18)	24	27	63	50					
EMOTIONALITY-s	(17)	33	18	79	58	83				
EMOTIONALITY-ns	(16)	22	5	84	52	67	83			
STABILITY	(15)	33	10	78	65	80	93	81		
PREFERENCE	(14)	-20	-25	-32	-9	-44	-22	-32	-13	
RELATIVE PREF.	(13)	11	-5	-14	-5	9	4	-24	3	41

Table 5. To save space the lower right-hand corner of this table has been moved to the lower left-hand corner and rotated counterclockwise. Numbers in brackets refer to behaviours recorded during mo. 3 (1-4), mo. 11 (5-8), intergroup testing (9-11), ratings taken during the stimulus tests (15-20). Correlations greater than .50 (p< .01) are underlined. (s= social, ns= nonsocial)

Table 6.

Factor Loadings (x = 100)

	Factors		
	I	II	
Play - NS (3 mos)	99	09	
Rank (D)	99	37	
Play - NS (11 mos)	91	-10	
Withdrawal - S (IG)	51	01	
Aggression (IG)	54	47	
		89	Cling (3 mos)
	-28	87	Stability
	24	80	Preference
	13	80	Withdrawal - NS (11 mos)
	-33	71	Withdrawal - NS (3 mos)
	-24	70	Emotionality - S
	37	61	Relative preference
	23	59	Extraversion
	-01	59	Body weight
	-03	58	Assertiveness
	-27	52	Sex (M)
Sociability	-52	12	
Play - S (IG)	-59	08	
Emotionality - NS	-64	09	
Cling (3 mos)	-68		
Play - S (11 mos)	-81	16	
Cling (11 mos)	-80	-74	
	-18	-99	Play - S (3 mos)

of Factor II loads heavily on clinging at 3 mo., subjective ratings of stability, preference for social partners, and non-socially-directed withdrawal during the stable experimental period; the other extreme loads on two items, early social play at 3 mo., and cling at 11 mo.

These results suggest that dominance rank is an important factor influencing social behaviour during early life. They also suggest that the different tests used here are measuring different aspects of behaviour.

Eight of the animals were not completely reliable in their dominance position: three D animals, two of which were females; two I animals, all female; and three S animals, all male. These animals usually were unstable with only one of the other 16 animals, and so were not put with these animals until some time had elapsed from when the problem was first detected. The unstable I females tended to submit rather than to dominate. This slight reduction in partner number was not felt to be important as it only reduced an animal's total number of partners by 1 or 2 in 16, and the unstable experiences were restricted to a few minutes in the first year of life.

Discussion

There were two major findings of interest resulting from this study, aside from the knowledge that dominance manipulation is feasible. If we consider "good" adaptation to be low levels of aggression, fear, disturbance and high levels of play, and poor adaptation to be the opposite, we can conclude the following: the first is that while males adapt well to a dominant or intermediate position, they do not adapt well to a subordinate one; while females adapt well to intermediate and subordinate ranks, they do not adapt well to a position of dominance. Specifically S males were slowest to contact and showed the most self-aggression when alone with novel objects, whereas D males contacted the objects rapidly. The S males showed the most appropriate withdrawal in the stimulus test and the most aggression in the intragroup test. D females did not show the normal decline in disturbance response with age towards novel objects and were slow to contact the objects. S females, however, were first to contact the objects, showed the greatest reduction in disturbance with age towards the objects, and were least upset by the objects. The D females showed more aggression than D males during social testing and showed a considerable amount of appropriate withdrawal in the stimulus tests, whereas S female showed the least appropriate withdrawal. It is reasonable that the amount of appropriate withdrawal reflects to some degree a tendency of the subject animal to instigate aggressive behaviour by the adult stimulus monkey.

The second major finding was the detached and rather emotional nature of the D animals, especially in novel situations. The D animals tended to show the most distress vocalization when with the novel objects, a high level of nonsocial withdrawal in the stimulus tests, and showed the most withdrawal in the intragroup test. They interacted least throughout social testing of all groups. This suggests that some of the behavioural characteristics described for feral dominant monkeys, such as general aloofness but reactivity in adverse circumstances, are a result of high rank rather than the characteristics of those individuals occupying those ranks.

The preference of D and I monkey subjects for high ranking partners extends the findings of Sackett (1970) and others (Chamove & Harlow, 1975; Chamove, 1979; Suomi et al., 1973) that macaques seem to prefer others that are similar on other dimensions to themselves.

I was impressed with the degree to which certain animals fit their appointed position whereas others did not. Some animals responded to challenge with aggression, some were aggressive primarily in response to the withdrawal behaviours invoked by a third animal, and still others responded to challenge by appeasement behaviours. In an unpublished study I switched infants at birth between dominant and submissive group-living mothers. In one instance the dominant female was a prior subordinate who had been raised to dominant by our promotion of an alliance between her and the dominant male. In all of four occasions, the infants adopted the rank adjacent to that of their new mother. It appears then that early experience with the mother may be more important in determining rank than personality characteristics of the individual, but in the absence of this maternal-experience factor or when when it is held constant, inborn factors play a measurable role in affecting the ease with which individuals fit into a dominance position unaided by the mother.

CHAPTER FIVE

Behavioural Recording System

In recording the behaviour of monkeys, the category of major interest here is that of social behaviour, and in that area two problems have confronted us: (a) which social behaviours to record and the definition of those behaviours, and (b) how to record and then summarize those behaviours chosen. This chapter describes the technique which was developed. Comparisons with other systems will not be concerned with systems in which the animal's behaviour is recorded automatically, such as the subjects breaking a photocell, pressing a lever to view the other animal, or touching toys (e.g., Sidowski & Spears, 1970; Sackett, 1970).

Several methods have been used to record the social behaviours of macaques and other monkeys in the laboratory: (a) check sheets, (b) clocks and counters, and (c) tape recorders. These systems require that the behaviours of interest be categorised and defined, then observed and scored by the experimenter as they occur so as to allow quantification.

With the check sheet the subject's behaviours are sampled within a preselected time interval and recorded by writing on a check sheet.

Time intervals of 10 (Griffin, 1966), 15 (Harlow, Rowland & Griffin, 1964), or 30 sec. (Rosenblum, 1961; Rhine & Kronenwetter, 1972) are demarcated by a buzzer (Hansen, 1966), a light (Chamove, 1967), or a tape-recorded voice (Thorne et al., 1969). Behaviours are coded, codes being a set of symbols representing specific behaviours or behaviour patterns such as threat or sex. Behaviours of the subject occurring within each of these intervals are recorded in separate areas on a prepared sheet (Rosenblum, 1961), or only behaviours occurring at the time of the signal are recorded on the sheets (Griffin, 1966). The notation of the behaviour is accomplished by the placing of a check under a pre-written behavioural category, or by the placing of the symbol denoting the behaviour, e.g., x signifying explore and $\dot{x}$ for oral explore, on the check sheet. The latter, often termed a symbol system, is the faster, involving less time locating the correct writing area but involves greater data tabulation time and suffers from errors of misinterpretation.

The number of behavioural categories that can be scored with good interobserver reliability (above +.85) is large, ranging to 200 responses (Hansen, 1966). With this high number of categories, however, reliability in scoring begins to suffer. A large number of these categories include those which rarely occur or are subdivisions of very similar categories, e.g., oral exploration of another animal, visual explore, or mother-directed, same-sex infant directed, etc. (see Kaufman & Rosenblum, 1966). One common subdivision classifies behaviours as a function of the receptors or effectors involved (Bobbitt et al., 1964). Simultaneous recording of up to six test subjects is possible by one observer (Chamove, 1973b). However the probability of identification inaccuracy is a function of the number of subjects tested, the number of behaviour categories, the salience of the categories, and the configuration of the test environment (see Heimstra & Davis, 1962; Thorne et al., 1969). Usually when using the check sheet technique a behavioural event is scored only once per subject per time interval. If, for example, a monkey plays with three other animals within the 15-sec. interval, the subject usually only receives a score of 1; if it plays for 2 sec. or 14 sec. within that 15-sec. interval it still only receives a score of 1. When the direction of the behaviours is also noted, an animal may receive one score per behavioural category per direction per interval (Chamove, 1967; Rhine et al., 1972; McGrew, 1972).

The data recorded is assumed to be a sample which would reflect behaviours recorded by continuous monitoring (reviewed by Arrington, 1943). The validity of this assumption is difficult to test for certain categories, e.g., those with very rapid rates of recurrence such as threat and bark, or those occurring with variable duration, e.g., sleep or play. There is little doubt that the system of using check sheets can be used to record large numbers of categories. Symbols are easy to remember and can be easily modified for use when attention is focussed on certain aspects of social behaviour, e.g., oral behaviour. Apparatus needs are minimal. Data tabulation time is moderate, about half that of testing time. (Data tabulation refers to time used to compile for final data values going into the analysis, e.g., total frequency of contact play during the first half of the test session). The major advantage of the system is its flexibility. Categories can be easily added or deleted. This is quite suitable when testing an unknown species or in unusual conditions. The major disadvantage of this system of sampling is that the experimenter can only obtain duration or frequency estimations. These are often labelled one/zero samples or 'modified frequencies' since they are neither true frequencies nor true durations. Consequently scores of brief duration behaviours (e.g., vocalisations) are not comparable to those behaviours of longer duration (e.g., stereotypic movements). On the other hand behaviours of brief duration are well estimated from modified frequencies (Altmann & Wagner, 1970). There is, in addition, the problem of errors in transcription.

The clock and counter technique allows for the recording of absolute or true durations and frequencies, representing the true frequency and total duration of occurrence of the behaviours scored within the interval used. Using clock and counters the subject's behaviours are recorded continuously by depressing a number of microswitches. Depression of these switches pulses a counter and usually also activates a clock or running time meter for the duration during which the switch is depressed. This technique includes the use of clocks only (Chamove & Harlow, 1970; Boelkins, 1968), clocks and counters (Alexander, 1966; Odom et al., 1970; Chamove, Harlow, & Mitchell, 1967), clocks and/or counters (Rosenblum, 1961; Hammack, 1960), print-out counters (Sackett, 1968), or event recorders (Boelkins, 1968). The advantages of true durations and frequencies are intuitively obvious. Data tabulation of clocks and counters is quick and relatively free of error. Their disadvantages include the cost of the apparatus. This test technique necessitates that the experimenter activate a separate microswitch for the activation of one or a pair of recording devices. This imposes a limit on the number of switches. Otherwise the observer cannot respond with sufficient speed and accuracy to observed behavioural changes. As the number of switches increases above 10, experimenters tend to visually search for the correct switch, rather than attend to the animal's behaviour (Simpson, 1979).

A print-out counter offers advantages over clocks and counters: the counter time enables the tester to compute variance estimates for the duration measures of each category, in addition to frequency measures; also conditional probabilities can be computed as the order of behaviour emission is preserved. These machines are expensive and manual data tabulation of resetting print-out counters is, suprisingly, at least as long as testing time. A system using a print-out counter utilizes several of the channels of the counter for the coding of events and the rest for their duration. Usually two channels are used, the entry numbers corresponding to each of e.g., 12 buttons coding 12 behaviours. Other types of apparatus used to obtain true frequencies, durations, conditional probabilities, and within-behaviour variance estimates are briefly described in the following. A 10 pen Esterline Angus event recorder was used by Boelkins (1968)--1 pen per behaviour. It is slightly less expensive to purchase than a print-out counter with its clock and controls, but data processing time is at least twice that of testing time. In use for several years was a Stenotype machine (Heimstra & Davis, 1962; Davis et al., 1968). One of 9 keys was depressed every second indicating the presence or absence of certain behaviours by marking a paper tape in a manner much like that of an adding machine. A metronome demarcates the seconds. They also report the use of an IBM key punch plus metronome device for similar types of recording (Vanderpool & Davis, 1962). These investigators report increased reliability with fixed interval recording and automatic pacing. Presumably more than 9 keys can be alternately or simultaneously used. A similar piece of equipment was designed by J. A. Bauer, Jr. at the University of Wisconsin Primate Laboratory and was in use in 1962. It punched holes in paper tape sequentially coding behaviours as to type, subtype, etc. The holes were counted electrically. Used to evaluate orality in schedule- verses demand-fed monkeys, the hierarchical nature of the categories effectively utilised the four levels of behaviour.

Tape-recording is a popular method for data recording in the field and in the laboratory. Bobbitt, Jensen, and Gordon (1964) used three tape-recorders (one for animal vocalisations) onto two of which information as to the description, the beginning, and the termination of certain behaviours is dictated. This apparatus greatly increases the number of behaviours that can be scored and the flexibility of behaviour categories--a severe limitation of most clock-counter systems (Kaufman & Rosenblum, 1966). Recorders are easy to carry, but both tape-recorders and Stenotype recorders involve long data tabulation times.

More recently certain investigators have combined methods of the check sheet and clock-counter techniques (A. Deets, personal communication). These require two observers, one recording durations by microswitch depression and the other simultaneously using check sheets to record other behaviours, usually behaviours of brief duration. These check sheets are unlike those described above in that they have no time base and reflect true frequencies, i.e., whenever a subject's behaviour changes, a new entry is made. The clocks measure those behaviours of which it is felt that durations are more important than frequency, while the check sheets measure the other behaviours.

Apparatus

The behavioural recording device utilized here was briefly, a keyboard with a small number of keys (9), the behavioural coding of which was accomplished by patterned sequences of key punches coding behaviours in terms of easily learned numerals, and connected to a device which records frequency, duration, and preserves behavioural sequences.

The keyboard of this device was similar to that of an adding machine. Depression of the keyboard numbers was recorded by being entered on paper tape when the last button was depressed. When this button was depressed upon the termination of any behaviour constellation, this also resulted in the printing of the numbers entered into the machine. The behaviour constellations were coded into 4 numbers hierarchically arranged. The first number referred to the behaviour type as described below and was divided into 5 elements, such as play or withdrawal, and described the subject's behaviour. The second number entered referred to the direction of the behaviour type and was divided into 6 elements such as social or environmental. The direction described the object or the behaviour of that animal judged by the experimenter to be the intended recipient of the subject's behaviour. The third entry number referred to the level of activity and estimated how much energy the animals were believed to be expending. And the fourth number referred to (a) the distance between the subject and the object of its behaviour and (b) the presence of reciprocity of the behaviour between the subjects and the object of the subject's behaviour.

A behaviour was coded into its four numbers by pressing the appropriate adding machine buttons in the above order, such as 4-3-3-1, read by the device as four thousand three hundred thirty one.

This system has certain advantages over the above systems. Legibility of categories is greater than symbol systems. Accuracy of durations is greater than event record data which have to be hand measured. In this system 9 buttons are used, the location and meaning of which are easily learned. The speed of data recording is as rapid as any 9 button clock and counter system and is faster than writing behavioural symbols. Four buttons can be pressed in 1 sec., and one can continuously observe the subjects. This system enables one to compute frequency, duration, behaviour variances, and conditional probabilities just as event recorder, tape-recorder, Stenograph, and print-out counter systems. Unlike print-out counter systems it does not involve complex programming to input behavioural coding onto certain channels of the print-out counter recorder or the alternative of recording only a few behaviour categories. Also the number of categories that can be recorded are much greater than that used by all but tape-recorder systems and check sheets.

Restrictions of the system are few. Behaviours which last substantially under one second are either not recorded or recorded as having a duration of at least one second, but this is a limitation of all but films and tape-recorders. The most important restriction of the system is as follows. Any system using a large number of categories must have these categories in a factorial arrangement for ease of coding. This restricts the flexibility of the system. It is difficult to add sub-codes to further delineate behaviours of particular interest such as nipple contact or clinging vs. nonspecific contact or other behaviour patterns restricted to small segments of the total scored behavioural repertoire (Altmann, 1965).

Behaviour categories.

In the area of social behaviour the categorisation of behaviour can be seen as lying on a continuum between two extremes. One extreme is the precise definition in terms of their motor components (Kaufman & Rosenblum, 1966; Hansen, 1966). The other extreme is the use of educated judgements of position on a continuum of some abstract concept (e.g., Stevenson-Hinde & Zunz, 1978). One example of the former or molecular definition is as follows:

> "Noncontact play: noncontact play involving visually oriented charges and attack-like manoevres which involve at least two caroms or rebounds. The latter provision may be superceded if the orientation component and the vigor of the activity involved indicate definite attack-like components in the behaviour exhibited." (Hansen, 1966 p. 110).

This often-used definition type attempts to define behaviours so that contextual cues and subjective interpretation are reduced in so far as is possible. For analysis, several categories frequently are lumped into some aggregate, meant to reflect an important abstract concept such as play or disturbance which is in turn meant to reflect differential playfulness or emotionality in subjects which also differ in their position on some abstract concept such as mothering, experience, or development (see Hill, 1966).

The latter molar definition type, rarely used in its extreme, tries maximally to utilize the sophistication of the tester to rate or rank subjects directly with respect to possession of some trait such as security vs. emotionality or sociability-aloofness (see Chapter 4; Chamove et al., 1972; Zunz & Stevenson-Hinde, 1978). Using this method it is often necessary for the tester to be both knowledgeable of the particular behaviour used and often of the particular idiosyncrasies of the individual subjects so as to be able to differentiate between fearful, incidental, and playful withdrawal or between curious, playful, and assertive approach; and here, of course, one must be more careful of experimenter bias. The category system used in this experiment was chosen to (a) fall in the centre of this objective-subjective continuum, (b) reflect categories which have been found to be important in factor analytic studies of human research (Borgatta, 1964), primate research (Chamove et al., 1972), and (c) reflect orthogonal, functional relationships which had been found to discriminate between previous primate experimental treatments or variables such as male-female or isolate-control (van Hooff, 1971; Sackett, 1970).

