EXTERNAL AND INTERNAL INFLUENCES ON AGGRESSION IN CAPTIVE GROUP-LIVING MONKEYS*

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Infant nonhuman primates, particularly Old World monkeys and apes, typically interact with a number of different types of conspecifics on a daily basis. The interactants range from mothers and matrilineally related kin to unrelated adult females and males. In addition, a variety of different behavior patterns can occur. An infant can be the object of extremely solicitous and nurturing behavior, and, in a matter of seconds, the same infant can become the object of a murderous attack. Moreover, a wide range of behavioral actions is possible from most of the members of a group. In order to render the task of describing the various interactions between infants and other group members more manageable, this contribution will be restricted to interactions between infants and mothers, infants and adult males, and infants and nonmaternal females.

MOTHERS

The primate literature abounds with studies of mothers and infants. Indeed, the one area of nonhuman primate behavior that has long been the focus of study of many primatologists is mother–infant relations. In recent years, a clearer picture of the complexity of mother–infant relations has emerged through the application of behavioral–ecology theory to questions of behavioral interactions. The detailed work of Jeanne Altmann (1980) and Nancy Nicolson (1982) has provided a be-

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ginning toward understanding the complex effects of social and ecological variables on patterns of infant development and independence.

Among the range of potential social interactions between mothers and infants, the vast majority are nurturing and solicitous. However, one should not be too quick to dismiss mothers as a source of aggression toward their own infants. Aggressive behavior by mothers toward their offspring has been studied relatively infrequently when compared to other aspects of the mother–infant relationship. Aggression has typically been studied in the context of the weaning process in captive animals (Jensen, Bobbitt, and Gordon, 1967, 1969; Kaufman and Rosenblum, 1969; Negayama, 1981). However, Troisi, D'Amato, Fuccillo, and Scucchi (1982) reported murderous abuse of an infant by its wild-born Japanese macaque mother housed in a captive group, and Carpenter (1942) reported that 8–10 rhesus mothers killed their infants while in transit from India to Cayo Santiago.

Abusive behavior by monkey mothers toward infants has frequently been observed during studies of the effects of social isolation and separation (Ruppenthal, Arling, Harlow, Sackett, and Suomi, 1976; Suomi and Ripp, 1983). A review of laboratory studies of the effects of social isolation and separation on maternal behavior can be summarized as follows. Most reports indicate that infant neglect or abuse by macaque mothers has occurred when the mother was socially incompetent as a result of (*a*) inadequate early social experience, (*b*) solitary housing, or (c) living in an unstable social group.

Recently, interest and attention has been focused on nonhuman primates in the search for a greater understanding of the biosocial bases of child abuse (Caine and Reite, 1983a; Suomi and Ripp, 1983). It has generally been concluded that mothers that were raised under laboratory conditions and were abused as infants tend to be abusive themselves. This is particularly true for mothers that also showed external manifestations of depressive behavior, social withdrawal, etc. (Caine and Reite, 1983b). Furthermore, field observers have noted mothers that act inappropriately or exhibit varying levels of maternal competence (Altmann, 1980).

The findings suggest that mothers are capable of aggressive acts toward their offspring and that these acts would be predicted only to the extent that they represent a disagreement between mother and offspring over termination, or at least reduction, in parental investment (Trivers, 1972).

Adult Males

For many species of Old World monkeys, in particular, cercopithecines, resident females and their offspring form the stable core of a social group (Wrangham, 1980). Adult males are typically immigrants who were born elsewhere (Packer, 1979). Given this model, application of evolutionary biology predicts very different types of behavior between mothers and adult males toward infants.

On the one hand, males should be protective and solicitous of the infants they have sired. In fact, many researchers have observed parental behavior by adult males under both laboratory and field conditions [see Redican and Taub (1981) and Taub (1984) for a review]. Adult male Japanese macaques have been reported to adopt infants and to serve as their primary providers (Alexander, 1970; Hasegawa and Hiraiwa, 1980; Itani, 1959; Wolfe, 1981). Although death is the most probable outcome if a male adopts an unweaned infant (DeVore, 1963; Hamilton, Busse, and Smith, 1982; Hasegawa and Hiraiwa, 1980; Rhine, Norton, Roertgen, and Klein, 1980), Berman (1982) reported that an 11-week-old orphan was cared for by four adult males on Cayo Santiago with no adverse consequences. The successful rearing of this infant was probably due to the food-rich and predator-free environment on Cayo Santiago, the persistent care by four unrelated adult males and a sister, which eventually led to a foster parent–infant relationship, and continuous interaction with peers.

Adult males do have the potential for positive affinitive behavior toward infants under certain circumstances. Indeed, adult males that are armed with strong, powerful canine teeth and heavy musculature have the potential to inflict serious wounds on infants. The most dramatic aggressive behavior that can be directed toward an infant results in death or infanticide. Infanticide has been observed or suspected in a wide variety of nonhuman primates, including colobine and cercopithecine Old World monkeys, the great apes, and a single genus of New World monkeys [see Hrdy (1977, 1979) and Hausfater and Hrdy (1984) for an extensive review]. As Sarah Hrdy (1977) noted, it is likely that several different categories of infanticide have developed for very different evolutionary reasons. Hrdy (1977) and Hausfater and Hrdy (1984) suggested that male infanticidal behavior, especially in nonhuman primates, can be explained as a result of sexual selection. For infanticide based on sexual selection, competition over breeding opportunities rather than over ecological resources seems to be the issue. Typically, infanticide occurs when a male from outside the troop usurps the social position of a resident male. However, resident males have been reported to engage in infanticide after changing from a nonbreeding to a breeding status (Busse and Gordon, 1983; Leland, Struhsaker, and Butynski, 1984; Wolf, 1980, cited in Hausfater and Hrdy, 1984). In either case, the male assumed a new status in a breeding situation in which he had previously been excluded and in which he was not the probable father of any infants. Often, related individuals protect the infant against a potentially infanticidal male (Collins, Busse, and Goodall, 1984; Crockett and Sekulic, 1984; Fossey, 1984; Leland *et al.*, 1984).

Adult males may aggress against infants or at least put infants in a state of high potential risk in other, sometimes more subtle, ways. Itani (1959) first suggested that provisioned adult male Japanese macaques (*Macaca fuscata*) might use an infant to aid them in their social relations. He noted that at least one adult male used an infant as a passport in order to gain access to the central part of the troop. Kummer (1967) also described males using infants in their social interactions. He reported that subadult males would pick up an infant during fights with adult males. Deag and Crook (1971) observed extensive infant-carrying by adult male Barbary macaques (*Macaca sylvanus*) and coined the term "agonistic buffering." The concept of agonistic buffering has been applied to gelada baboons (*Theropithecus gelada*) (Bernstein, 1975; Dunbar and Dunbar, 1975), Japanese macaques (*Macaca fuscata*) (Kurland, 1977), chacma baboons (*Papio anubis*) (Popp, 1978; Seyfarth, 1978), and yellow baboons (*Papio cynocephalus*) (Shopland, 1982; Stein, 1981). Packer (1980) noted that infants are at some risk during these encounters. He observed one infant who was wounded severely while being carried during an intermale fight and suggested that three other deaths may have resulted similarly. Shopland (1982) reported the fatal injury of an infant who was used as an "agonistic buffer" in an intergroup encounter of yellow baboons. Stein (1981), however, noted that during nearly 1000 agonistic episodes involving adult male–infant interactions in yellow baboons, no infant received detectable physical injuries.

These observations of nonhuman primates suggest that unrelated adult males may pose a serious threat to young infants, and these males may be responsible for a significant proportion of aggressive behaviors received by immatures. Aggression may be directed toward the immature either directly or as a consequence of other types of interactions.

