

REASONS AND RISKS ASSOCIATED WITH MANIPULATING CAPTIVE PRIMATES' SOCIAL ENVIRONMENTS

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Abstract

Efforts to promote the psychological well-being of captive non-human primates through the application of environmental enrichment techniques are becoming more common. However, from this perspective relatively little empirical work has been done on the effects of manipulation of the social environment. The data currently available indicate that primates kept in solitary confinement are likely to develop a variety of behavioural and physiological disturbances reflecting reduced well-being, whereas most compatibly socially housed primates appear better adapted. There is always some risk associated with manipulating the social environment for experimental or husbandry reasons, but the risk of deleterious consequences can be reduced by a good knowledge of the animals' normal repertoire and careful monitoring of how the animals adjust to the new conditions. Attending to the social environment of captive primates is fundamental to their welfare.

Keywords: *animal welfare, enrichment, non-human primates, social behaviour, stress*

Introduction: improving captive primates' well-being

Ethical issues regarding the experimental uses of non-human primates, and the maintenance of primates in zoos have become a major and controversial topic for scientists and laymen. Primatologists often feel to be at the forefront of the more general debate about the ethics of experimentation on animals because their subjects undoubtedly possess relatively advanced psychological capacities, and there can be little doubt that they may suffer (eg Dawkins 1980). Nineteen-eighty-five was an important turning point in this respect: after years of scientific and philosophical discussions about whether animals can even be said to possess 'mind' (see eg Mason 1979, Griffin 1982), there was official recognition in the *Amendments to the Animal Welfare Act* (by the United States Department of Agriculture) of the legitimacy of the term 'psychological well-being' and of the necessity to ensure that captive primates' psychological well-being is adequately attended to.

The task of setting up regulations and defining psychological well-being for housing primates in laboratories and zoos has produced heated debates, numerous specialist meetings, and even more related papers and books (eg *American Journal of Primatology* 1989 Supplement 1, Segal 1989, *Laboratory Animal Science* 1991 41(4), Novak & Petto 1991). These lengthy discussions have been characterized by three main phases. The first phase saw attempts to delineate rules for environmental and social enrichment that might be implemented by researchers and colony managers. The second phase was characterized by a growing recognition that there is no 'prototype primate' and that no single set of rules will satisfy the needs of all members of a given species, let alone all species (Novak & Suomi 1988, 1991, Anderson & Visalberghi 1990). To borrow Sapolsky's (1990) terminology, if ethology consists of 'interviewing an animal using its own language', the interviews used as the basis for regulations have too often been conducted by foreigners not fluent in the animal's language. Early experience, individual life history, personality, sex, age and species are all factors influencing what is 'good' or 'bad' for any particular individual. In other words, the diversity of primates is so great that precise regulations cannot seriously be expected to adequately accommodate all captive individuals. Therefore general principles, not rigid rules, are needed. Also, it is becoming increasingly evident that the suitability of any given procedure must be evaluated on the basis of the outcome (Novak & Suomi 1988, Anderson & Visalberghi 1990). If the goal is to promote the individual's psychological well-being, there may be several different acceptable ways of attaining it. Flexibility is too important a component in animal management to be swallowed up by rigid rules and legislation; indeed, the rigorous application of inappropriate laws may well stifle research into innovative husbandry techniques (Mason 1989, Wolfle 1991). The third phase in the quest for improved psychological welfare of captive primates, taking place at present, is characterized by a more empirical approach in which the aims are to collect enough valid and comparative data with which to evaluate the effectiveness of different techniques (see Bloomsmith *et al* 1991).

Social manipulations

We consider it appropriate to place special emphasis on manipulating the social rather than the physical environment. Although there is general agreement that social housing is in most cases the most naturally enriching condition for primates (eg Novak & Suomi 1991), the amount of work done on social as opposed to non-social enrichment techniques is inadequate. For example, in a recent special issue of the *American Journal of Primatology* devoted to psychological well-being and environmental enrichment, only one third of the papers dealt with social enrichment. Why the relative lack of social enrichment studies? One reason may be that social experiments carry greater risks than introducing an inanimate object or device into a cage. Social encounters in particular can be dangerous and require extensive, careful monitoring. Broken toys do not need veterinarians. A second reason is that social experiments require particular advance planning if they are to yield sufficiently solid data to justify undertaking further similar

manipulations. The range of possible reactions to social stimuli is considerably greater than to inanimate stimuli, going from enthusiastic and lasting acceptance to extreme injurious aggression. In general, it is easier to predict what an animal will do with something new than with somebody new. A final consideration is that moving animals around for socialization purposes, with associated chances of failure, is more hard work and time-consuming for personnel than providing inanimate objects.