Because emphasis was to be on social interaction, behaviours such as ingestion and elimination were not recorded. The interest in social adequacy engendered the development of a general response code which measured both the subject's response and also yielded an estimate of the stimulus event. For example, withdrawal from a hostile animal was believed to be more apropriate than withdrawal from a fearful one. There are two major ways of measuring the stimulus events to which the subject responds. The first is by controlling to some extent the stimulus input. This ranges from controlling (a) the animal with which the subject is paired to maximise certain types of behaviour (Chamove, Harlow, & Mitchell, 1967; Mitchell, 1970; Davis et al., 1968; Chamove 1978); (b) using trained stimulus personnel (Sackett, 1970; Bijou et al., 1969); (c) drugging the stimulus animals to further ensure the uniformity of their behaviour (Sackett, 1968); (d) using films or slides of stimulus animals (Sackett, 1966); (e) using electrical brain stimulation to control the stimulus animals (Delgado & Delgado, 1962). The second, more commonly used, is testing the subject in a 'normal' or stable situation with peers. The stimulus situation is either grossly defined as 'in the school yard' or defined more specifically, as in this system as 'towards a playing peer'. A combination of the two techniques can yield either confirmatory evidence (Chamove, 1973b) or additional evidence (Mitchell, 1970) for group effects.

In the system used here any behaviour constellation was coded within five basic dimensions: type, direction, activity, contact, and reciprocity. When a behaviour was emitted it was coded as to its type by depressing one of five keys corresponding respectively to the elements withdrawal, exploratory, play, hostility, or associative behaviour as defined below. This depression could signify that the subject was, e.g., playing. The same behaviour was then coded as to its direction by immediately pressing one of six keys. The first five of these keys were designated as social-directed and coded the behaviour engaged in by the animal who was believed to be the object of the subject's behaviour. For example if the monkey was playing with another animal who was withdrawing, this was coded as play-withdraw. The sixth key coded direction as nonsocial and included self-directed behaviours. Thirdly the behaviour was coded to record the activity of the subject, and the elements were categorized as either not moving, moving at a rate equal to a walk, or rapidly moving. The fourth dimension reflected whether the subject was in contact or not with that object which was the direction of its behaviour. And the fifth coded whether the subject or the object appeared to be reciprocally interacting or not. The fourth and fifth were combined for ease of recording into one category with four possible levels. These levels, within categories, were coded using numbers. When the behaviours were scored, the dimensions were recorded in the above order.

The behavioural categories were defined as follows:

Withdrawal--all behaviours which function to reduce the amount of sensory input (see also Barnett, 1963). These behaviours may serve to increase the distance between the subject and these stimuli, may compete with external stimuli by giving the subject very regular and subject-controlled input (e.g., stereotyped behaviours), or may serve to stop some assertive behaviour in another animal (e.g., subordinance).

Explore--all behaviours which function to increase the amount of variability of sensory input. It is through the tentative and simple behaviours of this type that the animal learns the properties of stimuli in the environment.

Play--all behaviours which function to establish more complex interaction patterns with objects through the utilization of information gained in exploration (see also Loizos, 1966; Dolhinow & Bishop, 1970). They are 'careless' manipulations serving to integrate and practise more simple skills and suggests that the animal 'knows' what to expect from these objects.

Hostile--all behaviours which function to structure the social environment in a manner maximising the number of prerogatives, also called dominance.

Associative--all socially directed behaviours often functioning to reduce emotionality in the subject or in another animal, also called epimeletic and et-epimeletic behaviour.

The categories were chosen to reflect those items repeatedly found in several factor analyses of human interactions: love-hate or likeability, anxious-calm or emotionality, social aggressive-submissive or assertiveness, and involved-detached or extraversion (Eysenck & Eysenck, 1969; Borgatta, 1964). The system as described will record absolute frequencies and durations and sequences of response, use of which is so clearly demonstrated in Altmann (1965) (see also Jensen et al., 1969).

Reliability

Evaluation of the system was divided into four parts; reliability between two experimenters (discussed at length by Caro et al., 1979), reliability within an experimenter, reliability within an experimenter over time, and accuracy. Two copies of a 30 min. 16 mm film were made reflecting different ages, and behavioural patterns of rhesus monkeys. Each of the two films was composed of 75% identical material, but sections of sequences were shifted in order. After completion of training and when testing was about to commence, each of two testers was given each film just as in actual testing. After completion of testing, some two years later, this was repeated. The tester was compared with the other tester on non-redundant parts of the film at the same period in his training; with his performance on identical segments at the one interval; with performance at the beginning and end of testing on identical parts of the film; and finally with the 'true' duration and frequency of behaviours as determined by measurement of the film using a stop and reverse action analysis projector. There were problems in defining reliability.

The area concerning determination of an index of inter-observer reliability is a confused one (see Thorne at al., 1969; Bijou et al., 1969). One contested sub-area is that of non-occurrence of a behaviour, particularly important in categories which rarely occur. This investigator decided to weigh agreement on non-occurrence increasingly with decreasing occurrence of the behavioural category. In brief, this involved setting the measurement intervals by use of the true pattern of that behaviour. Each experimenter received a score for his recording of behaviour X during the period it actually occurred. He also received another score for his non-recording of behaviour X during the period it did occur. The latter was evaluated in 15 sec. blocks. One may look at the situation when the monkey played for only the first 20 sec. of the film. Experimenter-one, scoring play for the first 15 of those 20 sec. would receive scores of 15, 0, 0, 0, etc., the zeros indicating no score for play in successive 15 sec. intervals when it did not occur. Experimenter-two, however, scoring play for 15 sec. starting after 10 sec. from the start of the film, would receive a score of 5, 10, 0, 0, etc., 10 sec. during the true 20 sec. of play, five erroneous seconds of recording during the first 15 sec. of non-occurrence, and agreement with Experimenter-one thereafter.

These numbers were used to compute product-moment correlation coefficients which served as numerical indicants of reliability. Because of the short length of the film, many of the possible behavioural constellations were not represented. Preliminary analysis, reported briefly below, was performed only on the major categories--behaviour, direction, mobility, contact, etc, and not their interactions.

Product-moment accuracy coefficients on categories of behaviour, mobility, and contact of both frequency and duration scores ranged between .86 and .99 for all categories except the following two: categories with true durations often under one second, and durations of categories following one of the categories with true durations under one second. Categories with coefficients in the eighties were, with one exception, those occurring rarely such as non-reciprocal play. The exception is 'visual exploration' where both frequency and duration coefficients were between .78 and .85 (see also Hansen, 1966; McGrew, 1972). Direction scores averaged .04 lower than comparable behaviour scores.

Product-moment reliability coefficients on behaviours computed between testers and within a tester over time were above .85, with the same exceptions and qualifications as above. Visual explore, especially social-visual explore with high locomotion was often in the middle 70's. Some testing using the usual procedure of two testers testing one subject in the actual test situation was also done. Although the testers were at different stages of sophistication, visibility of facial cues was greatly improved. Test-retest over a week had within-tester coefficients about 92% except for visual exploration which averaged .88 to .91. In general, frequency data has yielded correlation coefficients averaging 6% above those of duration. These data of reliability coefficients using films and direct observation techniques will be presented elsewhere.

Table 7 enumerates the intercorrelation between frequency, duration, duration/frequency, and modified frequency, for behaviour broken down into behaviour, direction, and contact. They all were derived by a computer analysis from the data of 91 animals. The true duration/frequency and modified frequency was not recorded, but since a continuous record was kept, these scores could be derived, the latter done in such a way as to simulate 15-sec. intervals. As associative behaviours were rarely seen in this situation, described below, it was not used in computation of these statistics.

It can be seen that frequency-duration correlations were quite high. Duration correlated better, without exception, with duration/frequency (r=+.74) than did frequency (r=+.58). Duration correlated very slightly better with modified frequency (r=+.94) than did frequency (r=+.93). Duration correlated +.87 with frequency. The low correlations of noncontact (i.e., visual) exploration, of noncontact play, and of environmental-directed behaviours should be noted.

Table 8 presents the results of four factor analyses performed on the data derived from 91 animals tested a minimum of twice weekly between the ages of six to 12 months. Most were on abnormal diets of some description, but in the animals used in these analyses no behavioural abnormalities could be ascertained in either learning or social behaviour. Roughly 80% were male, and all had had daily social experience

Table 7.

Correlation coefficients (X100) between different time-bases for different behaviours. Capital letters denote the behaviour of the S, lower case letters denote the direction of the behaviour and asterisks indicate correlations of special note. F = frequency, D = duration, M = modified frequency (15 secs.), D/F = duration per frequency, W = withdrawal, X = explore, P = play, D = dominance, e = environment (nonsocial).

		F-D	F-D/F	F-M	D-D/F	D-M	D/F-M	F-D	F-D/F	F-M	D-D/F	D-M	D/F-M
W	w	87	59	94	75	94	65	99	42	96	47	98	62
	x	97	69	91	80	90	78	93	74	84	78	97	79
	p	95	54	94	65	97	66	97	64	98	70	95	65
	d	99	68	97	68	96	77	98	65	98	68	99	70
	c	86	76*	90	90*	96	87*						
X	w	89	67	80	86	88	74	98	75	97	75	97	72
	x	98	48	96	49	98	50	98	13	98	20	97	17
	p	83	44	73	69	63	38	95	39	89	49	95	50
	d	93	24	85	31	81	24	98	34	92	42	94	40
	e	70*	13	79	63	97	50						
P	w	97	63	97	64	98	68	98	43	72	53	74	58
	x	88	60	88	78	83	65	96	18	78	32	84	34
	p	99	52	95	53	94	54	88*	27	78	62	82	44
	d	78	23	78	68	74	31	95	28	92	40	94	39
	e	79	-50	78	- 2	96	- 4						
D	w	99	58	98	61	99	61	99	58	99	62	99	60
	x	91	48	80	63	79	57	96	12	93	24	94	21
	p	91	45	72	58	74	51	92	52	80	65	69	41
	d	93	54	93	65	98	70	93	40	82	54	93	61
	e	95	26	95	38	99	37						

Table 8.
Loadings (X 100) on the four factor analyses

Behaviour						Modified		
type	Direction	Frequency		Duration		frequency		Dur/Freq.
Withdrawal	W	-93	2	-65	-20	-13	53	-14
	W	0	-38	19	13	- 6	5	7
	Ex	26	54	18	-64	57	33	-53
	Ex	3	-15	- 1	10	5	10	- 2
	P	-99	20	-81	7	- 8	73	-49
	P	-37	-11	-22	24	-13	19	-11
	H	34	12	30	-46	51	- 2	0
	H	16	-12	16	- 9	8	- 4	6
	env	-53	24	-25	21	4	12	-53
Explore	W	-71	26	-48	- 8	3	25	-43
	W	11	51	- 4	-49	55	11	-10
	Ex	-99	44	-57	20	0	28	-33
	Ex	-37	38	-52	-11	17	34	-22
	P	-31	43	-20	-11	70	23	12
	P	-82	28	-98	21	-12	43	-29
	H	-24	86	99	2	99	- 1	55
	H	24	69	86	9	76	-16	53
	env	-47	19	11	27	92	- 4	-10
Play	W	-34	73	-47	-45	15	56	-73
	W	49	66	5	-79	13	49	-56
	Ex	-34	-34	-26	-37	-65	-15	-34
	Ex	4	-72	-65	-48	-65	-18	5
	P	-67	55	-94	11	-28	56	-27
	P	90	0	-82	20	-93	34	2
	H	-28	50	-28	-18	- 9	55	3
	H	42	68	72	16	- 1	- 1	68
	env	32	-45	-91	- 3	- 7	- 3	-36
Hostility	W	39	57	17	-44	53	- 7	-28
	W	52	50	22	-66	81	-10	-30
	Ex	-16	-22	36	-24	-74	- 2	-19
	Ex	- 7	22	73	-12	-63	-16	- 8
	P	11	-24	- 7	-32	-80	9	-23
	P	-20	63	3	-37	-59	23	29
	H	17	91	82	- 9	-39	7	22
	H	26	95	81	3	-25	6	37
	env	- 7	1	47	-16	-88	- 5	49

starting at between 15 and 90 days of age in both dyads and quadrads (see Chamove, Eysenck, & Harlow, 1972; and Chamove, 1980a & b for details).

Testing consisted of at least sixty 60-min. sessions during which each animal was observed for three 5-min. periods. All testing was in familiar groups of four, the same animals with which the monkeys had experienced social interaction since social interaction had first commenced and therefore quite stable groups. Data was converted to 'percent of total time tested' and analysed using a principal components method rotated to oblique simple structure. Interfactor correlations of the promax factors were derived, and all factors with eigenvalues less than unity were ignored.

Two primary factors resulted from eath of the Frequency, Duration, and Modified Frequency analyses having inter-correlations of +.69, +.55, and +.44 respectively. The loadings of these six primary factors and the single factor resulting from the Duration/Frequency analysis are presented in Table 8 the values having been multiplied by 100. As can be seen, the Duration/Frequency results are clearly divergent from the others. The factors are moderately similar for the three other analyses, Modified Frequency being more similar to Duration than to Frequency. This similarity is most apparent in the strongest common factor, one which could be labelled assertiveness.

A look at the higher-order factors reveals even more similarity. Duration/Frequency has six, Modified Frequency eight, and the remaining nine. Six of these are extremely similar; these are factors which could be labelled fear, hostility, explore and play, explore-assertive (that is, explore directed toward assertive animals), bully, and play-assertive. Duration/Frequency has all of these factors except the last. A factor labelled inappropriate fear is not found in Modified Frequency and is most closely approximated in Duration/Frequency by an assertive-directed behaviour category. A category termed explore and play is not seen in Modified Frequency or D/F.

The results of these analyses stress the importance of careful selection of category and of the time base utilized in recording category. They also suggest that certain clusters of categories are intercorrelated and for that reason potentially of interest.

CHAPTER SIX

Dark Study

One way of assessing the role of vision in social development has been to observe and test individuals with visual impairment (Partridge & Pitcher, 1980). Observations from such studies impress one with the lack of any gross effects of visual deprivation on personality (Zahran, 1965 and reviewed by Dinnage, 1972), on intelligence (Vander Kolk, 1977) or on behaviour (Fraiberg, 1977; Dinnage, 1972; Norris, Spaulding, & Brodie, 1957), although perception is affected (von Senden, 1960). In one of the few well-designed studies Imamura (1965) compared 10 blind 3-6 year olds with 12 controls and found a few interesting behavioural differences. The blind were found to interact with people more than sighted subjects. This effect did not interact with type of partner, i.e., the blind did not prefer to interact with the mother relatively more than with other people. This normality of preference was not confirmed by Burlingham (1961) who reported that many blind people show abnormal bonding relationships. But Fraiberg (1977) found that the blind showed a normal development of preference, at least for the mother versus strangers. Earlier too she states that "...something vital is missing in the social exchange, a resonance of mood...." although the development of attachment to others is normal (1974, p. 217). Imamura found no differences in the tendency to instigate behaviour with the mother, but found that the blind did instigate less frequently with others, which he interpreted as having less initiative. The blind were found to show a greater rate of behaviour, especially succorance and sociability behaviours, but showed less variety of behaviour, i.e., were more repetitious. Succorance was clearly the most prevalent behaviour for the blind but not for sighted subjects. The blind showed half the amount of dominance (control or assertive behaviour), one-third the amount of nonsocial (anti-social) aggression, equal amounts of submission, and more succourant behaviour in comparison to sighted children. Whereas the blind children showed equal amounts of dominance to mothers and peers, the sighted children showed more dominance to the mother than to peers. Imamura speculates that the blind cannot "let off steam" by being aggressive.

This lack of assertive behaviour in the blind confirmed earlier findings although it has not been stressed by Imamura or by earlier researchers. Burlingham (1961) had to teach and encourage nonsocial physical aggression in one blind patient. Imamura suggests that his findings are similar to a study by Barker et al. (1946) on children with other physical disabilities and concludes that it may not be blindness per se, but the physical handicap or resulting overprotection which changes behaviour (see also Schnittser & Hirshoren, 1981).

More detailed analysis by Imamura revealed even more differences. Behaviours involving physical action were equal in frequency in blind and sighted but the blind performed more gestural and verbal acts than the normal children. Only 22% of the blind childrens' acts were physical (involved contact) whereas 30% of the sighted childrens' were. Another analysis correlated behaviour of the mother with behaviour of the child. Two interesting effects emerged suggesting blind children respond to certain types of maternal behaviour differently than do the sighted. Dominance behaviour by the mother led to more submission in the blind but less submission in the sighted; whereas aggressive behaviour in the mother led to less submission in the blind but more submission in the sighted. Towards more dominant mothers the blind child is nurturant and submissive, i.e., accepting, but the sighted is less nurturant, more succourant, less sociable, and more aggressive, i.e., nonaccepting. Towards more compliant mothers on the other hand, the blind is more dominant and less submissive, but the sighted is more sociable and less dominant. In general the behaviour of the blind child correlates less well with the behaviour of the mother, i.e., is less predictable.

Other studies which report differences between the blind and normally sighted individuals are more general in approach. Sandlers and Wills (1965) speculate that to the blind, inanimate objects are less interesting, the blind are more self-centred, and that social stimuli have less of the 'double simultaneous stimulation' and are therefore less interesting than to controls. The blind have shorter attention spans and are more distractable (Schnittser & Hirshoren, 1981). Pettrucci (1953), assessing 32 blind students with a Bernreuter Personality Inventory, reports them to be more neurotic, more introverted, less self-sufficient, and less confident than controls.

More recently those interested in the role of vision in social interaction have used observation of visual interaction in normal individuals (see e.g., Rutter, 1973). Gergen, Gergen, and Barton (1973) began by manipulating the environment using sighted individuals. They observed groups of unfamiliar university students when in the dark for periods of 60-90 min. They report less talking, more movement, and more physical contact than groups of control strangers in the light.

Most of the work manipulating light levels with animals has involved documenting the effects of reduced levels or patterning of light on physiological development (Riesen, 1965; von Noorden et al.,1970; Weiskrantz, 1972). A few studies have looked at the role of vision in social interaction. Lagerspetz (1969) observed mice bred for increased aggressiveness, and reports that "motion of the target was necessary for the occurrence of aggression, and also increased its intensity" (p. 83). Davanzo (1969) looked at the effects of blindness on isolation-induced aggression in mice. Although subjects enucleated after isolation showed no differences in aggression compaired with sighted controls, those blinded before isolation suffered retardation in the development of aggression performing at a level 50% below sighted controls after 7 weeks of isolation and 10% below controls after 9-12 weeks of isolation.