Females Other Than Mothers

Among Old World monkeys, females other than mothers often direct considerable attention toward young conspecifics. This behavior has been called aunting, allo, or play-mothering [for reviews, see Hrdy (1976) and Spencer-Booth (1970)]. It is important to realize that these interactions are often positive and affinitive, and, in extreme cases, can lead to the successful adoption of an orphaned infant (Berman, 1982; Boggess, 1976; Jay, 1965; Marsden and Vessey, 1968). Of course, infants may be "at risk" from the actions of nonmothers. There are reports of females kidnapping unweaned infants and keeping them until they died of starvation or dehydration (Bourliere, Hunkeler, and Bertrand, 1970; McKenna, 1979; Quaitt, 1979).

Perhaps the most extreme examples of violence by nonmothers against immatures can be found in Goodall's (1977, 1983) accounts of infanticide and cannibalism by an adult female chimpanzee and her daughter. Goodall observed three instances and reported eight other possible instances of infanticidal attacks by these two females. Fossey (1984) also noted circumstantial evidence of infanticide and cannibalism by an adult female mountain gorilla (*Gorilla gorilla berengei*) and her daughter. Although cannibalism was not observed, Carpenter (1942) has reported that adult females killed infants during the first year following the release of 350 rhesus monkeys on Cayo Santiago.

Silk and Boyd (1983), Silk, Clark-Wheatley, Rodman, and Samuels (1982), and Silk, Samuels, and Rodman (1981) also observed aggression by adult females toward infants and juveniles. Indeed, daughters of low-ranking mothers were the victims of harassment and aggression significantly more often than were sons of low-ranking females. Harassment and aggression against young females by other females in the group may begin prenatally through preferential attacks upon mothers pregnant with daughters (Sackett, 1981).

Captive Group Studies

Given the diversity of social interactions among nonhuman primates, it was important to determine whether drug effects observed in individual, isolated subjects would generalize to a social setting. Others have reported that *d*-amphetamine can increase aggressive behavior in group-living nonhuman primates (Bellarosa, Bedford, and Wilson, 1980; Haber, 1979). Our research has focused on aggressive and affiliative behaviors in captive, group-living monkeys. Although we recognize that studying primates under field conditions provides an opportunity to answer important questions relating to behavior and ecology, the study of captive, group-living, nonhuman primates allows a measure of control and observability that is often lacking in field observations. Studies of the behavioral effects of psychoactive agents have traditionally emphasized isolated animal preparations, an approach that has provided orderly, systematic data. Experiments with isolated, individual, animals have been useful in characterizing the behavioral effects of drugs and in predicting their effects on human behavior. We have developed a paradigm for studying drug effects on behavior within a social setting, an approach that can determine the generality of effects observed in experiments with individual animals. Experiments were conducted that involved the acute administration of a range of doses of *d*-amphetamine to adult male stumptail macaques living in the study group.

The subjects for these experiments lived within a group of 39 stumptail macaques (*Macaca arctoides*) housed in a 28.4 × 32.7 m outdoor enclosure at the Yerkes Regional Primate Research Center Field Station. Details of the housing conditions can be found in Smith and Byrd (1983). For the various experiments described here, subjects were typically observed during 15-minute focal-animal samples (Altmann, 1974). A group-scan observational technique was also used that involved recording the number of individuals engaged in several classes of behavior (e.g., aggression, submission, affiliation, general social activity, play, sexual behavior, and self-directed or solitary behavior) at 1-minute time intervals. This technique does not allow the precision or detail of the focal-animal technique, but it does permit the collection of group-interaction profiles (Smith and Byrd, 1983). Data were collected using a microprocessor-based data-collection device and were computer analyzed (Smith and Begeman, 1980). The drug administration protocol has been described in Smith and Byrd (1983) and will not be discussed in detail here except to note that the procedure does not involve the use of physical restraint and that the negative effects of handling are avoided. Blank, Gordon, and Wilson (1983) have reported the absence of elevated serum cortisol levels using a similar procedure.

Hierarchical dominance rankings of the males in the group have been determined weekly since the animals were initially released into the outdoor enclosure in December 1979. The positions of the five male subjects within the dominance hierarchy ranged from the highest- to the lowest-ranking. The dominance positions of individual animals were determined and verified based on the outcome of agonistic encounters among members of the group under baseline or nondrug conditions. An independent measure of dominance ranking was also obtained that involved scoring priority of access to a preferred food item (pieces of fruit). Correlations between rankings based on the outcome of agonistic encounters and displacement over preferred food items were high (r_s = 0.96).

Given that aggressive behavior is only one of an array of potential behaviors, we also decided to study changes in affiliative behavior. In order to study changes in aggressive and affiliative behaviors as a consequence of *d*-amphetamine administration, the drug was dissolved in sterile normal saline (0.9%) and injected intramuscularly in a volume of less than 1.0 ml. Sodium chloride solution (0.9%) served as a control (placebo) injection. Except for the highest dose (0.56 mg/kg) studied in monkey M-13 and the lowest dose (0.003 mg/kg) studied in monkey M-18, each dose was studied three times in each subject in a mixed, unsystematic order.

Mean hourly rates of occurrence of affiliative and aggressive behaviors were determined for each subject following drug or saline administration based on observations during a period 90–180 minutes postinjection (see Figure 7.1). This time period had been determined previously to encompass the period of maximum effect. Under saline or control conditions, affiliative behavior initiated by each of the five

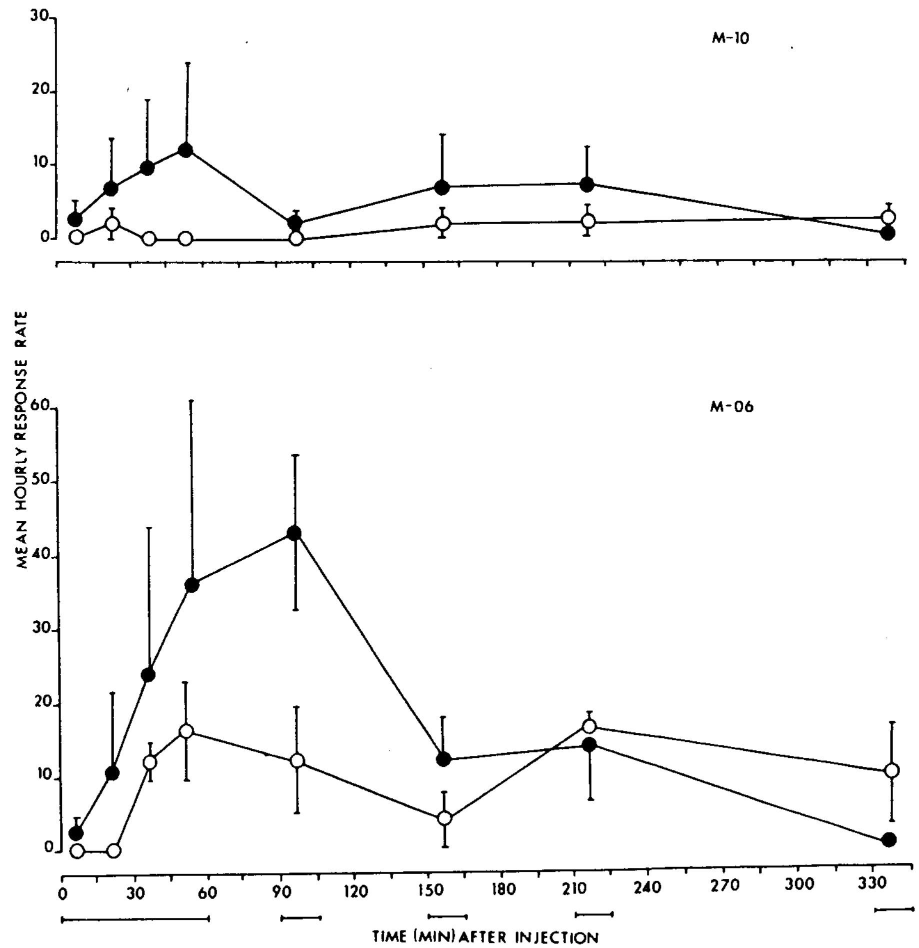

FIGURE 7.1. Time-course effects of 0.1 mg/kg *d*-amphetamine on self-aggressive behavior in monkeys M-10 (top) and M-06 (bottom). Each data point is the mean ± SEM based on three administrations of the drug (filled circles) or saline (unfilled circles). Line segments beneath the X-axis indicate time periods during which subjects were observed and data were obtained. (Reprinted by permission from the *Journal of the Experimental Analysis of Behavior.*)