Enlargement and other modifications to cage systems in line with proposed regulations are likely to cost a lot of money. It has been estimated that in the USA, implementation will require over one billion dollars (Mason 1989, Wolfle 1991). The sheer cost of this projected exercise gives another good reason to look more carefully at less expensive enrichment strategies, such as those based on social manipulations.

Although it would appear important to compare the outcome of social and non-social enrichment procedures, few relevant quantitative data exist. Reinhardt (1990a) assessed the behavioural effects in adult and sub-adult rhesus macaques (*Macaca mulatta*) of being housed with a companion for one year compared with the effects of providing the animals with a plastic pipe and a branch segment. He found that 72% of the animals interacted with the branch, 88% interacted with the pipe, and 97% interacted with their companion. More importantly, the amount of time spent in these activities reached almost 25% for the companion, compared to 10% for the pipe and only 5% for the branch. Pair living rhesus monkeys prefer to stay in close proximity to each other even if this means conceding space (Reinhardt & Reinhardt 1991). Furthermore, in the Reinhardt studies, almost all the time devoted to the companion consisted of affiliative behaviours, and these were shown by all age-sex pairings.

Reinhardt (1989a,b) has systematically investigated how to optimize procedures for pairing macaques. His research, on hundreds of monkeys of different age-sex classes and different backgrounds, illustrates methods that can be employed in order to minimize the risk of injurious aggression, and how to assess the outcome of such social manipulations. It is recommended that previously singly caged individuals be allowed to establish clear-cut dominance-subordination relationships during a preliminary period of non-contact familiarization. However, the direct formation of new pairs from recently socially housed animals is also feasible, possibly due to the development of social skills that help reduce the risk of potentially injurious aggression between the new partners (Reinhardt 1989c, 1991). These studies have shown that compatibility in general is attained in over 80 per cent of possible pairings.

Despite data such as those described above, however, the National Institutes of Health (NIH) were recently reported to be still keeping over 80 per cent of adult primates in single cages (Bayne 1989). Potential 'negative' effects of social housing, such as increased risk of wounding, of disease transmission, and of social stress and undernutrition in subordinate animals are sometimes used to justify individual housing, but these effects are usually presumed rather than proven. Reinhardt's data are again pertinent here: in pairing 295 previously singly housed adult rhesus macaques as described above, serious wounding occurred in only 0.8 per cent of the animals over a

36 month period (Reinhardt 1990b). Nor is there any good evidence for increased disease transmission in pair versus single housed monkeys. During 1989 at the Wisconsin Regional Primate Research Center, 23 per cent of single housed rhesus macaques required non-experimental veterinary treatment compared with only 10 per cent of pair housed monkeys. Finally, blood cortisol levels, a widely used measure of stress, are not higher in paired monkeys than in single housed monkeys.

The formation of pairs in laboratory primates is not the only recent advance in social manipulation from the viewpoint of enrichment. Knowledge has also increased regarding the risk-laden practise of introducing individuals into established groups. Immature individuals have been re-introduced to their natal group following early separation from the mother and subsequent hand-rearing (eg Meyer & Wilcox 1982, Visalberghi & Riviello 1987) and successful introductions of non-familiar adults have also been reported (eg Anderson *et al* 1991). Most of these reports have described the use of progressive degrees of contact eventually leading to the final, full introduction, but Bernstein (1991) has recently questioned whether non-contact familiarization periods are always necessary or advantageous.

Finally, it should be noted that in some cases a desirable social manipulation may involve the *separation* of individuals from their familiar social partners, for example when there is persistent or serious aggression (see below). In some species, eg bush babies (*Galago*), neonatal mortality in captivity is decreased if pregnant females are separated from conspecifics until after they have given birth (Izard 1991).