Of the few studies of social development in blind monkeys most have been done by Berkson and associates. His first study (Berkson & Karrer, 1968) used three monkeys with induced corneal cataracts and reared for 3 mo. with their mothers. "In a familiar environment the blind animals appeared normal on superficial inspection" (p. 173). Although all showed some threat and self-bite subsequent to maternal separation, there was by the blind subjects almost no threat when observed at 9 mo (probably observed alone in a cage). Later (Berkson, 1974), comparing blinded infants housed with their mothers for the first 6 mo. in a small laboratory cage with control infants, found no differences in their social development while in the small cage, but reports that the visual deficit became noticeable in novel situations. When comparing five blind long-tailed (M. fascicularis) macaques with controls in a series of studies, Berkson and Becker (1975) reported no threat face in the blind monkeys. After using anesthetized mothers they further concluded that smell was probably not important in these blind animals. In the wild (Berkson, 1977) mothers were especially protective of blind offspring. The blindness affected others also, and suprisingly no instance of aggression towards the blind animals was ever seen. There was no effect of blindness on the quality of relationships with other animals. The only behavioural difference reported was the high level of fear-grin in the blind monkeys.

Dark-reared monkeys reared in pairs for the first 3-6 mo. of life were reported to be relatively unresponsive in visual tests, and it was noted that they were more fearful in general (Regal, Bothe, Teller, & Sackett, 1979). In a pilot study Chamove (1978b) gave four macaques all of their social experience in the dark. In comparison to all light controls, these restricted animals showed almost no aggressive behaviours.

The above studies summarise what is known about social behaviour in the blind. These describe behaviour in the blind but tell us little about the role of vision in social interaction. The blind human infant is carefully trained, helped, and guided to model its behaviour on and therefore successfully interact with individuals with normal vision. Also the blind are often in situations where another individual, usually sighted, is dominant. It is not surprising that in studies of blind children, like in children with normal vision, parental attitudes are often found to override other factors of development (Zahran, 1965).

These and other restrictions make it difficult to observe the uninfluenced behaviour of the blind individual to see how it would differ from the visually normal. To observe the unique qualities involved with the inability to see, one ideally needs two conditions: the blind individual interacting solely with other blind individuals, therefore not relatively handicapped; and an experimentally induced reversable blindness, both to allow evaluation of what has been learned and also to ensure that the inability to see is the only deficit of the individual. By using monkeys that are given all of their social experience in the dark, we are able to study the role of vision; and by restricting the subjects "blindness" to social situations, were are able to restrict our deprivation only to visual social interaction.

Method

Subjects

Eight newborn stumptailed macaques (M. arctoides) were selected from consecutive births and separated from their lightly anesthetised mothers at five days of age, with the restriction that separation weights be within one standard deviation of the mean of 30 normal separation weights (Chamove, 1981). Eight such monkeys were selected from nine, born between 26 May and 12 July in 1976 and from multiparous wild-born mothers. They were formed into two groups with one male and three females in each. The age range of the first group was 37 days and of the second was 6 days; the age range between the means of the two groups was 28 days.

Subjects were trained to feed themselves within about 24 hr., as described elsewhere (Chamove, 1975), and were housed with a diaper in individual mesh cages measuring .65 x .60 x .60m where they could hear and smell but not see other monkeys. These cages had solid, removable, white perspex sides which projected out from the cages so that animals could not contact others in adjacent cages. Removal of these sides allowed eight cages to be interconnected in one continuous row when subjects were 21 mo. of age.

Animals were weighed daily at 10 a.m. by a masked technician until they reached 76 days of age and on three consecutive days at monthly intervals thereafter until 346 days of age. Milk was continuously available and was the only food offered until 106 days of age at which time solid food and water were gradually introduced; see Chamove (1981) for details.

Apparatus

Two test cages were used in this study. One, a large mesh rectangular cage .86 x 2.88 x 1.20m and painted blue, was briefly used as a novel cage. The other, a black mesh cage, termed the Wedge cage, averaged 2.85 x 2.10 x 1.45m and was used throughout the experiment. This cage was designed so that a television camera would have an unimpeded view from a single position while maximizing the cage area. This cage was located in a room which could be completely darkened. The cage was then viewed through a wall-mounted end panel of glass. On the other side of the glass window was mounted a monochrome Jackson model CIT-10 television camera with a silicon vidicon tube (type 20 PE-13A) for infra-red sensitivity. The addition of six infra-red lights mounted behind a pair of infrared wratten filters (Kodak no. 87) allowed viewing and audio-visual recording of the behaviour of the occupants of the Wedge cage on a Sony Videocorder (model 3260-CE) and viewing on a National video monitor (model VW 5319E/B).

Most data was recorded using a Data Transfer Unit (DTU) of our design. The DTU was a device which transferred onto punched paper tape the information coded by depressing sequences of buttons together with automatically-produced time information. The punched paper tape was computer analysed, producing information as to bout-length and durations of each behavioural combination. The duration was expressed as percentage of the total time observed and the bout-length was the average duration of each event.

Procedure

Longitudinal testing. Beginning at 2 mo. of age, each monkey spent 2 hr. each day alone in the Wedge cage with milk and its diaper. Monkeys always had a diaper present with them. At about one year of age when they began eating their diapers, these were replaced with plastic bottles. At 3 mo. of age daily pairwise social experience was begun and continued throughout testing. Each monkey received a minimum of two hr. of social experience each day six days a week until the end of testing at 21 mo. of age. At this time they were housed in two groups of four in their homecages. Throughout these 21 mo. the monkeys only had experience with other members of their own group.

Social testing was carried out using a similar procedure to that of daily social experience. Testing was done at ages 3, 9, 15, and 21 mo. of age. Half of the testing was done in groups of two and half in groups of four. Each animal was tested in every condition a minimum of four times with each of the other three animals in its group and a minimum of eight times in a group of four. This meant that behaviour could be recorded on two occasions using each animal independently as a subject for observation.

Two conditions of test were used: (1) testing in darkness; and (2) testing in normal lighting conditions. The Light group were always tested and given social experience under both of these conditions; the Dark group were always tested and given all of their social experience only under the first of these conditions, i.e., darkness. All monkeys were housed under normal lighting conditions.

When the first four monkeys averaged 3 mo. of age, their social experience was begun, and they were termed the Light (L) or control group. Half of their social experience was to be in darkness and half under normal lighting conditions. The second four monkeys reaching 3 mo. of age were designated the experimental or Dark (D) group, and all of their social experience was to be in darkness. The presence or absence of light during their 2-hr. daily encounters with other animals was to be the only difference between the two groups. The Dark group never saw other monkeys, the Light group saw other monkeys half the time they were with them. Daily social experience was always in pairs. Testing in fours only occurred during the four test blocks and then after the pair-wise tests had been given.

Brief testing. One week after 21-mo testing was completed and just before group housing was begun, a 30-hr. dark test was carried out. All four animals of a group were placed together in the darkened Wedge cage at 10 a.m. and remained there for 30 hr. Normal feeding at 5 p.m. and 9 a.m. was done in the dark and water was continuously available. The subjects were observed for 25-min. periods at 10 a.m., 11 a.m., 1 p.m., 4 p.m., 11 p.m., 11 a.m., and 4 p.m.

Just prior to group housing at 21 mo., and one week after the 30-hr. dark test, a 30-hr. light test was carried out. The procedure was exactly the same as for the previous 30-hr. dark test except for the presence of normal lighting levels. After the four animals of one group were placed in the darkened cage and the video was on for 1 min., the lights were gradually increased to normal levels over a period of about 5 sec. and testing begun. The lights were left on for 30 hr. This was the first social experience in the light for the D group.

The third brief test was termed the mixed test. Animals were tested in their living groups of four at 24 mo. of age. Their social interactions were observed for 25-min. periods during the following conditions: (1) normal social housing, (2) milk competit ion, (3) unfamiliar room, (4) reunion after 24-hr. separation, (5) 3-mo. old infant, (6) adult male, (7) novel object, (8) novel object in dark.

The baseline test involved observing in the normal social housing group of four on two consecutive days, the two days being averaged. The milk competition test used the standard competition procedure. A single bottle of highly desirable milk was introduced resulting in competition for the milk. The milk spout was made smaller than normal so as to prolong the test. This test was designed to increase the frequency of affiliative and aggressive behaviours and also to assess the dominance order. This test too was repeated three days after its first trial and the results combined.

For the next test subjects were carried to an unfamiliar cage in an unfamiliar room, and they were placed together in the cage for one hr. This test was designed to increase the occurrence of fear behaviours. For the next test, the homecage was divided by opaque partitions into four segments each with one animal. After 24 hr. the partitions were removed and the behaviour during the first 25 min. of reunion was recorded. The next two tests used unfamiliar stimulus animals. In the first a 3-mo. old infant stimulus monkey was placed into the cage with the four subjects. In the second a docile male adult stimulus monkey was introduced into the cage with the subjects. The former was designed to elicit aggressive behaviour, the latter to elicit withdrawal and affiliative behaviours. The novel toy light test involved the introduction of an unfamiliar black rubber cylinder about .3 m long and .1 m in diameter. Black was chosen so as to be more frightening. The novel toy dark test was similar but used a ticking clock as the novel object. This last test alone was done in the dark.

These eight tests were done in the above order and were begun every day at 11 a.m. All tests lasted for 25 min. The following behaviours were recorded: aggression, play, affiliation, withdrawal, and explore as defined in Chapter 5. These were subdivided into two types--contact and noncontact, and into direction--either self-directed, directed towards one of the three other animals (animal specified), directed towards a nonsocial aspect of the environment, or directed towards the stimulus object if there was one.

During the 30-hr. tests a metronome produced a tone every 3.7 sec. Between every 3.7-sec. interval a different focal animal was observed and the presence or absence of the above behaviours noted on a 0-1 basis. Every subject was observed for 100 3.7 sec. intervals. During the mixed tests the metronome sounded every 15 sec. and, since all subjects were observed in every interval, each subject was tested for 100 intervals.

Preference. It was considered desirable to ascertain if subjects in the dark could discriminate between partners as well as subjects in the light; and if they could, would they develop as extreme preferences for their partners. To test the hypothesis that vision is important for discrimination and preference, it was predicted that the variability of a subject's positive or negative behaviour towards its three different partners would reflect its discrimination of and preference for the partners; a subject with a strong preference for subject P would show relatively more positive behaviour and relatively less negative behaviour towards P than towards the others. Then the standard deviation of its scores towards the three partners would be greater than a subject whose scores towards its partners were more similar. To test this prediction standard deviations were computed separately for contact and noncontact socially-directed play, aggressive, affiliative, and withdrawal behaviours for the three groups using longitudinal pairwise data for each of the four test months. These were averaged to give four monthly scores for each subject for each behaviour, and an ANOVA was used to assess the differences.

In order to reduce a possible source of variance in the analyses of social interaction, another measure of preference was made. In social tests using individuals, little attention is paid to the injection of variance due to the possibility that subjects will have different preferences for their partners either when tested in pairs or in larger groups of animals. To my knowledge no-one has attempted to analyse or control for this source of variance although it is commonly acknowledged to exist. When the groups had been living in their groups in the light for 1 mo. an estimate of preference was made using the Wedge cage in lighted conditions. The wider half of the wedge was divided into three channels by the insertion of white, opaque partitions. At the end of these channels, in transport cages, were placed a subject's three housing partners. A subject was placed in the narrow half of the wedge for 1 min. during which time it was restrained from leaving that half by transparent perspex, but it could see into the channel half of the cage and, down the channels, into the transport cages where its group mates were kept. At the end of the minute the perspex was removed and the subject could enter any one of the channels and approach to within .03 m any one of the other monkeys during the 25-min. test. A record was made of the percentage of choice time (in a channel) during the test towards each partner by each subject as well as the type of behaviour shown by the subject when making its choice. Order of testing and of position in the transport cages was randomized. For the data analysis two numbers were computed for each pair of subjects: the percentage of choice time per subject relative to choice time towards other subjects, and percentage of relative choice time minus choice time spent in aggression. If the ranking based upon the two tests did not agree, a second test was given, the latter estimates compared, and if not agreeing, more tests given. From this test a ranking of partner preference was obtained and termed least-preferred, intermediate-preferred, and most-preferred partners. These rankings were used in the analyses of behaviour over the previous 21 mo. and for the mixed tests as best unbiased estimates of preference. A discussion of the correlation of this test with other tests of preference is given by Chamove (1979).

The results of this test also was used as a secondary test of the above hypothesis, i.e., that subjects in the dark have less pronounced preferences than those in the light. To do this a score was computed for each subject based on the sum of the three differences of percentage positive preference scores between each pair of possible partners. A subject with strong preferences would be expected to have a wider range of choice times and therefore a larger sum of difference score than a subject with a less strong preference. The scores were subjected to a t-test (two-tailed).

<u>Self-aggression</u>. At 16- and at 20-mo. of age, each subject was observed when alone in its homecage on two consecutive days for 30 min. each day and the amount of time spent exhibiting self-aggression was recorded with a stopwatch. The two days were averaged and the data was analysed using an analysis of covariance with sex as the covariate and age as repeated measures. Males are known to show more self-aggression than do females (Chamove & Harlow, 1970; Anderson & Chamove, 1980 and 1981).

<u>Dominance stability</u>. Although the relative stability of any type of interaction might be affected by visual experience, stability of the dominance hierarchy is one that can be easily measured. Since most of the social experience was in pairs, it was possible that pairwise dyadic dominance relationships were set up that were only challenged at 6-mo. intervals when tested in groups of four. After the

testing in fours at 21 mo., two 30-hr. tests were given as described above; the first in fours in darkness, the second in fours in the light. . After this test two milk dominance tests were performed. Two measures of dominance stability were assessed. (1) A dominance ranking was assigned to the subjects based on the results of the milk competition tests. The time to drink for 30 sec. and 60 sec. were computed for each animal and subjected to an analysis of covariance (ANCOVA). The more unstable the hierarchy, the longer subjects might be expected to take to accumulate the 30 or 60 sec. of drinking time, due to interruptions and fights. (2) That same dominance ranking also was used in the prior 30-hr. tests. If dominance was stable, one would expect relatively litle aggression to be directed towards those above one and little fear to be directed to those below one in the hierarchy. The percentage of these "inversions" of aggression plus withdrawal behaviours were calculated for each of the seven tests over the two 30-hr. periods and groups compaired using an ANCOVA. It should be noted that for the dominant animal it was not possible for it to produce an inversion for aggressive behaviour but only for withdrawal behaviour; for the subordinate all aggression was an inversion and all fear appropriate to its position.

<u>Fear test</u>. Five of the mixed tests which were designed to increase the level of fear behaviours were used to see if the D differed from the L in the levels of fear shown in novel situations. The tests were ranked on the basis of prior data in terms of novelty, and the scores of withdrawal directed towards the novel object were evaluated with an ANCOVA. The

tests used were, in ascending order of fearfulness, novel toy, novel room, infant stimulus, toy dark, and adult stimulus monkey.

Analyses

Repeated measures analyses of variance (ANOVA) or analyses of covariance (ANCOVA) were used to assess the effects of experience in darkness, either between the two rearing groups or between dark and light social experience conditions in the light group (here also termed "group" comparisons for convenience). Six ANOVAs assessed the longitudinal pairs tests. The first two compared behaviours of the dark group while in the dark, DD, with the light group while in the dark, LD; the second compared DD behaviour with LL behaviour, D in the dark with the light group in the light; and the third compared behaviour of the light group when in the dark with their behaviour in the light, LD-LL. Age (3, 9, 15, 21 mo.) was a repeated measure, as was behaviour type (contact or noncontact), direction (social or nonsocial), and partner (most-, intermediate-, or least-preferred partner). Two additional repeated measures used play, aggression, affiliation, and withdrawal behaviours, the first two and last two measures were designated as less- and more-assertive behaviours; the first and third were termed positive, the remaining two more negative behaviours. The first of each pair of ANOVAs used percentage as the measure of behaviours, the second used bout-length.

A comparable set of six ANOVAs were used to analyse behaviour during the longitudinal tests in groups of four. The use of as few as 12 ANOVAs was intended to reduce the inflation of alpha per experiment as much as possible (Li, 1966). Three ANCOVAs were used to analyse the three brief tests at 2-years of age. The same four behaviours were analysed as above, the same type condition, but direction used self, three levels of partner (least-, intermediate-, most-preferred), and other. The repeated tests were another repeated measures, 7 in the case of the 30-h. tests and 8 for the mixed test.

An ANCOVA was performed on the weight data from 3-day averages taken at 76, 106, 136, 166, 196, 226, 286, and 346 days of age. The first value, weight just before the experimental treatment was begun, was used as the covariate.

All analyses were two-tailed and alpha set at .05 unless specifically stated otherwise. All ANCOVAs used dominance rank, as determined from the milk competition tests, as the covariate unless stated otherwise.

Results

Longitudinal Pairs

The results of the ANOVAs of the longitudinal pair-wise tests were presented in Table 9 where all of the significant interactions with groups or dark/light condition were presented.