subjects was characterized by rates ranging between 20–50 occurrences per hour (see Figure 7.2). The highest-ranking subject (M-13) in the dominance hierarchy had a low control rate of affiliative behavior, and the lowest-ranking subjects (M-18 and M-24) had relatively high control rates. Following administration of *d*-amphetamine, four of the five subjects showed a dose-related decrease in rate of affiliative behavior. Moreover, the initiation of affiliative behavior was affected similarly in high- and low-ranking animals, and there was no discernible differential effect among those monkeys. When affiliative behavior was subjected to a more detailed analysis, the most pronounced change was evident in decreased rates of grooming, the most common type of affiliative behavior.

In contrast to the monotonically depressive effect of *d*-amphetamine on affiliative behavior, the drug markedly increased the rate of aggressive behavior in the same subjects (see Figure 7.3). *d*-Amphetamine increased the rate of aggressive behavior initiated by the highest- and the lowest-ranking animals and had little or no effect in the two mid-ranking subjects at the doses studied. The largest increase was observed in monkey M-13, the highest-ranking animal in the group. Rate of aggression in that monkey increased in direct relation to increases in dose, and at the highest dose studied (0.56 mg/kg), rate increased more than 30 times the saline values. *d*-Amphetamine also increased the rate of aggressive behavior initiated by monkeys M-18 and M-24, the two lowest-ranking subjects in the group, with a dose of 0.003 mg/kg having no effect and intermediate doses (0.01–0.03 mg/kg) increasing rate two- to eightfold over rates observed in the absence of the drug. A dose of 0.3 mg/kg produced decreases in rate in the two low-ranking monkeys, and the resulting dose-effect curves conformed to inverted U-shaped functions. There was no change in the rate of aggressive behavior over the same range of doses of *d*-amphetamine (0.01–0.3 mg/kg) in the two mid-ranking subjects in the group. Their behavioral rates remained within the range of rates observed in the absence of the drug (i.e., when saline was administered). The results of this experiment have been described in Smith and Byrd (1984).

The data showed that *d*-amphetamine can have qualitatively contrasting effects on different classes of naturally occurring behavior in individual monkeys comprising part of a large, heterogeneous social group (see Figure 7.4). *d*-Amphetamine decreased affiliative behavior to as little as 30% of saline control values, and the effect was monotonic and dose-dependent. In contrast, comparable doses of *d*-amphetamine increased aggression in the same subjects that exhibited marked decreases in affiliative behavior. The decrease in affiliative behavior observed in the present study is consistent with earlier reports of amphetamine's effects on the behavior of members of social groups.

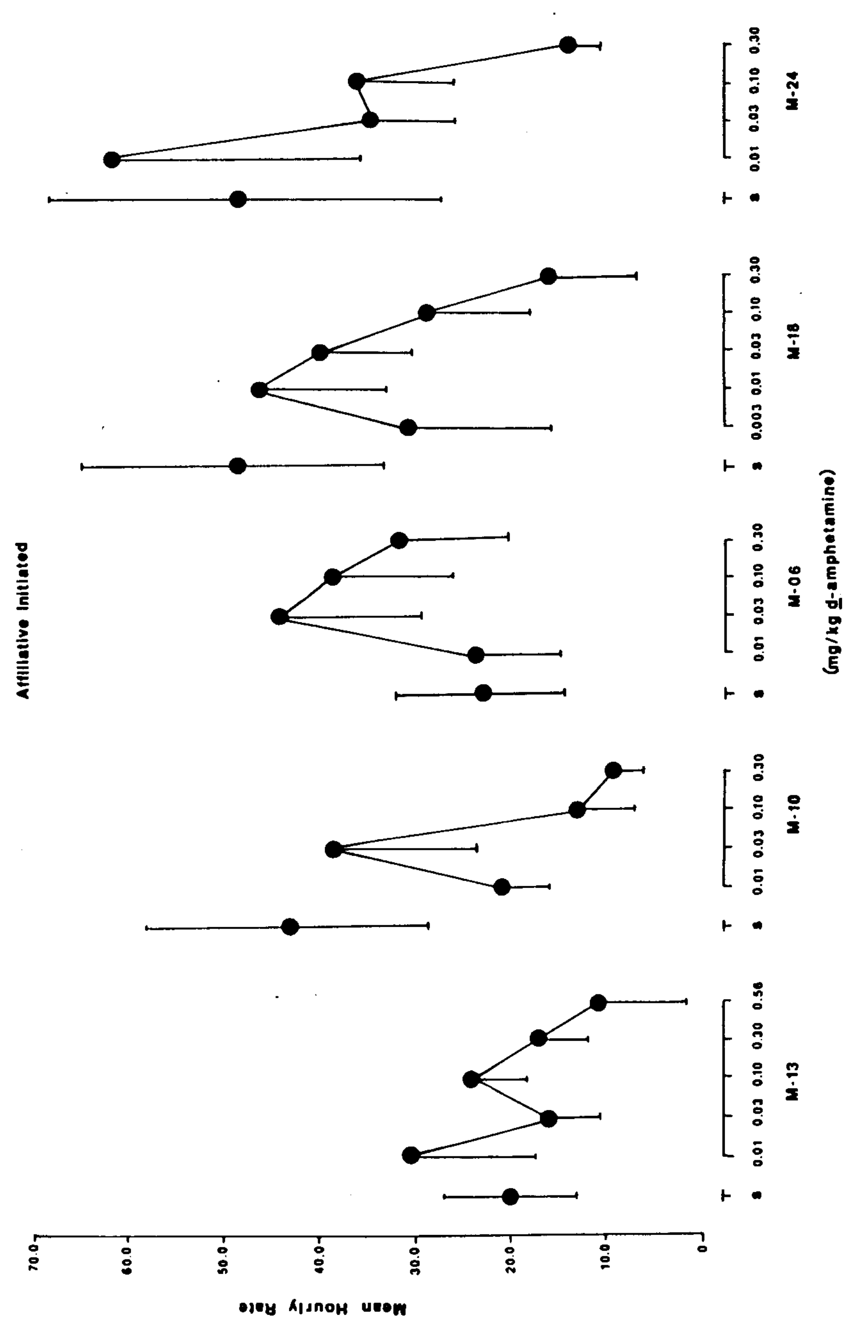

FIGURE 7.2. Effect of *d*-amphetamine on rate of affiliative behavior in five adult male stumptail macaques. Each data point is the mean ± SEM based on three administrations (except that the highest dose for monkey M-13 and the lowest dose for monkey M-18 are based on only one administration). Data points to the left of the dose-effect curves were obtained when saline was administered as a control. (Reprinted by per-