The need for background knowledge and evaluation

In the previous section we described some cases of successful and desirable social manipulation. However, we are aware that grouping animals does not always lead to an improvement in the animals' condition. The primatological literature contains many examples of failed social manipulations, including introductions of individuals into groups, group formations and group mergers, and these too have been informative. For example, it is now well established that many primates show xenophobic reactions to unfamiliar individuals introduced to their group, and the formation of new groups using previously unacquainted animals may also lead to serious - in some cases fatal - aggression (Bernstein *et al* 1974, Holloway 1974). For many of the most common primates in captivity, enough data has now been accumulated to allow reasonable predictions about the differential likelihood of acceptance or rejection by different age-sex classes following social manipulations in the form of introductions.

Needless to say, a prerequisite for the successful social housing of primates is sound knowledge of the species' natural behavioural profile and potentialities. Although successful unnatural groupings are possible and in some cases even preferable to non-social alternatives (Bernstein & Gordon 1980, Poole 1987), social units and transfers of animals that approximate those found in the wild are clearly the most desirable, both aesthetically and from the animal's point of view; however, restricted space may necessitate changes to species-typical social compositions (see McGrew 1981, van Hooff

1986, Lindburg 1991). Where possible, knowledge of natural history should be supplemented with as complete a record as possible of the major events in the animal's life, since early rearing experiences can have profound and long-lasting effects on the subsequent social potential of many primates (Mitchell 1968, Anderson & Chamove 1986, Anderson & Visalberghi 1991). Much of our knowledge about the effects of early social experiences comes from the many experimental studies evaluating different types of rearing, such as partial and total isolation, with the mother only, with one or more peers only, or with an adult male only (eg Harlow & Harlow 1965, Mitchell 1968, Sackett 1970, Erwin & Deni 1979). Although these earlier studies were not usually conducted with the explicit aim of improving the welfare of the subjects, they have undeniably contributed valuable data.

Mason (1991) has recently proposed guidelines for assuring species-adequate socialization in the captive rearing of some commonly used laboratory primates, based on programmes of social development. For example, it is recommended that infant macaques be left with their biological mothers for at least the first six months of life, in order that the infants' filial attachment tendencies be adequately fulfilled. However, mother-only rearing may lead to some behavioural abnormalities. Therefore, experience with peers should be initiated early - during the period when the infant is with the mother, if possible, and certainly soon after the permanent separation. In this way the 'exploitative' aspect of the infants' social development will be catered for. In the same vein, Bernstein (1991) has reviewed different techniques for introducing individuals into groups and forming new groups, taking into account behavioural differences between species and age-sex classes.

In general, progress has clearly been made in the social engineering of captive primates. Going from the disastrous attempt in 1927 to socially integrate nearly one hundred hamadryas baboons (*Papio hamadryas*) with a similar sized colony already living at London Zoo (Zuckerman 1932), and the varied outcomes of group mergers of stump-tailed macaques (*Macaca arctoides*) reviewed by Rhine and Cox (1990), to the highly successful groupings of chimpanzees (*Pan troglodytes*) with unnatural backgrounds at Arnhem Zoo (de Waal 1982) and the resocialization programmes at the Primate Foundation of Arizona (Fritz 1989); we can see an overall improvement.

Sociophysiological considerations

Another reason for careful consideration of the ways in which captive primates are housed, is that not only behaviour but the physiological profile of an individual may be influenced by both acute and chronic absence of social companions, or by inappropriate social environments (Kaplan 1986). Although the ways in which social housing conditions may affect biomedical research outcomes have yet to be adequately analyzed (Novak & Suomi 1991), data are now emerging. Social manipulations can either increase or decrease neuroendocrine stress response systems (Mendoza 1991).