Percentage. The first figure (Figure 15) illustrates the results of ANOVAs comparing the Dark group tested in the dark (DD) with the Light group also tested in the dark (LD) with the Light group tested in the light (LL), and the LD-LL comparison within the Light group. The figure illustrates the significant interaction of groups (DD-LL and LD-LL) with age x

ALL SIGNIFICANT INTERACTIONS WITH GROUP

Effects / df			Bout-Length						Percent					
	L-L	D-L	DD-LD		DD-LL		LD-LL		DD-LD		DD-LL		LD-LL	
			F	p	F	p	F	p	F	p	F	p	F	p
main	1,3						11.31	.04						
Age		3,18									5.90	.005		
Dir	1,3				14.69	.009					35.95	.001	22.05	.02
	[1,3	1,6]									[6.64	.04	60.42	.004]
Cont	[1,3]												[99.87	.002]
With	[2,5]	2,12	3.95	.05									[5.28	.05]
AD	3,9								5.32	.008	9.62	.001	5.43	.02
AW	6,18						3.05	.03					3.06	.03
AC	3,9		3.66	.03			3.93	.048					8.71	.005
AP	3,9										3.26	.049	15.42	.001
DC	1,3										15.30	.008	10.30	.05
AS	3,9										4.87	.01	5.25	.02
SD		1,6			22.21	.003					8.74	.02		
SP	[1,3]												[68.49	.004]
ASW	6,18						2.77	.04						
ASP		3,18	3.00	.047	3.65	.03								
SPD	1,3	[1,6]			[6.76	.04]					9.64	.02	10.22	.046
	[1,3]												[15.48	.03]
ASC	3,9										3.23	.047	4.44	.03
ADC		3,18									3.27	.03		
SPW		2,12	4.04	.04										
SPC	[1,3]	1,6			13.90	.01	22.15	.02					[34.60	.01]
WASP	6,18						3.32	.02						
ASPD		3,18							3.56	.03				
SPDC		1,6									15.56	.008		

Table 9. This table shows all significant main effects and interactions with group or with dark/light condition in the case of the LD-LL comparison. The table gives the significant effects, the degrees of freedom for comparisons of light animals with themselves and dark animals with light, and the three bout-length analyses followed by the three percent analyses. Within each of the three analyses, the table shows the F and the p values. P values refer to the nearest value except when indicated as .05 which indicates < .05 but > .046. All values within brackets refer to comparisons using groups of four, all not in brackets refer to pairwise comparisons. (S=assertive, P=positive, W=partner preference, C=contact, D=direction, A=age)

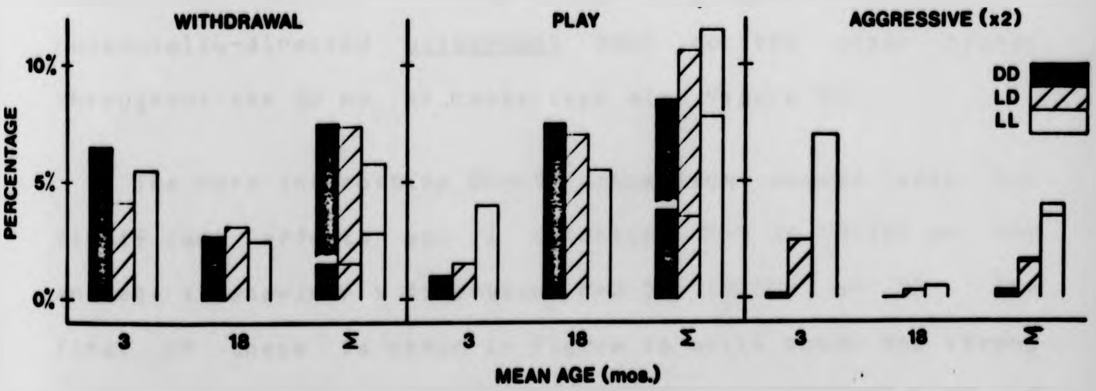


Figure 15. The group x age x behavior interaction for pairs testing. Where summing overall four age blocks, the lower segment of the bar indicates the average of socially-directed behavior, the upper the average of nonsocially-directed behavior; 18 is the mean of mo. 15 and 21.

assertive behaviour and age x positive behaviours. As affiliation rarely occurred and is almost identical in the different groups, it is not plotted here. The important age differences were reflected in the 3-mo. block compared with the 15- and 21-mo. blocks which were very similar and were averaged together in the figure. It shows that the LL, in comparison with others, show more play and aggressive behaviours at 3 mo. of age.

In the same figure, the effects of age were averaged to give a histogram which is subdivided to show direction. This reflects the significant behaviour (assertive x positive) x direction effects for both the DD-LL and the LD-LL comparisons. It shows that the LL show more socially-directed play and more socially-directed aggression and less nonsocially-directed withdrawal than do the other groups throughout the 20 mo. of tests (see also Figure 21).

The more interesting DD-LD comparison showed only two significant effects: age x direction, F=5.32 (3/18) p= .008 and age x behaviour x direction, F=3.56 (3/18) p= .03. The first of these is shown in Figure 16 which shows the strong preference for nonsocially-directed behaviour over socially-directed behaviour in the DD at age 3 mo, the slight preference in LD, and the reversal in the LL. With increasing age, the preference for social direction reverses in the LL and approaches that shown in the DD group. Although not interacting significantly with behavioural type, this effect shows up most clearly for noncontact behaviours (connected symbols in the figure).

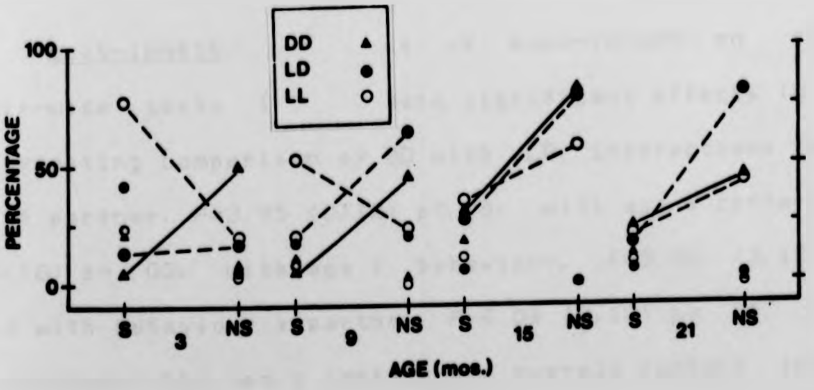


Figure 16. The mean percentage of total time tested in pairs directing behavior towards social (S) and nonsocial (NS) stimuli, and of contact and noncontact behaviors. For clarity only the noncontact behaviors are connected. The mean over all 21 mo. is very much like the 9-mo. data except that the two groups in the dark condition are more similar to one another.

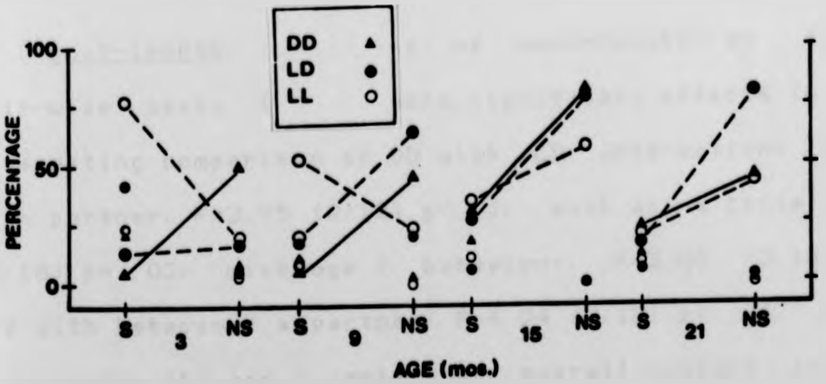


Figure 16. The mean percentage of total time tested in pairs directing behavior towards social (S) and nonsocial (NS) stimuli, and of contact and noncontact behaviors. For clarity only the noncontact behaviors are connected. The mean over all 21 mo. is very much like the 9-mo. data except that the two groups in the dark condition are more similar to one another.

The other significant DD-LD effect, age x behaviour x direction, is not illustrated but appears to reflect the high level of socially-directed *affiliative* behaviour in the LD group at 3-mo of age, and the high level of nonsocially-directed affiliation at 9-mo of age, and the low level of socially-directed affiliation at 21-mo of age, although the total levels of affiliation were similar for all groups.

There were more significant effects in the percentage analyses. In comparison with subjects tested in darkness, the LL show more of both contact and noncontact forms of the two *assertive* behaviours (play and aggression) in the first two test periods. The DD were showing less of all of the four behaviours during mo. 3 than the LL group, and LL show more *noncontact* behaviours in that month than the LD.

Bout-length. Analysis of bout-length on the same pair-wise tests led to more significant effects in the most interesting comparison of DD with LD: interactions of group with partner, $F=3.95$ (2/12) $p<.05$; with age x contact, $F=3.66$ (3,18) $p=.03$; with age x behaviour, $F=3.00$ (3,18) $p<.05$; and with behaviour x partner, $F=4.04$ (2,12) $p=.04$. Figure 17 illustrates the age x contact and overall contact interaction with all groups. In the figure it can be seen that the DD have *contact* behaviours with shorter bout-lengths early in life than the LL, which surprisingly have shorter bouts than the LD. These effects cannot be due to low levels of the long-bout length behaviours, e.g., withdrawal, as the D animals show lower bout-lengths for all behaviours, but especially low values in the longer bout-length behaviours,

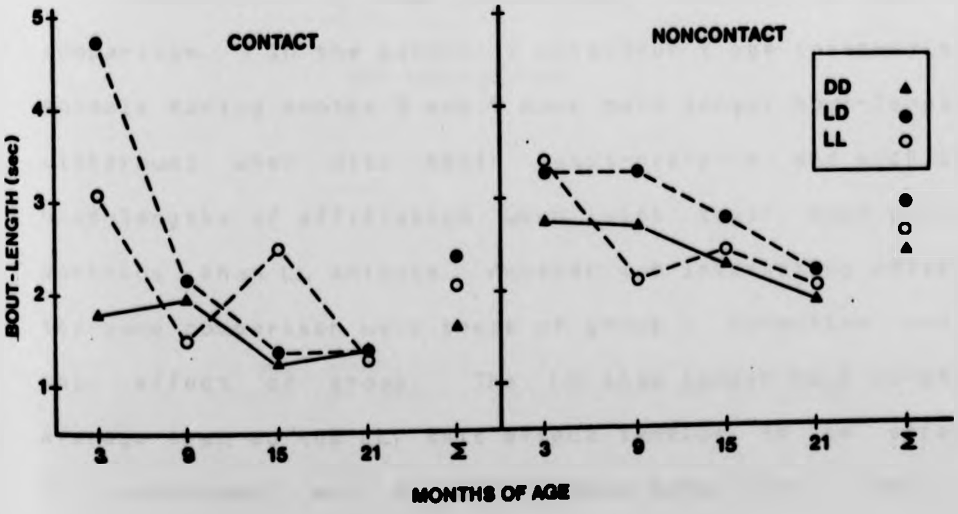


Figure 17. Illustration of the average bout-lengths for the age x contact interaction and the overall contact interaction with all groups.

withdrawal, play, and affiliate.

In the DD-LD bout-length comparison, behaviour interacts with age. Bout-lengths were shorter for DD in the first two age categories for behaviours withdrawal, affiliate, and play; but these differences were not so clear in the last two age categories. Partner preference also interacted with DD-LD as can be seen in Figure 18. Whereas the Light group in both the LD and LL conditions showed longer bout-lengths when paired with their most-preferred partner, the D group actually showed lower values. This effect also interacted with behaviour; the D group showed shorter bout-lengths towards their most preferred partners when playing but longer bouts of withdrawal towards their least- and intermediate-preferred partners when compared with the two L groups.

There were a few interesting effects in the LD-LL comparison. In the partner x behaviour x age interaction, LD animals during months 3 and 9 have much longer bout-lengths of withdrawal when with their least-preferred and much longer bout-lengths of affiliation when with their most-preferred partners than LL animals. Another two interesting effects in the same comparison were those of group x direction and the main effect of group. The LD show longer bout-lengths on average than do the LL, this effect tending to be strongest for withdrawal and for affiliative behaviours. The LL also show longer bout-lengths of nonsocially-directed behaviours than do the DD group.

Longitudinal fours

The longitudinal testing of groups of four was a

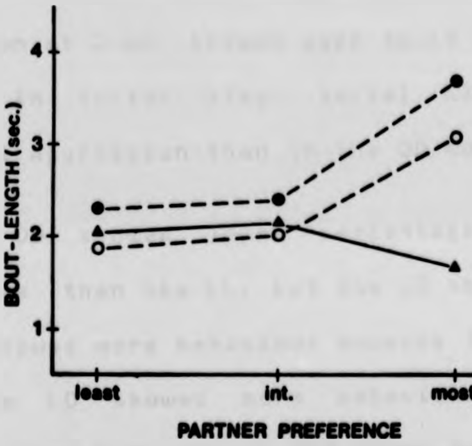


Figure 18. The mean bout-length of all behaviors during pairs tests over 21 mo. towards the least-, intermediate-, and most-preferred partner.

disaster. Testing at 3 mo. went well. So much data was lost from electrical problems in the DTU, camera problems, illness, difficulty in animal identification in the dark as monkeys became older and more mobile, and a burst radiator soaking data, that only the DD-LD and DD-LL comparisons were available for mo. 3 and the LD-LL only for mo. 3 and 9. The results of these ANOVAs were presented in Table 9.

No DD-LD comparisons from mo. 3 were significant. The single significant effect of bout-length from the DD-LL comparison at 3 mo. showed over twice as long bout-lengths for the LL in social play, social withdrawal, and social and nonsocial aggression than in the DD monkeys.

The DD showed lower percentages of socially-directed behaviours than the LL, but the LD showed higher percentages. The LL showed more behaviour towards least-preferred partners and the LD showed more behaviour towards most-preferred partners than partners in the other two preference categories. The LD showed more contact behaviours than but less positive behaviour than did the LL. The LL showed more play than did the LD.

Brief Tests

30-h. light. Surprisingly the test using the two groups continuously in the light for 30-hr. showed no significant interactions with group, even though this was the first light social experience for the D group. The levels of social behaviour were surprisingly low throughout this test for both groups, levels which increased by the time of the baseline measurements for the mixed test several weeks later (see

Figure 19 and 20).

30-hr. dark. The test where subjects remained for 30-hr. in the dark in groups of four did differentiate the two groups. There was a significant group x time effect, F=7.52 (1,6) p=.034 . Most behaviours of the D group tended to increase with time, especially play and affiliation, whereas the L were either relatively stable over time, e.g., affiliation, or decreased, e.g., play, although the opposite trend was seen in aggressive behaviour as will be expanded below. There was also a stable group x positive x direction x time effect, F=1.87 (24,144) p=.013 . The D group were showing more of the two positive behaviours, as can be seen in Figure 19, especially socially-directed positive behaviours, whereas the L group were showing relatively more of the negative behaviours. When the 30-hr. dark results were presented as a percentage of the four social behaviours analysed and subdivided into social and nonsocial direction, these group trends can still be seen (Figure 24 below).

Mixed test. The test designed to evoke higher levels of certain behaviours resulted in clear group differences. An overall group x test effect, F=4.08 (7,42) p=.002, showed that for most of the tests, the L groups were showing more of the four behaviours measured. The significant group x behaviour x test interaction, F=6.60 (4,24) p=.01, is illustrated in Figure 19. It shows the greater play and aggression of the L group in most of the tests. It also shows that the D group were less fearful of visually and auditorily novel inanimate objects but more fearful of strange animals than the L group. The group x behaviour x direction x test

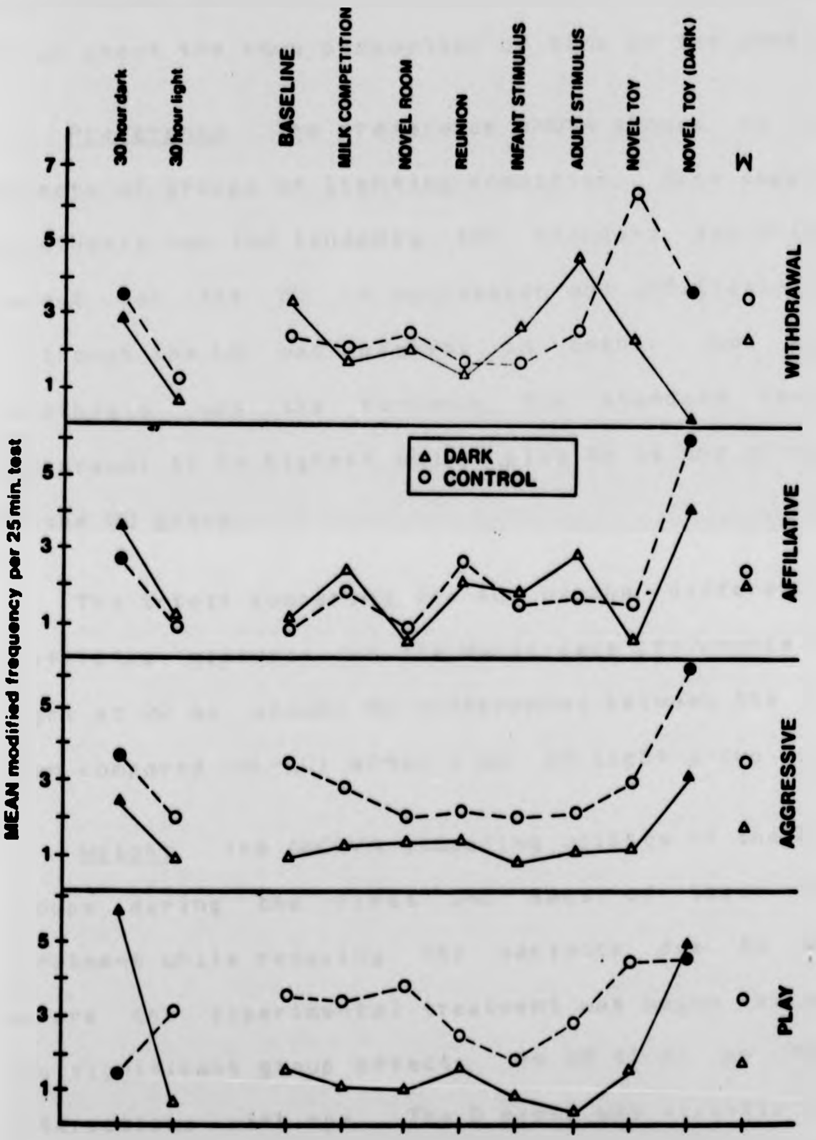


Figure 19. Results of 30 - hr. and mixed tests for the two groups. Solid symbols indicate those tests occurring in darkness. The sigma indicates the mean of the eight mixed tests only.

interaction, F=1.77 (28,168) p= .02, was also signficant. The group x behaviour x direction component can be seen in Figure 20 below. This figure also shows the success of the tests in equating the different levels behaviour; all four were being shown about the same proportion of time in the control group.

Preference. The preference ANOVA showed no significant effects of groups or lighting condition. Some support for the hypothesis was the tendency for standard deviations to be lowest for the DD in aggression and affiliation behaviours (although the LD was highest in both); but against the hypothesis was the tendency for standard deviations of withdrawal to be highest and of play to be one of the highest in the DD group.

The t-test comparing the sum of the differences between preference measures in the Wedge-cage preference test in the light at 22 mo. showed no differences between the two groups when compared (DL-LL) after 1 mo. of light group housing.