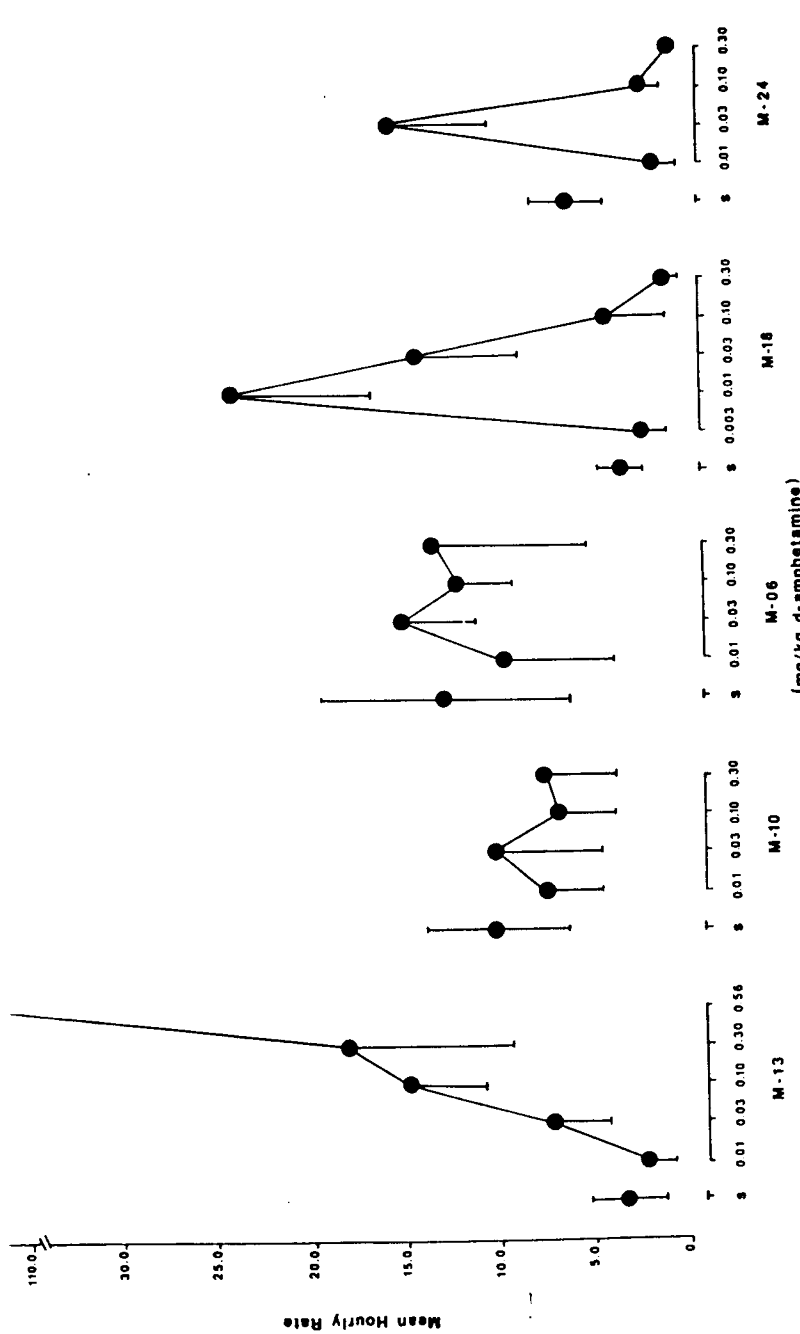

FIGURE 7.3. Effect of *d*-amphetamine on rate of aggressive behavior in five adult male stumptail macaques. Each data point is the mean ± SEM based on three administrations (except that the highest dose for monkey M-13 and the lowest dose for monkey M-18 are based on only one administration). Data points to the left of the dose-effect curves were obtained when saline was administered as a control. (Reprinted from *Pharmacology Biochemistry & Behavior.*)

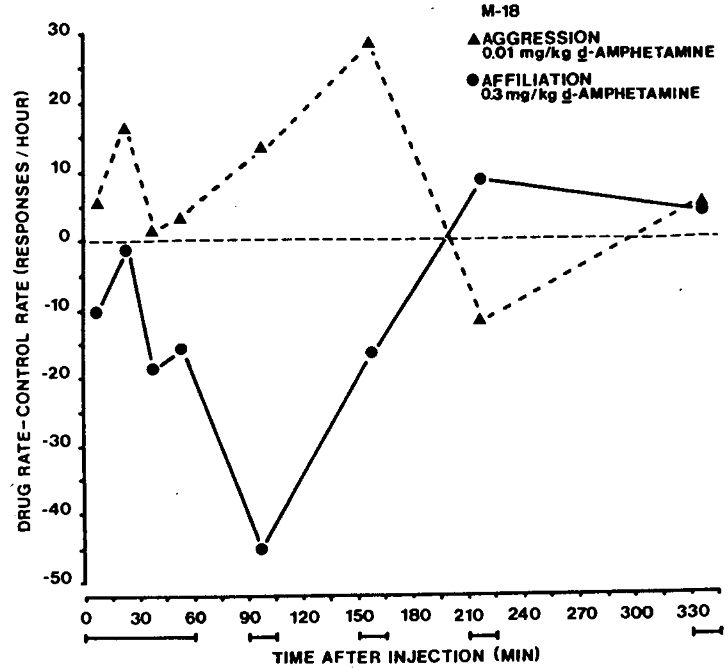

FIGURE 7.4. Time-course effect of 0.01 mg/kg *d*-amphetamine on aggressive behavior (triangles) and effect of 0.3 mg/kg *d*-amphetamine on affiliative behavior (circles) in monkey M-18. Data points are mean differences (drug rate – control rate) on three administrations of the drug. (Reprinted by permission from *Pharmacology Biochemistry & Behavior.*)

Kjellberg and Randrup (1972), Miller and Geiger (1976), and Scraggs and Ridley (1978) reported dose-dependent decreases in social grooming, a major component of affiliative behavior, following the administration of *d*-amphetamine. The uniformity and generality of the reports indicating decreases in affiliative behavior as a consequence of amphetamine administration compel one to regard this effect as characteristic of a number of primate species, especially when constituted as social groups. The basis of the differential effect of amphetamine on affiliative behavior is unclear, however.

Given the relatively uniform decrease in the initiation of affiliative behavior following *d*-amphetamine administration in the present study, the qualitatively dissimilar effect on aggression in the same subjects was striking. The high- and low-ranking subjects exhibited pronounced, dose-related increases in aggressive behavior at doses that either decreased affiliation or had no effect. In the two low-ranking subjects, the dose-effect curves described an inverted U-shaped function characteristic of the effect typically obtained with this drug on operant behavior maintained under certain types of reinforcement schedules (Dews and Wenger, 1977; McMillan, 1969). Moreover, the range of doses having behavioral effects in the present study was quite similar to the range others have found to have effects on conditioned behavior in various species of nonhuman primates (Byrd, 1982; Kelleher and Morse, 1968; McKearney, 1968).

In addition to the qualitatively different effects of *d*-amphetamine on affiliative and aggressive behaviors, the present study provides additional evidence that the effects of this drug are a function of processes evolving out of group dynamics, for example, interactions between one animal and others occupying the same environment or the dominance hierarchy characteristic of a group. *d*-Amphetamine produced marked increases in rate of aggression in the high- and low-ranking subjects but did not cause similar change in the behavior of mid-ranking subjects. Moreover, the dose-effect curve for the highest-ranking member of the group was shifted to the right more than 1 log unit relative to the other subjects that showed increased responding. These differences in effects suggest that the hierarchical or dominance position of an individual subject in a group may serve as a determinant of the way in which a drug such as *d*-amphetamine can alter ongoing behavior characteristic of that individual. This hypothesis is supported by other reports that various psychoactive drugs can act selectively to alter the behavior of individual members of a group (Crowley, Stynes, Hydinger, and Kaufman, 1974; Haber, 1979; Miczek, Woolley, Schlisserman, and Hiroyuki, 1981).