The deleterious effects of insufficient early social input on the subsequent social adjustment of monkeys and apes are well known. Rearing in social isolation is also

associated with increased basal cortisol levels in infant macaques (Champoux *et al* 1989). Involuntary separation from an attachment figure followed by isolation causes immediate rises in heart rate and cortisol levels in immature subjects (Reite *et al* 1981, Levine *et al* 1985), and separation of mother and infant macaques results in diminished immunological responsiveness to mitogens (agents which induce mitosis) (Laudenslager *et al* 1982). Markers of immunocompetence appear to be altered in adult macaques that have undergone a forced separation in infancy (Laudenslager *et al* 1985), while recent data suggest a relationship between early psychosocial experiences and latencies to show physical and haematological signs of simian AIDS (acquired immunodeficiency syndrome) in rhesus macaques (Capitani & Lerche 1991). Infant squirrel monkeys (*Saimiri sciureus*) isolated from their mothers and placed in an unfamiliar environment also show significantly reduced immunoglobulin levels, whereas infants subjected to the same separation procedure but left in the home environment with familiar infant companions show normal immunoglobulin levels (Coe *et al* 1987).

Psychophysiological stress reactions may also occur when adults of those species that form strong interindividual attachments are separated from each other. This is the case, for example, when mated pairs of titi monkeys (*Callicebus*) are separated. Analogously, female-bonded squirrel monkeys (*Saimiri*) when tested with companions show reduced signs of stress compared to isolated individuals (see Mendoza 1991 for review). Baboons (*Papio*) housed alone or in the presence of a stranger show higher arterial blood-pressure values than baboons tested in the presence of familiar companions (Coelho *et al* 1991). Finally, it may be noted that positive physiological effects of social grooming, including heart rate reduction, have been demonstrated in a pigtailed macaque (Boccia *et al* 1989).

If separation and isolation have such profound negative effects on how individuals cope with challenge, it is worthwhile reflecting on the widespread procedures currently being adopted for studies using primates as models for AIDS and other virological diseases, in which restriction of any kind of social interaction - with either conspecifics or personnel - is strictly imposed. In our opinion, the gap between principles derivable from constantly updated knowledge on primates' psychological and physiological well-being and many existing regulations and practises is wide and unfortunate (see Anderson & Visalberghi 1990). For example, the 1986 EEC directive (86/609) for legislation covering the protection of animals used in scientific research merely mentions the possibility that two primates may be housed together if they get along, adding that if not, cages may be placed in such a way that animals can see each other, but, adding again that if necessary, visual contact can also be dispensed with. To us, this represents an inadequate approach to satisfying the social requirement of laboratory primates.

The difficulty of making decisions

In captive groups of primates it may be fairly common for an individual to be attacked and wounded by its cagemates. Certain individuals, usually but not always low-ranking, may even become permanent scapegoats (Bertrand 1969, de Waal 1989) while in lemurs (eg *Lemur fulvus*) there are occasional outbreaks of persistent and serious aggression by

almost all members of the group against one unfortunate individual (Vick & Pereira 1989). Primatologists do not consider such phenomena aberrant, since they also occur in natural settings where they might lead to normal social processes such as peripheralization and emigration (see below). In the more restricted setting of the laboratory, however, a dilemma arises: should humans intervene and remove the target of the aggression, or should the animals be allowed to arrive at their own solution? Of course if the victim is already seriously wounded and/or in a state of shock then its prompt removal takes priority over any reflection about the *pros* and *cons*. Alternatively, order can be restored by removing persistently aggressive individuals (Reinhardt *et al* 1987). But what about the animal being mistreated by its cagemate(s) but not yet injured or distressed? As we have indicated, being isolated from conspecifics can be traumatic in itself, and social re-introduction after separation may be difficult. It is probably also the case that sooner or later another member of the group is likely to become a new scapegoat or target for others.

In general, the primatologist decides what to do based on his or her previous experiences. On some topics the existing literature is often too vague or dissimilar from the problem at hand to provide any ready solution. Social settings (eg age-sex distribution and density), cage structures, individual histories and experimental requirements usually vary across laboratories. The management decision taken is in fact an educated 'guess' about what is more likely to work out with the minimum of risks for the group as a whole. A similar dilemma arises in re-introduction projects, where an often considerable percentage of less well-adapted individuals is likely to die while the remainder will survive and reproduce (see Kleiman *et al* 1991). Furthermore, it is worthwhile to stress that whatever the outcome, the role of the different variables involved can usually only be interpreted approximately. Primate husbandry does not lead to strict laws and rules because of the impossibility of fully determining the role of each of the multiple factors at play. Therefore, future problems will be able to benefit only from general pointers drawn from past emergencies. In Mason's (1979) terms, there is a degree of 'muddling through'. However, close monitoring of the effects of management techniques and lessons from past experiences can help to improve the 'feeling' about what may or may not suit the animals' needs.