Weight. The ANCOVA comparing weights of the D and the L groups during the first 240 days of their experimental treatment while removing the variance due to weight just before the experimental treatment was begun failed to reveal any significant group effects. F=.08 (1,6) p= .78 or group interactions with age. The D group was slightly heavier than the L group throughout. Not surprisingly the covariate was a highly significant (F=25.11 (1,5) p= .004) source of variance.

Self-aggression. During the period of the experimental treatment and while housed alone in cages, the D group were exhibiting 5-times as much self-aggressive behaviour as were the L group, F=8.88 (1,5) p= .03 . The difference between the two groups tended to decrease with time as the self-aggressiveness of the D group tended to decrease in the second test.

The data for the 30-hr. tests were also used to test some post hoc comparisons concerning self-aggression. Previous observations when individually housed in cages in the light had shown the D to be more self-aggressive than the L, and group assessment had shown the DD to be less socially aggressive than the LD which, in turn, were less socially aggressive than the LL. It might be that total aggressiveness is equal in these groups but only the direction differs. Therefore the 30-h tests were used to compute self-aggression, contact social aggression, and noncontact social aggression (nonsocial aggression was very rare and was not included), and the data compared using ANCOVA with dominance as the covariate and seven repeated tests as correlated variables.

Almost all of the statistical interactions with group were significant as well as a strong overall lighting effect (p= .004). Group interacted with time, F=2.90 (6,36) p= .02, particularly strong at the quadratic and linear levels; with time x lighting, F=2.87 (6,36) p= .02; with direction, F=6.88 (2/12) p= .01;' and with light x direction, F=12.32 (2,12) p= .001 . There was no significant group effect, F=.14 (1,5) p= .72 or group x lighting effect, F=1.15 (1,6) p= .32, suggesting that when self-aggression is added to the aggressiveness measure at 2-years of age, the D were nonsignificantly less aggressive than the L. When comparing levels of self-aggression between the two lighting conditions the two groups showed almost exactly equal levels of self-aggression in the light and dark, the D showing about twice the amount of that behaviour as the L group. The L showed slightly more self-aggression in the dark test than in the light, the D showed the reverse. Both groups showed more noncontact aggression in the dark than in the light, but only the D showed more contact aggression in the dark than in the light. The largest effect was the very high level of noncontact aggression in the dark by the L group. The interaction of group x lighting x test illuminated different trends in the two groups. In the light condition both groups showed low and stable levels of total aggression, the L slightly but consistently highter than the D. In the dark however the D begin by showing high levels of aggression and steadily drop to a low level, a level comparable to their light levels. The L maintain an intermediate level of aggression for three test periods and then increase to a high level for three periods, only dropping to an intermediate level in the last period and always showing more aggression than in the light condition.

Self-aggression levels as a percentage of the four major social behaviours is illustrated for the mixed test in Figure 20. The Figure shows the tendency towards higher levels of self-aggression in the D group. It should be noted here that although self-aggression is compared with aggression on the one hand and with other self-directed behaviours on the other, this is not to imply self-aggression is some type of or subcategory of or similar to other types of aggression. There is evidence that self-administered stimulation is quite

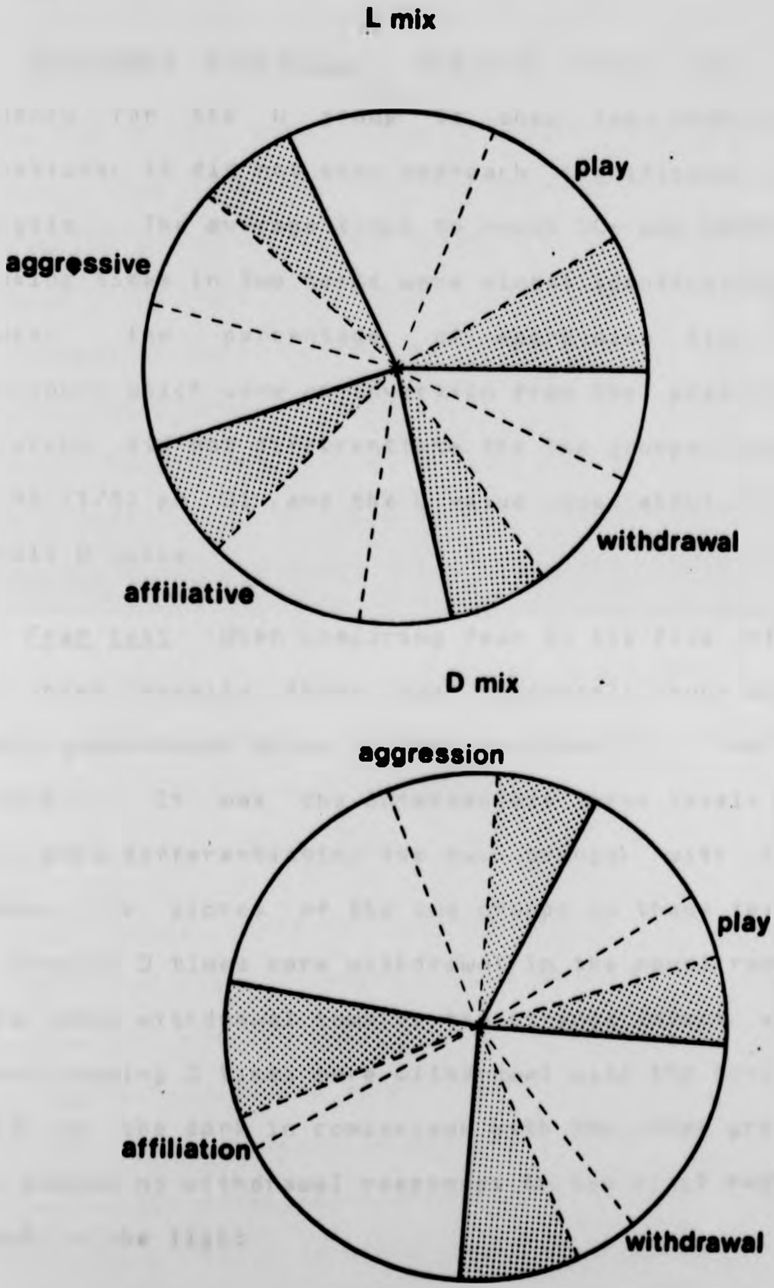


Figure 20. Pie chart showing the relative percentage of the social behaviors divided into self-, environmentally-, and socially-directed (moving clockwise) components during the mixed test. Social direction is indicated by hatching.

different from stimulation administered by other individuals (Weiskrantz, Elliott & Darlington, 1971).

Dominance stability. Although there was a slight tendency for the D group to show less stability in both situations, it did not even approach significance in either analysis. The average times to reach 30- and 60-sec. of milk drinking times in two tests were almost identical for the two groups; the percentage of aggression plus withdrawal behaviours which were an inversion from the predicted linear hierarchy did not differentiate the two groups: group effect, F=1.45 (1/5) p= .31 ,and the L value was about 75% of the overall D value.

Fear test. When comparing fear in the five mixed tests with high novelty there was no overall group effect but a highly significant group x test interaction, F=6.49 (4,24) p= .001 . It was the intermediate three levels of novelty which were differentiating the two groups, with no overlap between the scores of the two groups in these tests. The L was showing 3 times more withdrawal in the novel room and 10 times more withdrawal towards the strange infant, whereas the D were showing 3 times more withdrawal with the novel ticking clock in the dark in comparison with the other group. There were almost no withdrawal responses to the black rubber novel object in the light.

The following four figures summarize some of the behavioural comparisons between the groups. These pie charts illustrate the percentage of the behaviours included in the comparison and also were made up of percentage data only. The first figure (21) shows the behaviour x direction interaction during the longitudinal-pairs tests summed over the 21 mo. It shows the relatively higher proportions of aggression and lower proportions of withdrawal in the LL condition. The second figure (22) shows only socially-directed behaviours, dividing them into contact and noncontact. Included in the descriptive pie chart is the behaviour "explore", which is not included in the analyses. The chart shows the high percentages of noncontact forms of behaviours still present in the dark situations. Figure 23 is a descriptive answer to the question "If we look only at contact social behaviours, will there still be a difference between dark and light conditions?" The pie chart still suggests group differences even when restricting behaviours to those behaviour types easily performed in dark. Figure 24 describes four of the behaviours exhibited during the two 30-h. tests subdivided into social and nonsocial direction.

Discussion

This study looked at two comparisons. (1) Behaviour in the dark of subjects given all of their social experience in the dark (DD) can be compared with the behaviour in the dark of subjects given only some of their social experience in the dark (LD). This comparison enables one to look at the role of vision in the development of social behaviour. (2) Behaviour in the dark of subjects given some of their experience in the dark and some in the light can be compared with their behaviour in the light. This LD-LL comparison enables one to look at the role of vision in the expression of social behaviour. This latter comparison may also help in the

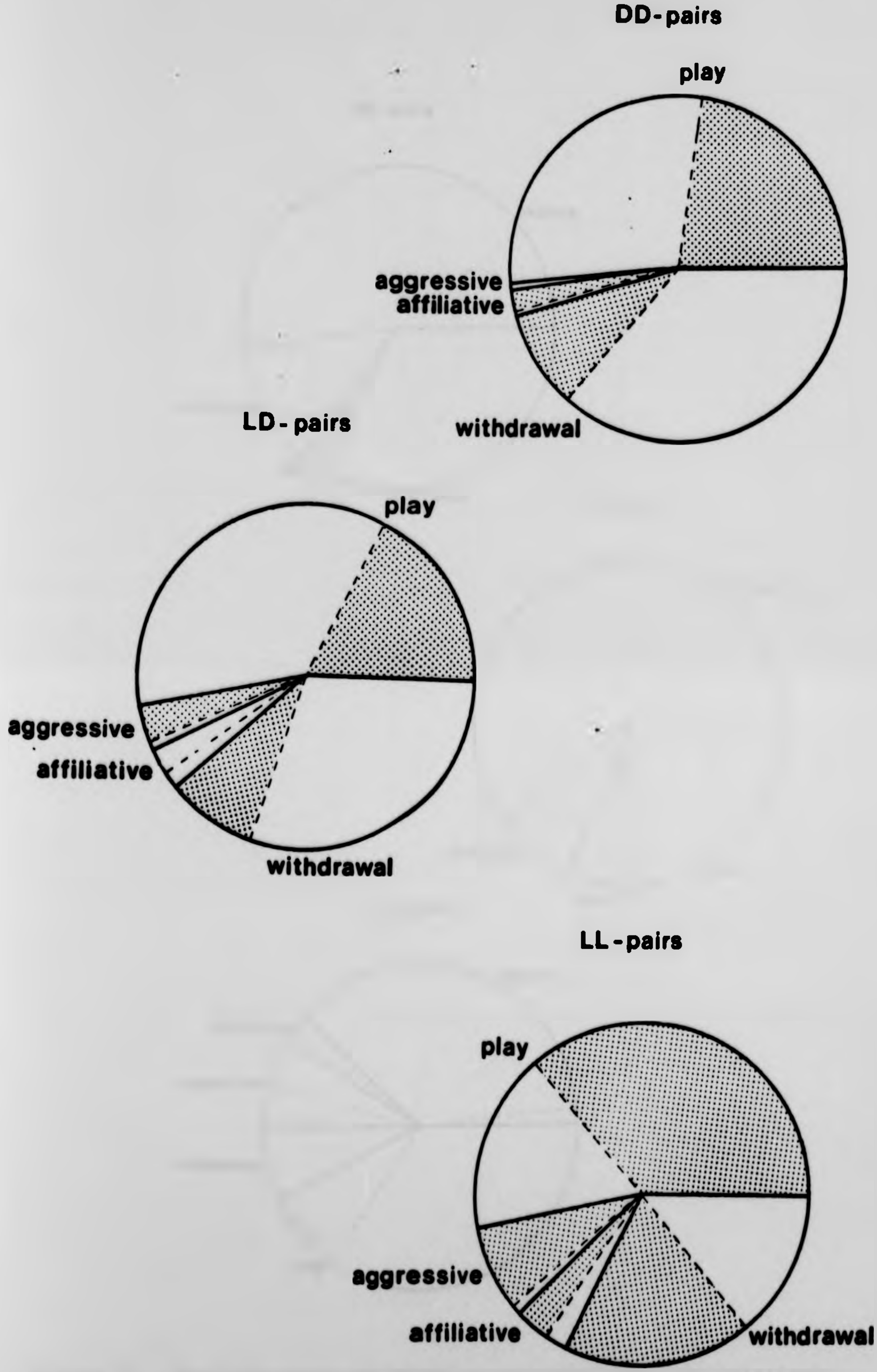


Figure 21. The behavior by direction interaction for the pairs test over 21 mo. The hatched segments indicate social direction, the open segments nonsocial direction.

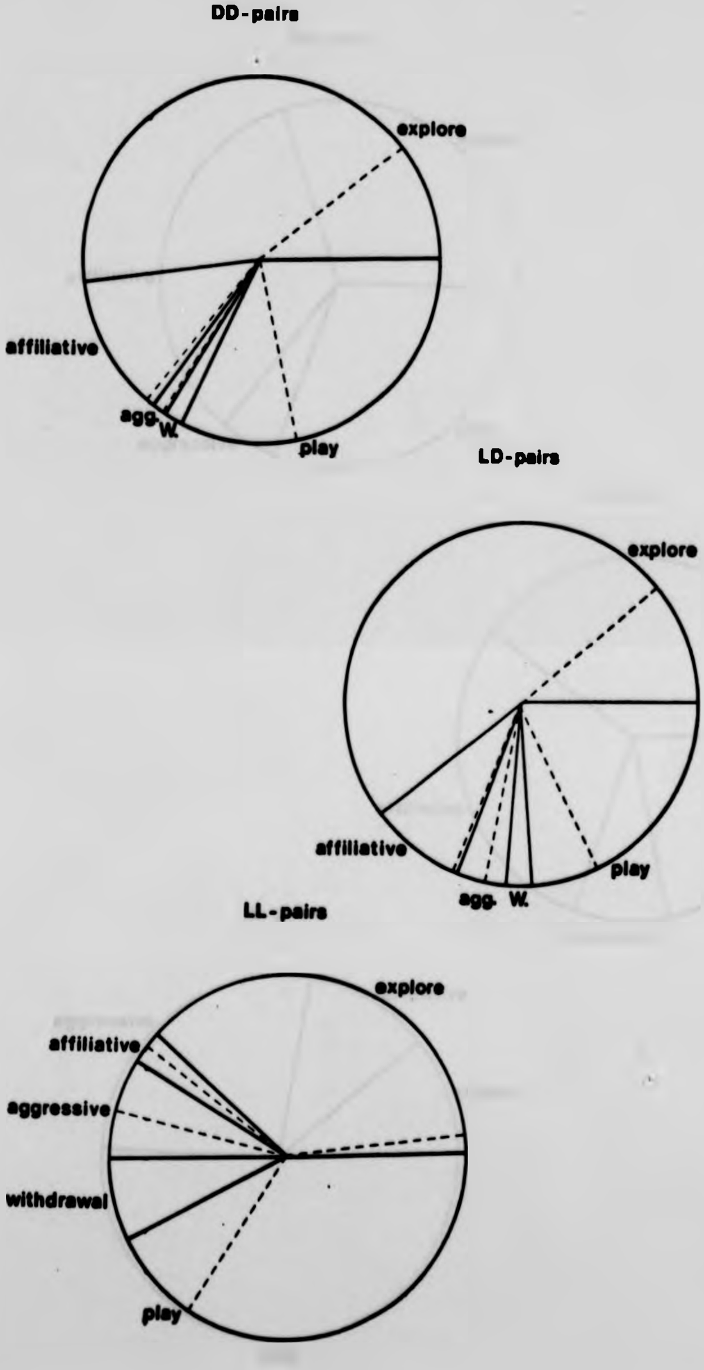
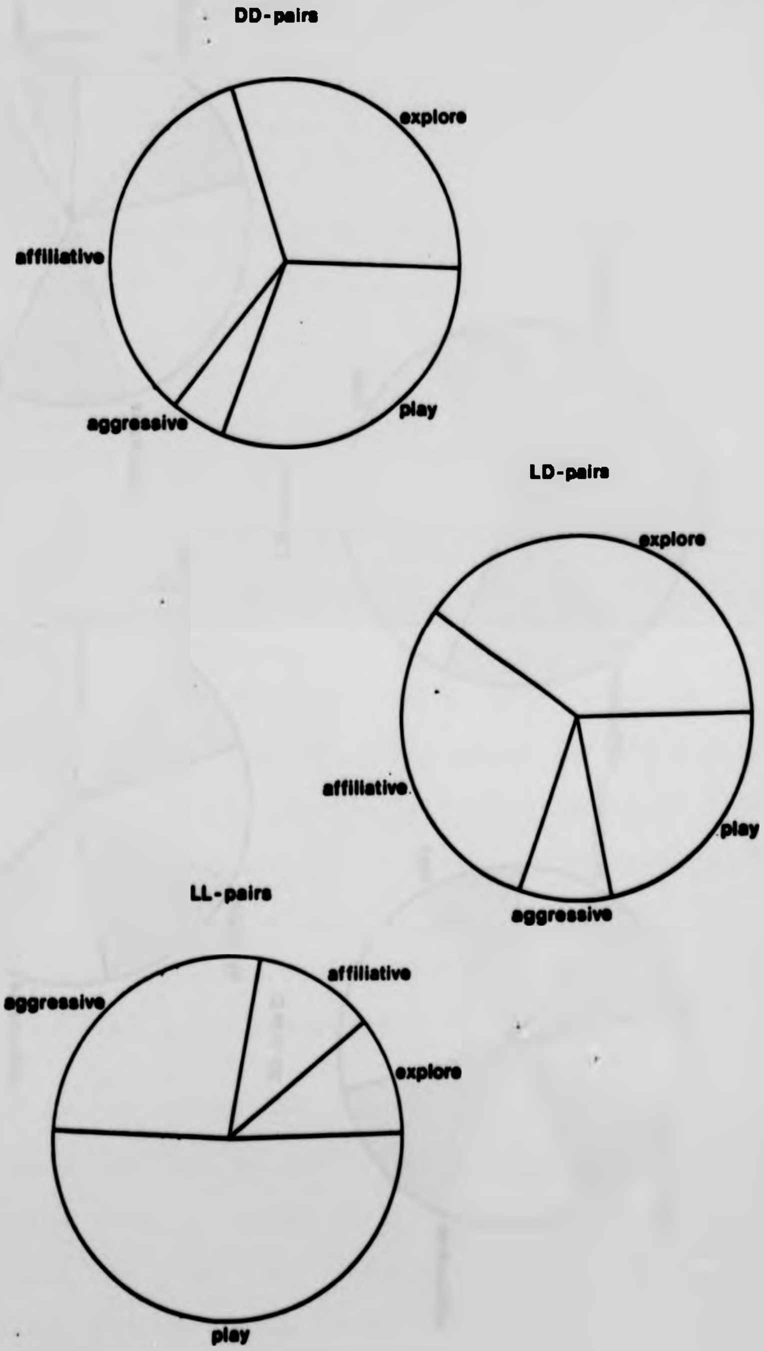


Figure 22. Socially-directed behavior separated into the relatively large noncontact and smaller contact component (moving clockwise).