The preceding results have been based on observations of individual male monkeys under treatment and nontreatment conditions. Additional information on the effects of drugs on the behavior of individuals can be obtained from an analysis of the data characterizing activities of the group as a whole. This technique allows comparison of the number of individuals in the group engaged in a given activity under different conditions. Figure 7.5 shows the proportion of total group members engaged in play behavior per scan sample expressed as a percentage change from saline conditions when each of five adult males received various doses of *d*-amphetamine. A sensitive indicator of normal social relations in most heterogeneous nonhuman primate groups or, for that matter, among most social mammals is the expression of play (Fagen, 1981). As can be seen in Figure 7.5, play behavior for the group decreased as a function of the drug dose administered to the highest-ranking male in the group (M-13). When the behavior of the alpha animal was altered, the typical expression of play behavior in the group was also altered and suppressed in a dose-dependent manner.

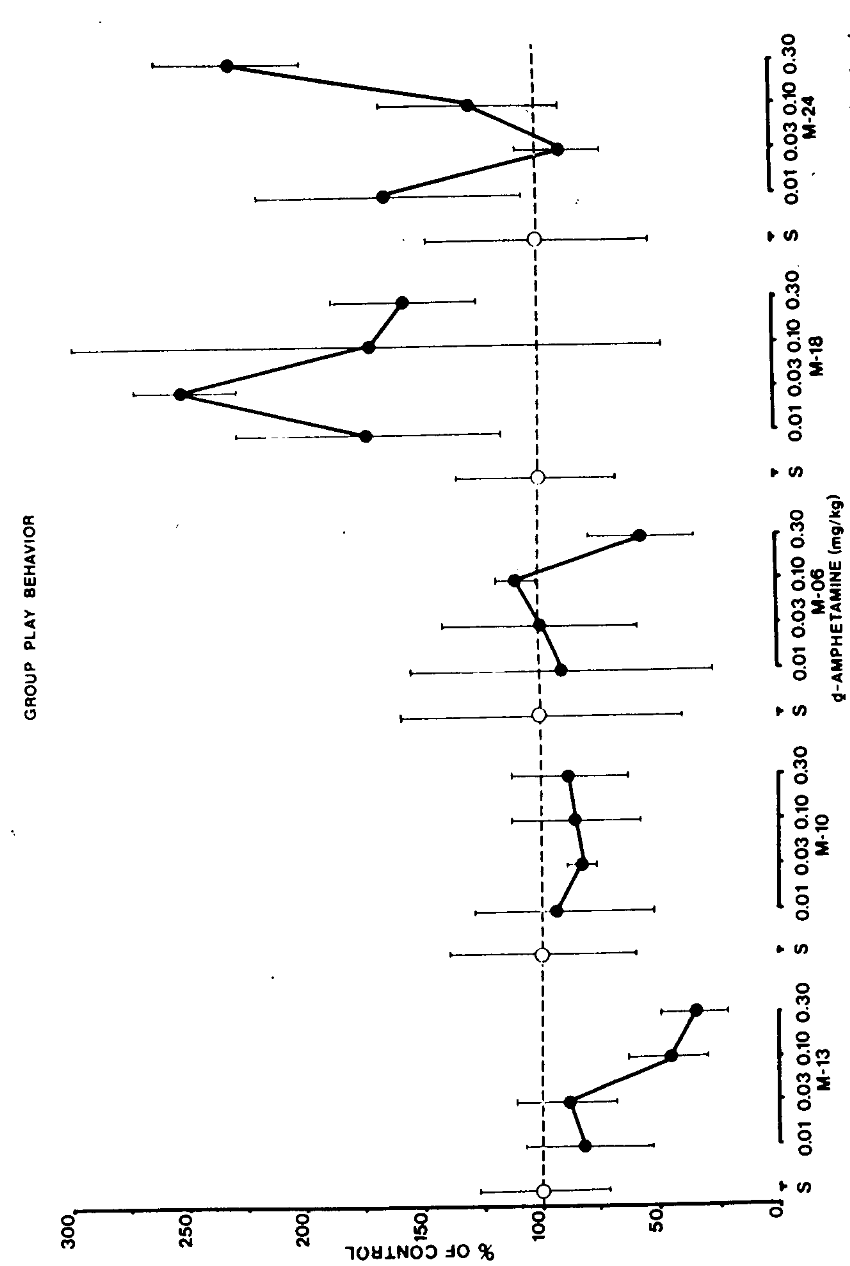

FIGURE 7.5. Effect of *d*-amphetamine on play behavior of nondrugged group members. Each data point is the mean ± SEM based on three administrations expressed as a percentage of control.

In contrast, similar drug administration to the lowest-ranking male (M-18) actually increased play behavior in the group. The result reinforces our view that alteration of the behavior of one individual in a group can have important effects on other aspects of group dynamics. Drug-treated animals can play an important role in altering stable patterns of ongoing social relations between nondrugged animals in a dose-dependent manner.

Given these contrasting results of the effects of *d*-amphetamine on the behavior of individual males and on nondrugged animals within the group, we sought to determine whether *d*-amphetamine would produce changes in the pattern or distribution of aggressive and affiliative behaviors toward specific members of the group. The purpose of the study was to describe the effects of *d*-amphetamine on the directionality of affiliative and aggressive behaviors and to determine if the recipients of these two classes of behaviors represented special subsets of the larger social group. First, data were analyzed to determine if behavior were directed consistently toward nonadult as compared to adult members of the group and whether *d*-amphetamine altered the directionality of aggressive and affiliative behaviors. Adults were defined as individuals 4 years of age and older and included those animals that were reproductively mature. Nonadults included monkeys less than 4 years of age. To apply the Chi-square test, the number of aggressive and affiliative interactions expected were determined based on the number of individuals in an age-class and on frequencies of behavioral interactions following saline administration. Mean hourly rates of occurrence of affiliative and aggressive behaviors initiated by male subjects following drug or saline administration were determined for each of five male subjects based on data obtained during preselected postinjection observation periods. Full dose-effect functions describing the results were reported previously (Smith and Byrd, 1984).

Table 7.1 summarizes data for the five male subjects that received *d*-amphetamine. Although maximum increases in aggressive behavior occurred at different doses for each of the five subjects, *d*-amphetamine uniformly increased aggressive behavior toward nonadult members of the group and decreased aggressive behavior toward adult monkeys in the group. The significance of the drug-induced changes was reflected in the results of the Chi-square tests, as shown in Table 7.1. The greatest redirection of aggressive behavior occurred in the three mid- and low-ranking animals, where values of $p \leq .001$ were obtained.