Physical wounds, disease, and psychological stress all influence the well-being of an animal, but it is extremely difficult to evaluate their relative importance. Veterinary scientists have traditionally been preoccupied with physical parameters, while primatologists have emphasized the importance of behavioural indices of well-being (Anderson & Visalberghi 1990). One point on which many observers of primates would agree, however, is that wounds which appear to us to be extremely painful often appear much less so for non-human primates. Most people with first hand experience of primates will be impressed by the animals' tolerance of injuries and their rapid healing. One example, observed in a large group of tufted capuchins (*Cebus apella*), concerned a young adult male with a head wound exposing several square centimetres of scalp. The wound was frequently groomed by other group members, who also dipped potatoes in it.

Although we might expect that this would be a painful experience for the wounded individual, his behaviour appeared quite normal. In fact he appeared to enjoy attention from the others, and actively sought more of this treatment (see also Dittus & Ratnayeke 1989). The wound eventually healed without any human intervention.

Was the wounded animal described above experiencing an unacceptable amount of pain or not? Was he tolerating some pain in order to receive grooming and attention from the others? In view of his slow recovery, should he have been separated earlier in order to receive medical treatment? There are no hard and fast answers to these questions, but it is obvious that interventions based on anthropomorphic preconceptions may not always lead to outcomes that are more desirable than those based on the animals' own preferences (see Dawkins 1990).

Animal welfare implications and conclusions

The main aim of this paper has been to underline the implications of experimental or management-related manipulation of the social environment of captive non-human primates for the animals' welfare. Modifying the social environment may lead to good or bad outcomes, which may be assessed on the basis of behavioural and physiological reactions. The decision to change the social environment is not always made easily. As already mentioned, social manipulations such as forcefully removing one or more individuals from an attachment figure or a social group, reconstituting group membership, or introducing strangers into an unfamiliar social environment are generally stressful events (Bernstein 1989). During group formation, cortisol levels and blood-pressure increase, reproductive hormones and functions may be suppressed, and an array of other negative somatic alterations including decreases in immunological functioning may occur, even in the absence of physical wounding (eg Gust *et al* 1991). In adult macaques, unstable social groups resulting from repeated experimental reorganization of membership increases coronary artery atherosclerosis in consistently dominant males (Kaplan *et al* 1982). Previously singly housed animals may require up to 15 months in order for stress indices to return to baseline levels following group formations (Sapolsky 1990).

So, should animals be made to live together 'for their own good'? In general, given an adequate physical environment, our answer would be yes, though as we have also stated, the optimal final solution will vary for different species and individuals. In this context, however, it is informative to consider experiences in the wild. Free-ranging primates are periodically confronted with a range of stressful experiences of social origin. One example of a naturally occurring 'social' stressor is emigration. This is not only risky - up to 80 per cent of emigrating macaque males may die from various causes, including starvation and injury (Dittus 1979) - it also increases physiological measures of stress (Rasmussen *et al* 1990). Adult male longtailed macaques (*Macaca fascicularis*) immigrating into a group have recently been reported to show increased urinary cortisol levels (van Schaik *et al* 1991). Perhaps the most dramatic examples of naturally occurring stressful events are those resulting in the death of conspecifics, for example infanticide (Hausfater & Hrdy 1984). Humans are not held responsible for these natural

stressful events or their sometimes unfortunate outcomes. In contrast, we are accountable for choices taken with regard to captive animals. Bernstein (1989 p34) has said that '... we *are* (emphasis added) responsible for balancing the risks and the benefits of animal removals, introductions and re-introductions'. Does this mean that whenever an animal suffers because of our management decisions we are guilty of misconduct? Not necessarily, since there will always be some degree of uncertainty surrounding the factors involved in a given outcome. However, if the suffering clearly appears to result from ignorance of either information about the animals or of relevant literature, or to a lack of careful monitoring of the animals at risk, then our answer would be yes.

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