Figre 23. Pie charts dividing socially-directed contact behavior into four subcategories. Withdrawal contact rarely occurred and so is not included here.

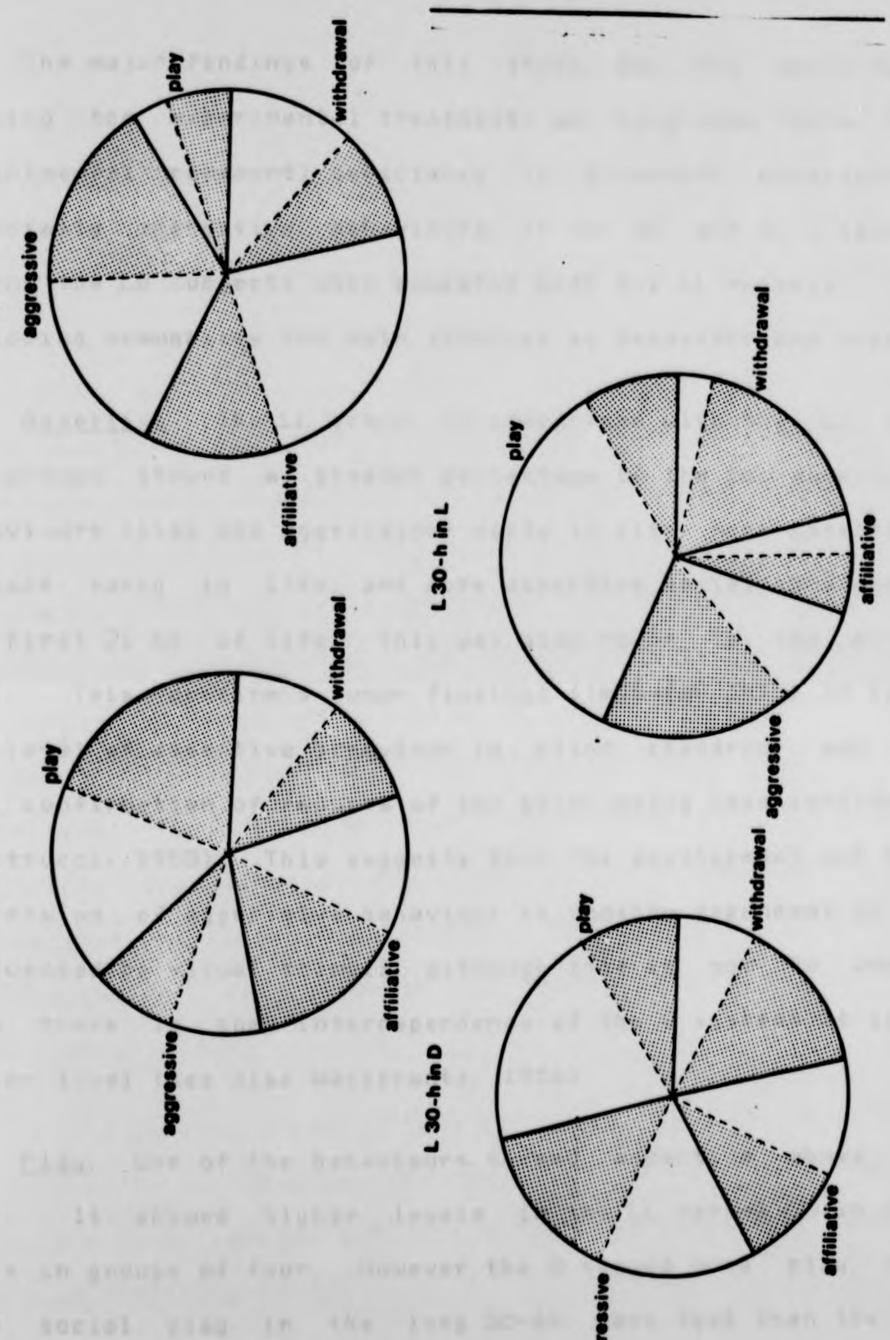


Figure 24. Four behaviors exhibited during the two 30-h. long tests subdivided into social (hatched) and nonsocial direction for the D and L groups.

understanding of the short-term handicap nature of blindness.

The major findings of this study was the short-term (during the experimental treatment) and long-term (after the experimental treatment) deficiency in assertive behaviours, especially aggressive behaviours, in the DD, and to a lesser extent the LD subjects when compared with the LL monkeys. The following summarizes the main findings by behaviour and type.

Assertive. The LL group, in comparison with the LD and DD groups showed a greater percentage of the two assertive behaviours (play and aggression) early in life, more assertive contact early in life, and more assertive social throughout the first 21 mo. of life. This was also found in the mixed test. This confirm's human findings (Imamura, 1965) of half the level of assertive behaviour in blind children, and is weak confirmation of reports of the blind being less confident (Pettrucci, 1953). This suggests that the development and the expression of aggressive behaviour is somehow dependent on or influenced by visual stimuli, although this is not to imply that there is some interdependence of the 2 systems at some higher level (see also Weiskrantz, 1956).

Play. One of the behaviours termed assertive above is play. It showed higher levels in the LL verses LD in the tests in groups of four. However the D showed more play and more social play in the long 30-hr. dark test than the L, possibly due to the D being more comfortable in that situation. If the L were more uncomfortable in the dark then one would expect the LD to show more withdrawal behaviour indicative of increased emotion, but this was not seen in the longitudinal test.

Aggression. The other assertive behaviour, social aggression, was consistently lower in the dark conditions. The L were more aggressive, even in the 30-hr. dark test than the other monkeys. This confirms reports that the blind show one-third the amount of aggression of sighted children (Imamura, 1965). The D are however more self-aggressive than the L group (a) when housed alone, (b) in the 30-hr. dark test, and (c) in the 30-hr. light test. This plus a tendency for higher levels of most self-directed behaviour (see Fig. 20) may support reports of Sandlers et al. (1965) of the blind being more self-centered and Pettrucci (1953) of being more neurotic and introverted. The consistent effects of reduced aggression confirms experiments by Devanzo (1969) that blindness has very basic effects on the induction of aggression. The finding that restricting visual social experience dramatically reduces aggression argues against the energy theory of aggression (Lorenz, 1966), but its partial replacement by self-directed aggression is some support for that theory.

There were no signs of less stability in the dominance heirarchy or preference abnormalities in the D group as suggested by Burlingham (1961) but not confirmed by Imamura (1965) or Fraiberg (1977).

Affiliation. No clear affiliation differences were found in the 21 mo. tests. The D showed more affiliation and more social affiliation in the 30-hr. dark test. This is some support for Imamura's (1965) finding of more succorance in the blind but succorance in the monkeys was never the predominant behaviour that it was in the blind children.

Withdrawal. This behaviour did not reveal group differences in the longitudinal test. The D showed less withdrawal in the 30-hr. dark test and in the mixed test in the light, which may reflect emotionality or responses to aggression. Imamura reports equal levels of submissive behaviour in the blind vs. sighted children, but Berkson (1977) claims that blindness in free-ranging monkeys primarily increases the level of fear reactions.

The D did seem less responsive, especially in levels of withdrawal, to visually-novel inanimate objects and were less reactive to the new room and the infant stimulus animal. This supports the finding by Regal et al. (1979) who report totally dark-reared monkeys being less responsive to visual stimuli. My D monkeys were more reactive in the presence of novel animals and more reactive towards the unfamiliar ticking clock in the dark.

Direction. The LL were more socially oriented early in life, but this may be because noncontact social behaviour is easier in the light. When compared with the LL the DD were less social in the quadrad longitudinal test also, although the LD were more social. This finding is contrary to Imamura's report that the blind interact more with other people. Perhaps as Sanders et al. (1965) suggest, inanimate objects are less interesting to the blind than to sighted individuals.

Type. The LD showed more contact behaviours that the LL when in groups of four but few other overall differences. On the other hand the LL showed more contact forms of assertive behaviour early in life in pairs. This does not confirm the findings of Gergen et al. (1973) of students showing more contact in the dark or of Imamura (1965) of the blind showing equal levels of contact but more noncontact actions than the sighted children.

Rate. The LL showed more overall behaviour than the DD at 3 mo. of age, and the L showed more than the D in the mixed test. The bout-length of most behaviours were longer in the LL verses the LD in the longitudinal fours tests. The DD showed longer bouts of contact behaviours than the LL (but the LD showed the longest). This supports Imamura's reports that the blind have high rates (short bout-lengths) of behaviour, especially succorance and sociability behaviours.

One of the most surprising aspects of this study was the speed at which the monkeys adapted to the dark social situation. Within a few days it was impossible to tell whether one was observing in the dark or light situation. In fact the animals seemed so competent in the dark that there was some concern that they could in fact see. They seemed to know where the other animals were even when not in contact with them and even in the more complex group of four (see Figure 25). Sitting with the animals in the dark, it was soon evident how this was possible. The animals were making considerable noise breathing. It was likely that the monkeys were using these cues to locate their partners. Whether they could recognise the other animals by these cues was not clear,

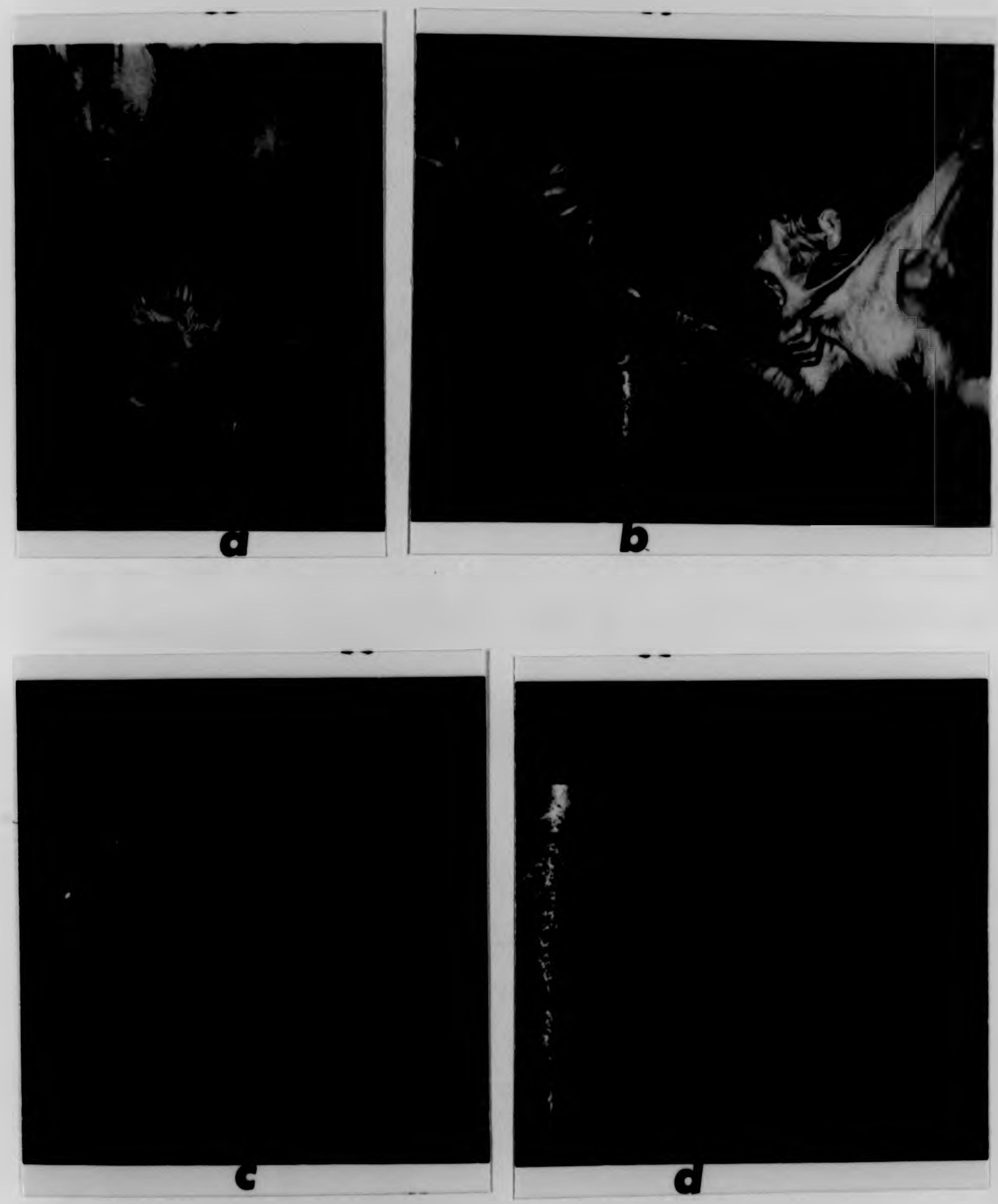


Figure 25. Four D monkeys aged 12 mo. interacting in total darkness. This figure illustrates(a) the open-mouthed play face with eyes averted, (b) an intentional play bite, (c) open-mouthed playing but attending to a third animal, and (d) a rare grab and threat face. Much of the time the monkeys choose to suspend themselves from the ceiling mesh and interact head downwards.

Figure 25. Four D monkeys aged 12 mo. interacting in total darkness. This figure illustrates(a) the open-mouthed play face with eyes averted, (b) an intentional play bite, (c) open-mouthed playing but attending to a third animal, and (d) a rare grab and threat face. Much of the time the monkeys choose to suspend themselves from the ceiling mesh and interact head downwards.


a
b
c
d

but when strange animals were introduced into the cage, the animals seemed to realize this at once, and their behaviour changed from that seen when a familiar peer was introduced. The dark situation did not appear to be at all aversive to the animals (Weiskrantz & Cowey, 1975).

In making the comparisons between monkey and human, we can speculate that the reduced levels of assertive and aggressive behaviours found in those who cannot see are clearly due to reduced visual input, that this is in some way cumulative, and that this leads to self-directed behaviours. The reduced levels of succorance in blind children is probably due to the disadvantage of the blind interacting with normally-sighted individuals.

CHAPTER SEVEN

Discussion

With the demise of Lamarckism it has been assumed that early-acquired behaviours which are adaptive can only be transmitted from parent to offspring through the vague mechanism of what has come to be termed "early experience". Here behaviour is either transmitted through observational learning, something very difficult to demonstrate under controlled conditions (Hall, 1963; Chamove, 1974b), or through some hypothesized mechanism whereby the behaviour of some other individual has some effect on some behaviour of an infant. This categorization excludes the indirect effects of an adult selecting an environment where certain behaviours are more likely to be learned (Galef, 1976). Examples of the latter are the various theories of aggression transmission, such as, catharsis, frustration, and instrumental theories (reviewed in Johnson, 1972; Moyer, 1976).

However, it would seem to be advantageous for an infant to be genetically programmed to adopt rapidly any (potentially adaptive) behaviours which have been developed in the mother through experience. This is on the assumption that since the mother is surviving, then these behaviours are relatively successful. One simple mechanism whereby this could be effected would be a genetically based predisposition for the infant to copy certain behaviours of the mother. One might expect, therefore, that mothers would transmit their behavioural traits to their offspring during that period of infant dependency. And as it grows older the infant would exhibit these behaviours towards other animals and, perhaps even towards its own mother. (I use the term mother and caretaker interchangeably in this discussion).

Social aggression

In an attempt to understand the differing aggressivity of young macaques experimenters have reared infant monkeys from birth in varying conditions which have subjected the infants to differing amounts of aggression from their rearing companions. These amounts varied from normal levels, as would be found in wild-born monkeys, downwards to almost none. They have also tested monkeys that were reared with others in such a way which subjected them to more aggression than normal. As these studies span 15 years, the data between studies are not always comparable, but the data within the studies are, and it is this data I will be using. I wish to concentrate on only one behaviour, social aggression, because this behaviour is relatively less affected by other behaviours, such as disturbance or withdrawal, than would be the case with most other behaviours and is therefore more easily studied. Self-aggression will not be discussed here (see review in Chamove & Anderson, in press). I will use the term aggression to mean overt aggression, usually physical assault or threats of assault. I will use the term aggressiveness to mean a predisposition for aggressive behaviour. This definition of aggressiveness includes both "preparedness to fight", which Wilson (1975) feels should not be part of aggressiveness but

Toates (1980) does, as well as "the duration and intensity of the act in the face of ambiguous stimuli", which some might interpret as a measure of persistence rather than aggressiveness. Lagerspetz (1969) found these two variables to be characteristic of mice bred for aggressiveness, but independent of one another in a factor analysis. He termed them Latency of Attack and Aggression. In Chapter 5, factor analyzing the behaviour of juvenile rhesus macaques I found nine different factor loadings on nine measures of behaviour depending on whether I used frequency or duration scores, although intercorrelations of frequency and duration measures were high. Aggressiveness is measured operationally by some measure of the duration or frequency of aggression in some specified test situation, and the predisposition for aggression is inferred from the level of this observed behaviour and latency to attack.

Also I will concentrate on monkeys reared by a single caretaker, given additional social experience with at least one other monkey, and tested by being in a situation of facing an unfamiliar peer or younger animal. I think that the results of studies on nonhuman primate aggression suggest the original hypothesis that: <u>There is some rather direct mechanism for the transmission of acquired levels of aggression from mother to offspring</u>. This hypothesis would be supported by a positive correlation between the amount of aggression experienced by the infant during the normal period of infant caretaking and the amount of aggression shown by that infant in conditions when it is possible for it to be aggressive. As I know of no study designed to test this hypothesis directly, I will review those studies which bear indirectly upon it. The subjects used were macaques unless otherwise stated.