When the data were analyzed in a similar manner for maximum decreases in affiliative behavior, a contrasting pattern resulted (Table 7.1). Three subjects decreased affiliative behávior toward nonadult animals in the group and increased affiliative behavior toward adults, and two subjects showed an opposite effect. The significance of the changes

TABLE 7.1. Effects of *d*-Amphetamine on Aggressive or Affiliative Behaviors Initiated by Each of Five Adult Males toward Adult vs. Nonadult Members of the Group

Subject	*d*-Amphetamine dose (mg/kg)		Nonadult	Adult	χ^2	$p \leq$
Aggressive behaviors						
M-13	0.56	Expected	45.9 ↑	118.1 ↓	0.50	.50
		Observed	50.0	114.0		
M-10	0.03	Expected	17.1 ↑	39.3 ↓	1.37	.30
		Observed	21.0	35.0		
M-06	0.03	Expected	32.3 ↑	53.6 ↓	16.12	.001
		Observed	50.0	35.0		
M-24	0.03	Expected	3.1 ↑	35.5 ↓	123.88	.001
		Observed	22.0	17.0		
M-18	0.01	Expected	26.9 ↑	70.1 ↓	21.40	.001
		Observed	47.0	49.0		
Affiliative behaviors						
M-13	0.56	Expected	6.3 ↓	30.7 ↑	7.58	.01
		Observed	0.0	37.0		
M-10	0.30	Expected	25.2 ↓	58.8 ↑	2.94	.10
		Observed	18.0	66.0		
M-06	0.30	Expected	15.2 ↑	110.5 ↓	3.27	.10
		Observed	22.0	105.0		
M-24	0.30	Expected	6.0 ↑	54.6 ↓	6.80	.01
		Observed	12.0	48.0		
M-18	0.30	Expected	9.7 ↓	78.3 ↑	1.57	.25
		Observed	6.0	82.0		

in recipients of affiliation yielded values of $p \leq .01$ for two of the five subjects when evaluated by Chi-square tests. However, none of the changes in affiliative behavior was so large as the changes in recipients of aggressive behavior.

To determine whether the recipients of aggressive or affiliative behavior could be differentiated on the basis of matrilineally defined, genetic relationship to the aggressor, data were examined for those drug-treated monkeys whose genealogy was known. Subjects for the genealogical analysis were monkeys M-18 and M-24, two adult males that were born into the group and the only two adult males for which exact genealogy was known. Other group members were classified as kin-related or nonkin-related based on matrilineal records. Using rates of affiliative and aggressive behaviors under saline conditions and relative numbers of kin versus nonkin individuals in the group, expected rates of behavior for monkeys M-18 and M-24 were derived as shown in Table 7.2. Following administration of *d*-amphetamine, both monkeys showed an increase in rate of aggressive behavior toward matrilineally kin-related animals and a decrease in aggression toward nonkin individuals.

d-Amphetamine also produced a significant change in recipients of affiliative behavior following the administration of 0.30 mg/kg *d*-amphetamine. Statistically significant results were obtained for both subjects indicating significant departures from expected values, but the effects were opposite in direction (Table 7.2). Monkey M-18 increased affiliative behaviors toward nonkin and monkey M-24 increased affiliative behaviors toward kin-related individuals.

The data presented here show that *d*-amphetamine can have pronounced effects on the expression of aggression and affiliation among animals living in a large, heterogeneous social group. When compared to the pattern of aggression and affiliation under baseline, nondrug conditions, significant changes in rates and in objects or recipients of the behaviors were found for both classes of behavior following administration of the drug.

Although previous research has revealed much regarding the effects of *d*-amphetamine on the behavior of individuals comprising various types of groupings (Miczek, 1983), none has involved a group that yielded the type of analysis presented here. When the objects or recipients of aggressive behaviors were analyzed by age, for example, an unequivocal pattern based on age was revealed. Aggression directed toward young animals in the group increased for all five subjects following *d*-amphetamine administration. Moreover, the magnitude of the effect was inversely related to dominance position of the subjects in the group, with the highest-ranking male showing the smallest effect and the low-ranking males the largest effect. Differences in the statistical significance of the effects relative to dominance positions of the subjects

TABLE 7.2. Effects of *d*-Amphetamine on Aggressive and Affiliative Behaviors Initiated by Two Adult Males toward Kin vs. Nonkin Members of the Group

Subject	*d*-Amphetamine dose (mg/kg)		Kin	Nonkin	χ^2	$p \leq$
Aggressive behaviors initiated						
M-18	0.01	Expected	6.72 ↑	89.28 ↓	13.78	.001
		Observed	16.00	80.00		
M-24	0.03	Expected	8.58 ↑	30.42 ↓	1.75	.20
		Observed	12.00	27.00		
Affiliative behaviors initiated						
M-18	0.30	Expected	26.40 ↓	61.60 ↑	12.83	.01
		Observed	11.00	77.00		
M-24	0.30	Expected	23.40 ↑	36.60 ↓	4.05	.05
		Observed	31.00	29.00		

indicated further that the magnitude of the effects might be due, in part, to the social position of each subject. These data are consistent with other reports showing that the behavioral effects of various drugs may be a function of the dominance position of the drug-treated subject. Wilson, Bailey, and Bedford (1983) reported that *d*-amphetamine decreased food retrieval in high-ranking subjects and increased food retrieval in lower ranking subjects. In other food competition tests, Bellarosa et *al.* (1980), Grove, Wilson, and Bedford (1977), and Lovell, Bedford, Grove, and Wilson (1980) found increased food capture by subordinate animals when either the entire group or only the dominant animal was administered *d*-amphetamine. In other studies, Haber, Barchas, and Barchas (1977) and Haber, Berger, and Barchas (1979) reported that *d*-amphetamine administration increased submissive behavior in low-ranking animals. Finally, Schlemmer and Davis (1981) found rank-mediated changes in behavior following chronic *d*-amphetamine administration in small groups of stumptail macaques.

Changes in the directionality of affiliative behavior following drug administration were less uniform among the five subjects. Three of the subjects decreased and two increased the frequency of affiliative behavior directed toward young animals in the group. A possible basis for this difference in effect among the five subjects was not readily apparent. The two subjects that increased affiliative behavior toward nonadult members of the group were in the low–middle positions of the dominance hierarchy, but there was little else to indicate that the dominance position of the subject was a major determinant of the drug effect on affiliation. Indeed, we reported previously that *d*-amphetamine decreased affiliation uniformly and independently of dominance position in the group (Smith and Byrd, 1984).

Of substantial interest in the present experiment were data showing that kin-related animals were more likely than nonkin-related animals to be targets of aggressive behaviors following *d*-amphetamine administration. Kinship groups have been shown to form strong interactional subunits for all primate species where kinship relations among members of a social group were known (Chagnon, 1975; Koyama, 1970; Nash, 1976; Chepko-Sade and Sade, 1979; van Lawick-Goodall, 1967). This fact has been well documented by behavioral primatologists, but a detailed analysis of drug-induced behavioral changes in group-living animals with a known network of genealogical relations has not been reported. Although this phenomenon might normally be explained by greater spatial proximity to kin versus nonkin, proximity did not account for the results when the data were corrected for a greater absolute number of nonkin animals. Furthermore, drug versus nondrug comparisons were made against the saline control rate. The data were convincing in that both of the subjects with known genealogical histories exhibited the same pattern of increased aggression toward kin members of the group. That *d*-amphetamine had opposite effects on affiliation for the same two subjects indicates that there are likely other complex variables regulating the expression of affiliation in a socially living primate.

These findings are suggestive of a phenomenon that might have relevance for studies of child abuse and neglect. Based on studies of aggressive behavior in nonhuman primates, one would predict that individuals should aggress least against, and assist in fights with, those individuals that are related to them. To some extent, these predictions have been supported for rhesus macaques (Kaplan, 1977, 1978), pigtail macaques (Massey, 1977), and Japanese macaques (Kurland, 1977). It is of considerable interest that administration of *d*-amphetamine increases aggressive behavior against not only immature individuals, but kin-related individuals as well. Unfortunately, due to the small sample size in the present study, the orthogonal comparison of kin-related young versus nonkin-related young could not be made.

Although these results were obtained in a single captive group, they are at least suggestive that a psychoactive substance may modulate in a direct manner the expression of aggressive behavior toward a particular class of individuals. Given available data on the number of male child abusers and on the abuse rate of *d*-amphetamine, we might be able to make some tentative predictions on the extent to which our animal model may pertain to the human conditions.