It seems that most studies of primate social development observe the effect of some general variable on specific behaviour. For example, Arling (1972) wished to see the effects on social development of being reared by an abnormally brutal mother. He recorded the development of playful, aggressive, etc. behaviour by the infants and recorded similar behaviour by the mothers. The mothers showed high levels of aggression towards the infants, and the infants were not very playful towards peers. The inference was then made that the abnormal mothering or the low peer play lead to those abnormalities later found in the social behaviour of the infants when in the second year of life, namely, high levels of aggressive behaviour (Sackett, 1968a). It is rare that an attempt is made to make statistically explicit these inferences. Is there a correlation between maternal aggression and infant play or juvenile aggression, or between infant play and juvenile aggression?

Nonhuman Primate Studies

Increased aggression.

Monkeys, because of the variance in their behaviour and its suspectibility to manipulation (Bronfenbrenner, 1966), have been the subjects of many experiments to observe the effects of manipulating early experience on later behaviour. The most aggressive, socially-reared monkeys found are those reared by so called motherless-mothers, females who were themselves reared in isolation. Less aggressive are normal wild-born mothers who have had at least one previous infant; these multiparous mothers also groom their infants more and retrieve them less than do primiparous mothers. Least aggressive of mother-reared monkeys are wild-born mothers with their first infant. During the first and second mo. after birth wild-born multiparous mothers punish their infants 5 times and twice as much respectively as do primiparous mothers (Mitchell, Ruppenthal, Raymond & Harlow, 1966), the difference being especially marked in the category labelled 'bite'; whereas the first-born infants of motherless mothers experience almost 10 times as much maternal rejection and punishment during the first 30 days of post-natal life and twice as much in the next 30 days as infants of wild-born multiparous females. Within these groups, mothers of males threaten and bite their infants 2 or 3 times more often than do mothers of females (Mitchell & Brandt, 1970).

During the first 6 mo. of life, and while still with the mother, these groups of infants showed levels of aggression of the order predicted by the hypothesis. Monkeys raised by multiparous mothers showed over half again as much aggression, specifically the clasp-bite-pull behavioural constellation, towards other infants as did first-born infants from wild-born mothers. And males were more aggressive than females. Mitchell concluded that the fact that rhesus mothers punish their male infants earlier and more often than their female infants, may promote male assertiveness (1969). He did not suggest a mechanism by which this may be accomplished.

After being separated from their mothers and housed in peer groups, levels of aggression continued as predicted. The infants reared by wild-born mothers aggressed against unfamiliar peer stimulus animals twice as much as did isolates reared in wire cages. But the former were surpassed almost three-fold by the very aggressive motherless mother-reared monkeys (Sackett, 1968c). Arling (1971) reports two types of motherless mother: active inadequate and passive inadequate. Infants of the former were more aggressive than infants reared by the latter. Finally, prepubescent later-born mother-reared monkeys showed 3 times the hostility of first-born, mother-reared monkeys (Mitchell et al., 1966).

Mitchell, Arling and Moller (1967) selected 32 juveniles about two years of age and tested them with an aggressive adult and a young infant monkey after the subjects had been separated from their mothers for an average of 20 mo. Most had been reared by normal wild-born mothers. After looking at the amount of punishment their mothers directed towards them during the first 3 mo. of life, the group was divided in half into a high-punished and low-punished group. The high-punished group threatened the stimulus monkeys over twice as often and bit them 8 times as much as the animals who had experienced less maternal punishment during the first 3 mo. of life, supporting the hypothesis.

In a study designed to assess the effects of inconsistent mothering, but also one which inadvertantly subjected infants to above-normal levels of aggression, Griffin (1966; also reported in Moller, Harlow, & Mitchell, 1968) rotated the infants of wild-born mothers between 4 different females, changing from one mother to another once a fortnight. These infants were often rejected and bitten when introduced to the new mothers. One of his control groups, the separation-control group, consisted of infants separated fortnightly, but without the rotation, and then returned to the same mother. This traumatic separation experience seemed to make the mothers even less punitive toward their infants than those mothers in the other control group which involved neither separation nor rotation. Again the aggresiveness of the infants was of the expected order. Aggression was almost nonexistent at the age of 19 mo. in the separation control monkeys, intermediate in the nonseparated controls, and over twice as frequent in the rotated mother groups as the nonseparated controls. This difference was still present when the subjects were retested at 3 years of age by Sackett (1968).

A study by Castell and Wilson (1971) offers some further support for our hypothesis. Using pigtailed macaque infants (M. nemestrina) reared only with their mothers and no peer contact, i.e., mother-only rearing, they found that reducing the cage sizes was found to double the level of infant-directed maternal aggressiveness (see Chamove for effects of cage size on aggression in peer-reared monkeys, 1973d). The three infants reared in the small cages with the aggressive mothers were ranked 1,2 and 4 in dominance when finally grouped with the two infants reared in larger cages, some support for the hypothesis.

Another study (Wolfheim, Jensen, & Bobbitt, 1970) offers only the most indirect support for the hypothesis. Two groups of mother-infant pairs were reared--one group in an impoverished environment and one in a much more complex environment of the same size. The infants of the impoverished group spent more time in contact with the mother and actually playing on her. If we infer from this that she punished her infant less, although there was no report of this behaviour category, then this result could be the cause of the reported lower levels of infant-directed aggression in this impoverished group when compared to the complex group.

Alexander (1968) found similar effects when he reared three groups of rhesus monkeys restricting peer social interaction to three different levels but allowing maternal social experience: (a) mother-only for 8 mo., (b) mother-only for 4 mo., and (c) mother-only for 0 mo., a control group given peer contact and contact with the mother from birth. When tested as juveniles, by confrontation with strange peers, aggression against these peer stimulus animals was greatest in the first group, intermediate in the second, and least in the control group. Retesting by Mitchell (1970) confirmed that these differences persisted up to 6 years of age. Children too reared in mother-only families are more aggressive than those raised in families with fathers and peers present and the mothers in these one-parent families are more aggressive as well (Howe, 1981).

Reduced aggression. To produce a situation of reduced levels of aggression from that found in normal mothering, I used the following three rearing conditions following separation of the infants from their mothers at birth: One group of monkeys was given an inanimate, surrogate mother made of cloth and allowed one hour of daily social interaction with another surrogate-reared infant; in another group each monkey environment of the same size. The infants of the impoverished group spent more time in contact with the mother and actually playing on her. If we infer from this that she punished her infant less, although there was no report of this behaviour category, then this result could be the cause of the reported lower levels of infant-directed aggression in this impoverished group when compared to the complex group.

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Reduced aggression. To produce a situation of reduced levels of aggression from that found in normal mothering, I used the following three rearing conditions following separation of the infants from their mothers at birth: One group of monkeys was given an inanimate, surrogate mother made of cloth and allowed one hour of daily social interaction with another surrogate-reared infant; in another group each monkey was continuously housed with another infant; and in a third group each monkey lived with three other infants. The surrogate mother of course never punished the infant, for it was a mother with "infinite patience", but the other surrogate-reared infants, with which the surrogate-reared infants were allowed to play, showed some aggression during their one-hour daily encounters. Although one could argue that the most salient figure in the infant's environment was the inanimate surrogate and that most of the attachment of the infant was towards that surrogate, it would seem that in such a situation (such as a peer-rearing situation), where the infant is exposed to the aggression of other infants, then the hypothesized mechanism for aggression transmission would respond to the levels of aggression found coming from the infant's peers. In the dyadic, 2-together-together group there was actually less aggression than in the surrogate group. The animals were called together-together because when disturbed they would cling together. Aggression in this group usually occurred when one of these infants tried to disengage himself from the affectionate clutches of the other. In the 4-together-together situation aggression was rarely seen, perhaps because there were always alternative bodies to cling to. In this situation the behaviours which are normally directed towards the mother are directed instead towards the peer. The three groups were compared with five other groups of four infants all reared by normal wild-born mothers, i.e., infants that had experienced a normal amount of aggression, but one which exceeded by several times that of the three experimental groups. Although only tested with familiar like-reared peers, the ordering of aggression during the first

6 mo. was as predicted by the hypothesis. The 4-together-together subjects showed the least peer-directed aggression, the 2-together-together subjects about twice as much, the surrogate-reared infants about 4 times as much as the dyadic group, and the mother-reared group over twice as much as the surrogate-reared monkeys (Chamove, Rosenblum, & Harlow, 1973).

As a sequel to the initial together-together study (Chamove, 1973b), I attempted to separate the unique components of the 2-together-together rearing, which consists of rearing an infant (a) always with another infant, (b) that infant being the same infant, and (c) that infant being a single infant. The reason for this was interest in the high level of clinging and low level of playing exhibited by the together-together monkeys. So four groups of six monkeys each were arranged: six always lived in the same pairs, the 2-together-together monkeys; six lived in pairs which were separated on alternate weeks, the together-apart group; six in pairs which changed in composition weekly, the changing-together group; and six lived in a group together, the 6-together-together group. The amount of aggression seen in the homecage rearing situation during the first year of life was highly related to that found after two years of age when the subjects were tested with unfamiliar stimulus animals. During rearing the changing-together infants were twice as aggressive as the almost totally nonaggressive 6-together-together animals, whereas the together-apart infants were almost 3 times and the 2-together-together dyads over 3 times as aggressive as the 6-together-together. When tested individually at two years of age with juvenile and adult stimulus animals the 6-together-together group were slightly above the changing-together group in aggression, a slight reversal of the predicted order. This was due to the fact that the 6-together-together group was more aggressive towards the adult stimulus animals than the changing-together were toward the juvenile stimulus animal. I cannot explain this differential responsiveness to adults and juveniles. As predicted, however, the 2-together-together group were four times as aggressive as the 6-together-together group and the together-apart group were intermediate in aggression.

In another study (Chapter 4 above) designed to manipulate dominance, 24 infant monkeys were assigned to one of three groups: the dominant group, given all of their social experience from infancy with two much younger monkeys; the intermediate group, always with one older and one younger monkey; or a subordinate group, always with two older monkeys. The dominant subjects were the most aggressive, were never the object of aggression, but were the object of most of the play behaviour; interestingly the intermediate animals received most of the aggression and an intermediate amount of play; subordinate monkeys were the least playful. The measures of aggression, when the monkeys were later tested with infant and juvenile stimulus animals, support the hypothesis. The intermediate group was the most aggressive, the subordinate group less aggressive, and the dominant monkeys the least aggressive of the stimulus animals.

When dominance is not manipulated experimentally and individuals in 2-year old groups of peer-raised animals are merely selected for study on the basis of their spontaneously emerged dominant and subordinate status, animals occupying different ranks behave differently (Altmann, 1969; Candland & Leshner, 1974). In such groups when hostility is not spontaneous but rather is accentuated by limiting a resource, i.e., in a water bottle competition test, the most aggression is shown by dominants, the least by subordinates (Chapter 1 above). When dominants are placed together in a single group and the same for intermediates and subordinates (also Chapter 1 above), aggression shows the same pattern as in the competition test--most for those previously and presently dominant, least for subordinates. This suggests that once dominance is determined, the behaviour patterns are maintained and not constantly modified by resulting changes in experience. This example is different from all others cited herein in that knowledge of the early experience of these monkeys relevant to the hypothesis is not available, and therefore the results do not bear directly on our hypothesis. In addition, one might expect the behaviours seen in different dominance ranks to be at least as characteristic of the individuals occupying those ranks as of the rank itself. Whether a dominant monkey is aggressive or not will depend upon its personality and how often it is challenged by subordinates; however, whether a monkey is dominant or not will depend on personality factors like its persistence, its use of strategies and alliances (Nash & Chamove, 1981).

Also of relevance to the hypothesis is another study I have just completed, from which results are only partly analysed. Four groups of stumptailed macaques were used. The merely selected for study on the basis of their spontaneously emerged dominant and subordinate status, animals occupying different ranks behave differently (Altmann, 1969; Candland & Leshner, 1974). In such groups when hostility is not spontaneous but rather is accentuated by limiting a resource, i.e., in a water bottle competition test, the most aggression is shown by dominants, the least by subordinates (Chapter 1 above). When dominants are placed together in a single group and the same for intermediates and subordinates (also Chapter 1 above), aggression shows the same pattern as in the competition test--most for those previously and presently dominant, least for subordinates. This suggests that once dominance is determined, the behaviour patterns are maintained and not constantly modified by resulting changes in experience. This example is different from all others cited herein in that knowledge of the early experience of these monkeys relevant to the hypothesis is not available, and therefore the results do not bear directly on our hypothesis. In addition, one might expect the behaviours seen in different dominance ranks to be at least as characteristic of the individuals occupying those ranks as of the rank itself. Whether a dominant monkey is aggressive or not will depend upon its personality and how often it is challenged by subordinates; however, whether a monkey is dominant or not will depend on personality factors like its persistence, its use of strategies and alliances (Nash & Chamove, 1981).

Also of relevance to the hypothesis is another study I have just completed, from which results are only partly analysed. Four groups of stumptailed macaques were used. The subjects comprising the mother-peer group were reared by the mothers in continuous contact with their own and other mothers and peers. All other groups were of infants separated from their mothers soon after birth and housed so they could not see other monkeys. These were all given social experience for at least one hour per day. The infants comprising the adult-peer group were put with wild-born females who had previously reared infants of their own, so these infants had contact with both adults and peers for one hour daily. The infants in the peer group were put with peers only. And the infants of the dark-peer group with peers in the dark, so that they never saw other monkeys; for the remaining 23 hours they were in their own cages in normal lighting, (this group was a replication of subjects described in Chapter 6).

When viewed with a special television camera sensitive to infra-red light, the dark-peer group showed surprisingly normal behaviour except that they were almost never seen to show any aggression. The peer group showed the usual, commonly-reported low levels of aggression. The mother-peer group infants were exposed to higher levels of aggression, i.e., normal levels. But the adult-peer group infants were the objects of the most aggression. It appeared that their playful and/or disturbance behaviours irritated the adults, and in the absence of a protective mother, they were threatened, chased, and bitten more than were the other groups in their groupings.

The experimental conditions were terminated after a year and all animals were tested alone with peer stimulus animals with which they were unfamiliar. They were then housed in groups of four with other familiar peer animals from their rearing condition. After this they were retested with stimulus animals and then in round-robin pairings. The results of all of these tests confirm the hypothesis with the monkeys ordered in their aggressiveness from highest to lowest: adult-peer, mother-peer, peer, and dark-peer groups.

Another experiment (Chapter 3 above), designed to evaluate different types of "therapy" administered to socially abnormal monkeys, is also relevant to the hypothesis. A group of 9-mo. old macaque monkeys reared alone in bare-wire-cages and a group of 3-mo. old similarly reared monkeys were each subdivided into three groups. Members of one subgroup from each of the two groups were paired daily for 20 weeks with 3-mo. old infants; members of another subgroup from each were paired with 9-mo. old partial social isolates; and the third subgroup from each was paired with 9-mo. old socially experienced but nonaggressive monkeys. Those paired with infants were exposed to the least aggression of the three, those paired with partial isolates were exposed to the most, and those with socially sophisticated partners falling intermediate. When tested with others from their own treatment condition, the following results again support the hypothesis. Those infants that had been paired with infants were the least aggressive, whereas infants paired with isolates showed almost one-half times as much aggression. The other infant group was intermediate. The isolates showed the same pattern. Infant-paired isolates were the most pacific. Almost twice as much aggression was recorded from isolates paired with socially sophisticated peers. And the highest levels of aggression, almost 3 times that of the former group, were seen in those isolates paired with other isolates. Play behaviour showed a similar pattern. Whereas infants were the most playful and isolates the least playful, the levels of play that the subgroups exhibited paralleled the levels of play shown by their partners towards them.

An instrumental model of aggression (Hutchinson, 1973) which assumes that an infant would positively reinforce aggression by withdrawal and fearful behaviour and that an experienced monkey would punish aggression by being even more effectively aggressive in return, predicts higher levels of aggression in monkeys paired with infants than in those paired with experienced and socially sophisticated animals. The reverse was found: Infants or isolates or even socially sophisticated monkeys paired with infants became less aggressive than those paired with experienced monkeys or with isolates.

Statistical Validation

In an attempt to validate this hypothesis statistically I have looked at two sets of data. The first is a correlation coefficient matrix (reported by Mitchell, 1968) on 30 behaviours of 32 mother-infant pairs during the first six mo. of life. Although the infants were able to interact with other infants, the behaviours reported by Mitchell were only those between mother and infant. Although the hypothesis suggests that maternally-instigated infant-directed aggression will be subsequently expressed in peer-directed aggression by the infant, an extension of this idea would predict that perhaps some of this infant aggressiveness will be seen in mother-directed aggression by the infant. If we look at the four maternal hostile categories--reject, threat, aggress, and clasp-pull-bite, we can see that three of these maternal behaviours correlate significantly with the only infant hostile category reported, i.e., clasp-pull- bite, +.40 ($p<.05$), +.74 ($p<.01$), -.11, and +.36 ($p<.05$) respectively.

I continued analysis of these data using a factor analysis according to the method described in chapter 5. Mitchell's intercorrelations were subjected to a principal components analysis rotated to oblique simple structure. Three factors with eigenvalues above unity were extracted (see Table 10). Factor 1 was found to correlate with Factor II and Factor III ($r=+.23$ and $+.73$ respectively) whereas Factor II correlates with Factor III ($r=+.28$). Factor I, which I have labelled Infant Assertiveness, supports our hypothesis. It suggests that aggressive infants, i.e., infants who clasp-pull-bite their mothers, have mothers who threaten, reject and clasp-pull-bite them but that do not show the behaviour termed aggress towards them. This rather more violent behaviour is reserved for Factor II, which I have labelled Maternal Accept/Reject, and suggests a less positive relationship between mother and infant at its negative extreme.

Although I have no explanation for this, it should be noted that the second order factors are 10 in number. One similar to Infant Assertive is the one with the largest eigenvalue, and the primary factor loadings here are even greater than in the three higher order factors (see Table 10). It is also interesting that in 32 rhesus mothers there is no

Table 10.