Based on a survey by the National Center on Child Abuse and Neglect, Burgdorf (1980), cited in Gelles (1982), notes that there were 351,100 cases of child abuse in 1979. Data provided by the American Humane Association, cited in Lenington (1981), indicate that males were responsible for 39.4% of the 139,580 cases of child abuse reported in 1979. Although these estimates differ by more than a factor of two and illustrate the difficulty in obtaining accurate data, they do give some indication of the extent of child abuse.

The 1982 Household Survey of Drug Abuse, conducted by the National Institute on Drug Abuse, provides information on the nonmedical use of amphetamine. Included in this survey were data indicating lifetime prevalence of the use of psychoactive substances. In a sample of 4100 individuals, 18 years of age or older, 9.7% indicated that they had used amphetamine for nonmedical purposes on at least one occasion. Since data on gender of respondent were not available, males will be assumed to have accounted for one-half the sample, which is probably an underestimate. Based on a population of more than 75 million males aged 18 years or older in the United States in 1979, this means that approximately 3.7 million individuals had used amphetamine at least once.

To the extent that our nonhuman primate model pertains, it may be of interest to compare these observations. Males who are known to abuse amphetamine at least once constitute approximately 5% of the United States population, and 0.2% of the adult males in this country account for the reported cases of child abuse. Based on probability alone, therefore, one would expect that our model might be applicable to approximately 6600 individuals, or about 5% of the total cases of child abuse. Moreover, it is possible that our model has yielded significant results at two different levels. First, we have shown that following the acute administration of *d*-amphetamine, important patterns of behavior can be disrupted and even altered in a consistent manner. Consistent with these results, individuals have been shown to aggress against kin-related individuals at a disproportionately high rate. However, the general increase in aggressive behavior by adult males toward youngsters should signal the potential for biological fathers as well as stepfathers to engage in child-abusive behavior. Johnson (1974) and Gil (1970) noted that stepparents were significantly more likely than biological parents to abuse children. Second, and of more clinical relevance, when our data are applied to the United States population, there are a substantial number of cases to which our research and findings might pertain.

In conclusion, it is only through careful observations and experimentation that we can begin to understand the complex interrelationship between biology and behavior. Our results demonstrate the importance of developing appropriate animal models for studying and understanding complex human behavior patterns.

Summary

The use of animal models to further our understanding of human behavior is significant only insofar as the experimental results have some generalizing properties. The experimental alteration of the behavior of individual, group-living, nonhuman primates has provided the opportunity to understand better the group dynamics of behavioral interactions. This chapter reports on experimentally induced changes in patterns of aggressive behavior by the acute administration of *d*-amphetamine to adult male stumptail monkeys (*Macaca arctoides*). Each subject that received *d*-amphetamine increased aggressive behavior toward nonadult and decreased aggression toward adult animals in the group. Moreover, where matrilineal relationships were known, *d*-amphetamine increased aggression toward matrilineal kin and decreased aggression toward nonkin animals. These results suggest that *d*-amphetamine not only selectively alters the types of behavior exhibited

by individuals, but also alters normal patterns of ongoing social interactions.

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References

Alexander, B. K. Parental behavior of adult male Japanese monkeys. *Behaviour*, 1970, *36*:270–285.

Altmann, J. Observational study of behavior: Sampling methods. *Behaviour*, 1974, *49*:227–265.

Altmann, J. *Baboon mothers and infants*. Cambridge, MA: Harvard University Press, 1980.

Bellarosa, A., Bedford, J. A., and Wilson, M. C. Sociopharmacology of *d*-amphetamine in *Macaca arctoides*. *Pharmacology Biochemistry & Behavior*, 1980, *13*:221–228.

Berman, C. M. The social development of an orphaned rhesus infant on Cayo Santiago: Male care, foster mother–orphan interaction and peer interaction. *American Journal of Primatology*, 1982, *3*:131–141.

Bernstein, I. S. Activity patterns in a gelada monkey group. *Folia Primatologica*, 1975, *23*:50–71.

Blank, M. S., Gordon, T. P., and Wilson, M. C. Effects of capture and venipuncture on serum levels of prolactin, growth hormone and cortisol in outdoor compound-housed female rhesus monkeys (*Macaca mulatta*). *Acta Endocrinologica*, 1983, *102*:190–195.

Boggess, J. E. The social behavior of the Himalayan langur (*Presbytis entellus*) in the Nepal Himalaya. Unpublished Ph.D. dissertation, University of California, Berkeley, 1976.

Bourliere, F., Hunkeler, C., and Bertrand, M. Ecology and behavior of Lowe's guenon (*Cercopithecus campbelli* Lowei) in the Ivory Coast. *In* J. R. Napier and P. H. Napier, Eds., *Old World monkeys*. NY: Academic Press, 1970, pp. 297–350.

Busse, C. D., and Gordon, T. P. Attacks on neonates by a male mangabey (*Cercocebus atys*). *American Journal of Primatology*, 1983, *5*:345–356.

Byrd, L. D. Comparison of the behavioral effects of phencyclidine, ketamine, *d*-amphetamine and morphine in the squirrel monkey. *Journal of Pharmacology and Experimental Therapeutics*, 1982, *220*:139–144.

Caine, N., and Reite, M., Eds. *Child abuse: The nonhuman primate data*. NY: Alan Liss, 1983.(a)

Caine, N., and Reite, M. Infant abuse in captive pig-tailed macaques: Relevance to human child abuse. *In* N. Caine and M. Reite (Eds.), *Child abuse: The nonhuman primate data*. NY: Alan Liss, 1983, pp. 19–27.(b)

Carpenter, C. R. Societies of monkeys and apes. *Biological Symposia*, 1942, *8*:177–204.

Chagnon, N. A. Genealogy, solidarity, and relatedness: Limits to group size and patterns of fissioning in an expanding population. *Yearbook of Physical Anthropology*, 1975, *19*:95–110.

Chepko-Sade, B. D., and Sade, D. S. Patterns of group splitting within matrilineal kinship groups: A study of social group structure in *Macaca mulatta* (Cercopithecidae: Primates). *Behavioral Ecology and Sociobiology*, 1979, *5*:67–86.

Collins, D. A., Busse, C. D., and Goodall, J. Infanticide in two populations of savanna baboons. *In* G. Hausfater and S. B. Hrdy, Eds., *Infanticide: Comparative and evolutionary perspectives*. NY: Aldine, 1984, pp. 193–215.

Crockett, C. M., and Sekulic, R. Infanticide in red howler monkeys (*Alouatta seniculus*). *In* G. Hausfater and S. B. Hrdy, Eds., *Infanticide: Comparative and evolutionary perspectives*. NY: Aldine, 1984, pp. 173–191.

Crowley, T. J., Stynes, A. J., Hydinger, M., and Kaufman, I. C. Ethanol, methamphetamine, pentobarbital, morphine, and monkey social behavior. *Archives of General Psychiatry*, 1974, *31*:829–838.

Deag, J. M., and Crook, J. H. Social behavior and "agonistic buffering" in the wild barbary macaque *Macaca sylvana* L. *Folia Primatologica*, 1971, *15*:183–200.

DeVore, I. Mother–infant relations in free-ranging baboons. *In* H. Rheingold, Ed., *Maternal behavior in mammals*. NY: Wiley, 1963, pp. 305–335.

Dews, P. B., and Wenger, G. R. Rate-dependency of the behavioral effects of amphetamine. *In* T. Thompson and P.B. Dews, Eds., *Advances in behavioral pharmacology*, vol. 1. NY: Academic Press, 1977, pp. 167–227.

Dunbar, R., and Dunbar, P. *Social dynamics of gelada baboons (Contributions to primatology*, vol. 6). Basel: S. Karger, 1975.