Loadings of 38 Behaviours on Three Factors. M refers to Behaviours of the Mother, I of the Infant. Numbers in Parantheses are Loadings of one Factor of Second Order Rank (see text).

Behaviours		Factors			
		I	II	III	
I	Approach	.90	.12	-.15	(.99)
I	Incidental contact	.80	-.12	-.14	(.89)
I	Clasp-pull-bite	.73	.04	-.01	(.95)
M	Grimace	.73	.11	.38	(.30)
I	Oral explore	.68	-.09	.18	(.58)
M	Threat	.60	-.07	.05	(.81)
I	Look at mother	.60	.08	.02	(.34)
I	Withdraw	.57	-.14	-.16	(.90)
M	Indifference	.52	.21	-.02	(.37)
I	Clasp	.42	.12	-.17	(.41)
M	Clasp	.42	-.34	.32	(.09)
I	Manual explore	.39	-.15	.10	(.34)
M	Present	.35	.27	.01	(.16)
M	Reject	.32	.62	-.23	(.59)
M	Clasp-pull-bite	.24	.48	.20	(.33)
M	Withdraw	-.09	.99	.12	(.11)
I	Gross contact	-.17	.88	.12	
M	Approach	-.08	.54	-.26	
M	Silly grin	-.11	.43	-.13	
M	Look at infant	-.12	.34	.05	
M	Aggress	-.30	.87	.12	(-.14)
M	nonventral contact	-.25	.69	.09	
I	Coo	-.45	-.06	-.07	(-.15)
M	Mount	-.28	.05	-.17	
M	Play	-.28	.05	-.17	
I	Ventral	-.25	-.72	.07	
I	Nipple	-.14	-.67	.04	
I	Embrace	-.17	-.74	.09	
M	Embrace	-.19	-.76	.04	
M	Groom	.10	0.57	.23	
M	Restrain	-.17	.15	-.55	
M	Retrieve	-.01	.09	-.42	
I	Submit	-.13	-.04	-.24	
M	Oral explore	-.09	.13	-.72	
M	Manual explore	.09	-.06	.75	
M	Convulsive jerk	-.04	-.03	.25	
M	Imitate	.19	-.22	-.05	
M	Submit	.06	-.08	.10	

correlation between aggress and clasp-pull-bite (r=.00), a negative correlation between threat and aggress (r=-.12), but a positive correlation between threat and clasp-pull-bite (r=+.50) (Mitchell, 1968). Also of interest here is the finding of an assertive factor. This supports previous results factor analyzing the behaviour of 91 (Chapter 5) and 168 (Chamove et al., 1972) juvenile rhesus monkeys and a different technique, principal components analysis of subjective rankings, on 10 rhesus monkeys (Zunz & Stevenson-Hinde, 1978).

The second aggregate of data used to statistically validate the hypothesis is a composite Kendall Rank Correlation derived from the ten studies described above. Rankings were made of the aggressiveness of the animate attachment figure and of the aggressiveness of the infant, choosing when possible, behaviours shown when in the absence of the mother. This ranking made use of the means of the attachment figures' scores and means of the infants' scores for each of the 39 groups making up the 10 studies described above. A close relationship was found (tau=+.95) suggesting that the level of aggression expressed by the most prominent attachment figure of a young monkey's social associates is positively and highly related to the later aggressiveness of the infant to its peers.

Some primate field workers have made similar suggestions. Imanishi (translated into English in 1965 from the 1961 Japanese text) suggested that infant males may assume both their "correct" (sic) sex role and dominance role by personal absorption of the personality of a specific adult male, that is, indentification in the Freudian sense. Others have felt that observational learning, e.g., by the infant of the mother's behaviour towards other group members, is more important than what they term the conditioning effects of the mother's behaviour (e.g., Nagel & Kummer, 1974).

Nonprimate Studies

A search through the rodent literature was unsuccessful in revealing studies directly bearing on our hypothesis. The only study approaching relevance was by Kahn (1951) partially replicated by Cairns (1973). He used rats past the age of weaning and therefore at an age when one might expect different mechanisms from those suggested in this chapter to be influencing the developing juvenile. He found that although a single severe defeat made a mouse temporarily more aggressive, multiple severe defeats lead to reduced aggression in survivors when later tested with a passive "dangler" mouse (see also Motshagen & Slangen, 1975). Work by Ryan and Wehmer (1975) suggests that aggression in the mouse may be more complex. They found that mice from large litters had lower weights but higher emotionality levels than mice from small litters. The former were more aggressive during group living, and they were more aggressive upon initial, but less aggressive upon subsequent, encounters with strange mice.

Similarly, prior exposure to inescapable shock reduces the frequency of shock-induced fighting in adult rats, while escapable shock does not lead to similar reductions (Maier, Anderson, & Lieberman, 1972).

Uyeno (1960) cross-fostered rats bred from parents selected for social dominance or subordinance. Surprisingly, genetically dominant rats reared by genetically dominant mothers became relatively subordinate compared with dominants reared by subordinate mothers. Genetic subordinates were not differentially influenced by maternal type. The behaviours the mothers exhibited during rearing were not reported. Lagerspetz (1969) cross-fostered mice pups from a strain bred for aggressiveness. She found little differential effects of mothering on aggressiveness of the pups. Most of the other studies have used subjects even older than weaning age, often in competition for food (Scott & Frederickson, 1951; Frederickson, Fink, & Parker, 1955).

Frederickson tested his two strains of mice, C57Bl/6 and BALB/C, at a very young age for experiments involving mice but after weaning, 30 days, in food competition and found no effect of the aggressive level of the rearing mother. Southwick (1968), using strains more divergent in aggressivity than the above study (A/J and CFW), found an increase in aggressive behaviour of between 50% and 100% percent in the passive strain cross-fostered by the aggressive CFW strain when compared to appropriate controls. Neither study reported maternal behaviours toward the infant. Denenberg has shown that early handling of rat pups affects several behaviours of the grandpups of the handled animals (Denenberg & Rosenberg, 1967), but again no measures of maternal aggressiveness towards the pups were taken.

Human Studies

The ethnological literature on human societies gives some support to the hypothesis. Those cultures reputed to be at the two extremes of aggressiveness are correspondingly extreme in their use of physical punishment during child-rearing. The aggressive Yanamamo (Chagnon, 1974) and Ik (Turnbull, 1972) use considerable physical punishment during this child-rearing period; the nonviolent Semai (Dentan, 1968) and Cheyenne (Hoebel, 1966) are reported to use none.

Kagan and Moss (1962) in their study of the effects of child rearing practices in the behaviour of individuals in western culture concluded that:

> Maternal restrictiveness during ages three to ten was the most consistent correlate of aggressive behaviour in adult men and women. Maternal hostility was the best correlate of aggression to peers during childhood. (p 224)

Sears, Maccoby, and Levine, among others (McCord, McCord, & Howard, 1970; Bandura & Walters, 1959; Becker, 1964), point that the pattern of child-rearing that produces the most aggressive behaviour in children is one where the parent punishes the child using physical aggression or threats of physical aggression (1957). Reviews of the published literature on agonistic behaviour concur with the suggestion that the antecedents of aggressive behaviour are past exposure to physical punishments (Johnson, 1972, Feshbach, 1964). Neither the mechanism for this connection nor the degree of association is specified. Nevertheless, recent reviews speculated that the situation is the most important determinant of human aggressive behaviour (Baron, 1977).

Punishment

Interpolation from the few existing studies manipulating punishment suggest that early punishment may lead to two different effects: aggression or withdrawal. Punishment of shock-induced aggression in squirrel monkeys leads either to self-directed aggression or a slumped posture suggesting helplessness (Ulrich, Wolfe, & Dulaney, 1969).

In my research on manipulation of dominance rank I have noticed a similar finding. When four monkeys were made subordinate as described above in Chapter 4, by placing them with older animals, and all of their early social experience was in a subordinate position, two types of monkeys were soon apparent: One was the type of animal I termed the "true subordinate", usually an emotional animal, but one that never or rarely challenged his position of subordination. The other type of individual was one that didn't seem to accept its status, i.e., showed rebellion in certain circumstances. In the latter case one had to be careful in the daily socialization procedure for if the dominant subjects did not immediately assert their dominance, the rebellious subordinates would sometimes threaten them. Also, when first grouping them with new dominants, one had to be very careful to arrange factors, such as territory and adaptation, so that the subordinate did not challenge the dominant. The one correlate which I found of this phenomenon was emotionality, the true subordinate was more emotional. With the rebellious subordinate monkeys, repeated defeats did not lead to withdrawal, whereas in the true subordinates it did. This suggests that some of the individuals are perhaps insulated against the development of helplessness, or at least from the mild defeats which occurred in the experiment. Relatively mild defeats may be like Kahn's (1951; Kahn & Kirk, 1968) single severe defeats, leading to recovery and hyperaggression, whereas repeated severe defeats lead to increased emotionality and withdrawal.

Physiological Basis

A possible physiological substrate of this dual response to attack is suggested in an experiment by Harwood and Vowles (1967; see also Andy & Stephan, 1974). They found that whether or not electrical stimulation of a site in the anterior hypothalamus of the ring dove led to aggression or fear towards a toy spider predator was determined by the emotional state of the subject at the onset of stimulation. If the dove was afraid, the stimulation led to exaggerated withdrawal; if the bird was aggressive, the stimulation induced more intense attack. Although they do not report intra-specific behaviour, probably preferring the control possible with a toy, one can see how such a mechanism could be adaptive both inter- and intra-specifically.

As a short term mechanism the individual could react more rapidly and strongly following exposure to a predator should the predator remain nearby. As a long term mechanism an individual could react more rapidly to varying social stimuli within the group. When near a dominant animal, for example, the subject could be "primed" so that any sudden movement of the dominant would lead to more rapid withdrawal than if the subject had to reclassify the sudden movement after it had begun.

Other work with mice (Henry, Stevens, Axelbrod, & Mueller, 1971) has shown that whereas early weaning and isolation reduces the enzyme required for the methylation of noradrenaline to adrenaline, housing so as to increase social conflict increases the levels of this enzyme above that of normally reared mice. Hofer (1974) suggests that all early experiences which entail decreased levels of stimulation lead to a tendency for later cardiac responses to stimulation to be decelatory; increases in early stimulation levels would lead to a subsequent tendency for heart rate acceleration.

The intervals between punishment may be critical for the effect. Male weanling CPB housemice when intro duced into a group of residents are defeated at every introduction. The subsequent behaviour of the mice is dependent upon "some sort of critical training frequency, i.e., if the periods of rest in isolation between the training introductions were too long, the effect of the whole training was the opposite of what was intended.... If a trainee was introduced once every week or once every other week instead of every day, he tended to put up skilled resistance." (p.10). The other trainees were transformed into fearful fleeing males. Van der Molden and van der Dennen (1981) speculate that short intervals of defeat do not allow hormonal testosterone or possibly LH and FSH levels to return to normal after the stress of defeat (see Eleftheriou & Church, 1968).

<u>Learning</u>

Wilson suggests the following:

> Unless some Lamarckist process is at work, individual acts of learning cannot be transmitted to offspring. If learning is a generalized process whereby each brain is stamped afresh by experience, the role of natural selection must be solely to keep the tabula rasa of the brain clean and malleable. To the degree that learning is paramount in the repertory of a species, behaviour cannot evolve.... What evolves is the directedness of learning-the relative ease with which certain associations are made and the acts are learned, and

> others bypassed even in the face of strong reinforcement. (1975, p.156)

Throughout the literature people often alternate between restricted and wide usages of the term "learning" without apparently realizing it, going from a set of well defined conditioning paradigms to the assumption that any change resulting from external input is an example of learning. I am suggesting that more than the directedness of learning is involved. In infancy aggression by X not only teaches the infant that X is aggressive and that the infant should withdraw from X (Fowler & Wischner, 1965); I am suggesting that the aggression also triggers a mechanism which causes the infant to be aggressive, a mechanism which, because it does not obey the laws of conditioning, does not appear to be learning in the sense Wilson means. The laws of conditioning suggest that if a subject is presented with an aversive stimulus there are two effects: Some negative emotional affect like fear is connected with the salient stimuli in some classical conditioning sense, and avoidance responses are reinforced and learned in some operant sense.

It is also not modeling in the sense that "...children are furnished with vivid parental examples of how to influence the behaviour of others." (Bandura, 1976, p.207) Bandura described four processes by which modeling activates aggression: (1) Copying the behaviour of effective models often is effective in reaching goals. (2) Copying aggressive behaviour is anxiety reducing when done in situations where prior aggression has been observed. (3) Observing aggressive behaviour is emotionally arousing which often facilitates aggression. (4) Observing aggression has stimulus enhancing affects.

Our results also cannot be explained by recourse to operant conditioning principles. They cannot explain how punishment of the subject later leads to increased levels of aggression in the subject. There is no reinforcement contingent on the performance of an operant (Motshagen & Slagen, 1975). Our results cannot be explained using principles of classical conditioning. These principles could explain how attack or punishment of the subject leads to conditioning of an emotional response to the stimulus of the caretaker or to certain behaviours of the caretaker. But it would not explain how this emotional response would subsequently lead to aggression towards other animals. It may be that emotional conditioning is foremost in early development but that later on operant effects are more important.

Emotionality

It is possible that the mechanism whereby maternal aggression is transmitted to her infant is similar to, or part of a mechanism for, the production of emotionality in the infant. Being the object of aggression early in life might be expected to lead to an increase in fear and perhaps general emotionality and reactivity. Part of the factor Cattell & Kline (1977) label Emotionality is that of "annoyance", the presence of which could reasonably be expected to increase the probability of being aggressive. The work of Salzen (1962, 1966) suggests that aggressive interactions early in life (perhaps even drastic changes later) may not lead to the normal reduction of fear levels which accompany experience. Comparable stimuli may lead to increases in fear, emotionality, or aggressive responses later in life.

Estes (1944) posits that some of the effects of punishment are probably mediated by the emotional reaction aroused by the noxious stimulus. Archer too (1976) links aggression and fear. Also stimulants have been found to enhance the effects of punishment whereas tranquillisers attenuated these effects (Boe & Church, 1968).

But not all emotion-producing situations lead to increases in aggression. Rat pups rotated among mothers every day (Ottinger, Deneberg, & Smith, 1963) and rhesus monkey infants separated every two weeks (Griffin, 1966) are more emotional but not more aggressive. Other related types of stress, but where there is a stable mother-infant bond, do increase aggressive behaviour. After mother-infant separation and reunion, rhesus infants are hyperaggressive towards peers (Seay, 1966). Similarly early handling in rats gives rise to more dominant rats when tested in repeated pairings (Becker & Gaudet, 1968).

The aggressive strain of mice bred for differing levels of aggressiveness were characterized as less emotional and more active than the nonaggressive strain. Inflicting pain before weaning retarded the appearance of aggression in these hyperaggressive animals (Lagerspetz, 1969).

Other types of early stress lead to reduced emotionality, e.g., shock and handling (Denenberg & Smith, 1963; Denenberg & Ottinger, 1962). But early shock experience has two effects: these animals defecate most in their first exposure to the open-field but defecate less over subsequent exposure (see also Ryan & Wehmer, 1975). This suggests the possibility of early stress resulting in an initial emotional response to novel situations which then leads to hyperaggression. Early stress may affect emotional response through blood sugar levels There is some evidence that moderate hypoglycemia enhances aggressive tendencies (Bolton, 1978).

Evolutionary Implications

There are evolutionary implications favouring the nongenetic inheritance of acquired behavioural characteristics. Such a mechanism would serve as a more rapid and more flexible alternative to genetic transmission of adaptive behaviour. If changes in a behaviour, say, an increased level of aggression, is associated with success in survival, then the caretaker can rapidly alter the characteristic levels of behaviours in her offspring, providing the infant is designed in such a way as to allow this transfer of behaviour potential. This would lead to even more rapid change than the microevolution suggested by Wilson (1971) which he claims can lead to significant behavioural alterations in under ten generations.

It might be possible to suggest a period when the effects suggested in this chapter would be most potent. I would suggest that two factors might be important: the behaviour of the mother and the behaviour of close relatives. If so, then the most sensitive period would be when infants are first leaving their mothers for periods of interaction with other young animals.

One of the implications from a provocative article by Christian (1970) is that dominant females should select mates to produce optimally dominant offspring. So too, the hypothesis I am proposing would imply that if some level of aggression is adaptive, the animals with this level of aggression would prefer others with similar levels of aggression for mating partners. It has been suggested that there are genes favouring such homogamy (Wilson, 1971). There is some indirect evidence that monkeys with abnormally high levels of aggression prefer to be with others with comparable aggression levels (Chamove & Harlow, 1975; Chamove, 1979; Sackett, 1968), and indirect evidence that dominant and number-two ranked animals prefer the highest ranking animals available, whereas subordinates do not (Chapter 4 above). Through these mechanisms, families with optimal levels of aggressiveness should increase.

Furthermore in those animals where there are considerable sex differences in levels of aggression, it may be advantageous for there to be early association between infant males and dominant, successful adult males such as has been reported in several primates (Itani, 1959; Mitchell, 1969; Chamove, 1981; Chepko-Sade & Olivier, 1979)

This chapter has attempted to marshall evidence supporting the empirical hypothesis that being the object of aggression early in life leads to increased aggression later in life. In the studies cited there are confounding variables in each. But taken together, and including studies where such transmission might have gone wrong, the findings mostly support the hypothesis.

An attempt has been made to discuss mechanisms through which transmission of acquired behaviours between mother and infant might operate. The most profitable appears to be one as follows. A young infant that has developed an attachment to its caretaker or peers is subjected to aggression or pain from these attachment figures. This is not aggression which is the result of aggression begun by the subject in some competitive situation (Rasa, 1976), rather it is pain which leads to conditioned emotional reaction of fear or perhaps conflict (Hutchison, 1973).

It may be that such a copying mechanism as has been posited exists for other classes of behaviour (see Chapter 3 above for an example of play). Indeed many of the advantages attributed to the transmission of aggression levels would hold for these. If so, it would suggest that the mechanism involved might be rather more direct than the one suggested above. Infants may directly adopt levels of behaviour equal or parallel to those of significant individuals in early life.

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