Fagen, R. *Animal play behavior*. New York: Oxford University Press, 1981.

Fossey, D. Infanticide in mountain gorillas (*Gorilla gorilla beringei*) with comparative notes on chimpanzees. *In* G. Hausfater and S. B. Hrdy, Eds., *Infanticide: Comparative and evolutionary perspectives*. NY: Aldine, 1984, pp. 217–235.

Gelles, R. J. Child abuse in the context of violence in the family and society. Paper presented at the Conference on Research Issues in Child Abuse, Oxford, England, November 25–27, 1982.

Gil, D. G. *Violence against children*. Cambridge, MA: Harvard University Press, 1970.

Goodall, J. Infant killing and cannibalism in free-living chimpanzees. *Folia Primatologica*, 1977, *28*:259–282.

Goodall, J. Population dynamics during a 15-year period in one community of free-living chimpanzees in the Gombe National Park, Tanzania. *Zeitschrift für Tierpsychologie*, 1983, *61*:1–60.

Grove, L., Wilson, M., and Bedford, J. Effects of diazepam and *d*-amphetamine on food competition in rhesus monkey. *The Pharmacologist*, 1977, *19*:228.

Haber, S. N. The effects of amphetamine on social and individual behavior of rhesus macaques. Unpublished Ph.D. dissertation, Stanford University, Stanford, 1979.

Haber, S. N., Barchas, P. R., and Barchas, J. D. Effects of amphetamine on social behaviors of rhesus macaques: an animal model of paranoia. *In* I. Hanin and E. Usdin, Eds., *Animal models in psychiatry and neurology*. Elmsford, NY: Pergamon Press, 1977, pp. 107–115.

Haber, S. N., Berger, P. A., and Barchas, P. R. The effects of amphetamine on agonistic behaviors in nonhuman primates. *In* E. Usdin, I. J. Kopin, and J. D. Barchas, Eds., *Catecholamines: Basic and clinical frontiers*. Elmsford, NY: Pergamon Press, 1979, pp. 1702–1704.

Hamilton, W. J. III, Busse, C., and Smith, K. S. Adoption of infant orphan chacma baboons. *Animal Behaviour,* 1982, *30*:29–34.

Hasegawa, T., and Hiraiwa, M. Social interactions of orphans observed in a free-ranging troop of Japanese monkeys. *Folia Primatologica,* 1980, *33*:129–158.

Hausfater, G., and Hrdy, S. B. Eds. *Infanticide: Comparative and evolutionary perspectives.* NY: Aldine, 1984.

Hrdy, S. B. Care and exploitation of nonhuman primate infants by conspecifics other than the mother. *In* J. S. Rosenblatt, R. A. Hinde, E. Shaw, and C. Beer, Eds., *Advances in the study of behavior,* vol. 6. NY: Academic Press, 1976, pp. 101–158.

Hrdy, S. B. *The langurs of Abu: Female and male strategies of reproduction.* Cambridge, MA: Harvard University Press, 1977.

Hrdy, S. B. Infanticide among animals: A review, classification and examination of the implications for the reproductive strategies of females. *Ethology and Sociobiology,* 1979, *1*:13–40.

Itani, J. Paternal care in the wild Japanese monkey, *Macaca fuscata. Primates,* 1959, *2*:61–94.

Jay, P. C. The common langur of North India. *In* I. DeVore, Ed., *Primate behavior: Field studies of monkeys and apes.* NY: Holt, Rinehart and Winston, 1965, pp. 197–249.

Jensen, G. D., Bobbitt, R. A., and Gordon, B. N. Development of mutual independence in mother–infant pigtailed monkeys. *In* S. A. Altmann, Ed., *Social communication among primates.* Chicago, IL: University of Chicago Press, 1967, pp. 43–53.

Jensen, G. D., Bobbitt, R. A., and Gordon, B. N. Studies of mother–infant interactions in monkeys (*Macaca nemestrina*): Hitting behavior. *In* C. R. Carpenter, Ed., *Proceedings of the 2nd International Congress of Primatology: Behavior,* vol. 1. Basel: S. Karger, 1969, pp. 186–193.

Johnson, C. L. *Child abuse in the southeast.* Athens, GA: Regional Institute of Social Welfare Research, University of Georgia, 1974.

Kaplan, J. R. Patterns of fight interference in free-ranging rhesus monkeys. *American Journal of Physical Anthropology,* 1977, *47*:279–288.

Kaplan, J. R. Fight interference and altruism in rhesus monkeys. *American Journal of Physical Anthropology,* 1978, *49*:241–249.

Kaufman, I. C., and Rosenblum, L. A. The waning of the mother–infant bond in two species of macaques. *In* B. M. Foss, Ed., *Determinants of infant behavior,* vol. 4. London: Methuen, 1969, pp. 41–59.

Kelleher, R. T., and Morse, W. H. Determinants of the specificity of behavioral effects of drugs. *Ergebnisse der Physiologie, Biologischen Chemie und Experimentellen Pharmakologie,* 1968, *60*:1–56.

Kjellberg, B., and Randrup, A. Changes in social behaviour in pairs of vervet monkeys (*Cercopithecus*) produced by single, low doses of amphetamine. *Psychopharmacologia,* 1972, *26*:127.

Koyama, N. Changes in dominance rank and division of a wild Japanese monkey troop in Arashiyama. *Primates,* 1970, *11*:335–390.

Kummer, H. Tripartite relations in hamadryas baboons. *In* S.A. Altmann, Ed., *Social communication among primates.* Chicago, IL: University of Chicago Press, 1967, pp. 63–71.

Kurland, J. A. *Kin selection in the Japanese monkey.* Basel: S. Karger, 1977.

Leland, L., Struhsaker, T. T., and Butynski, T. M. Infanticide by adult males in three primate species of Kibale Forest, Uganda: A test of hypotheses. *In* G. Hausfater and S. B. Hrdy, Eds., *Infanticide: Comparative and evolutionary perspectives.* NY: Aldine, 1984, pp. 151–172.

Lenington, S. Child abuse: The limits of sociobiology. *Ethology and Sociobiology,* 1981, *2*:17–29.

Lovell, D. K., Bedford, J. A., Grove, L., and Wilson, M. C. Effects of *d*-amphetamine and diazepam on paired and grouped primate food competition. *Pharmacology Biochemistry and Behavior,* 1980, *13*:177–181.

McKearney, J. W. Maintenance of responding under a fixed-interval schedule of electric shock presentation. *Science,* 1968, *160*:1249–1251.

McKenna, J. J. The evolution of allomothering behavior among colobine monkeys: Function and opportunism in evolution. *American Anthropologist,* 1979, *81*:818–840.

McMillan, D. E. Effects of *d*-amphetamine on performance under several parameters of multiple fixed-ratio, fixed-interval schedules. *Journal of Pharmacology and Experimental Therapeutics,* 1969, *167*:26–33.

Marsden, H. M., and Vessey, S. H. Adoption of an infant green monkey within a social group. *Communications in Behavioral Biology,* Part A, 1968, *2*:275–279.

Massey, A. Agonistic aids and kinship in a group of pigtail macaques. *Behavioral Ecology and Sociobiology,* 1977, 231–40.

Miczek, K. A., Ed. *Ethopharmacology: Primate models of neuropsychiatric disorders.* New York: Alan R. Liss, 1983.

Miczek, K. A., Woolley, J., Schlisserman, S., and Hiroyuki, Y. Analysis of amphetamine effects on agonistic and affiliative behavior in squirrel monkeys (*Saimiri sciureus*). *Pharmacology Biochemistry and Behavior,* 1981, *14*:103–107.

Miller, M. H., and Geiger, E. Dose effects of amphetamine on macaque social behavior: Reversal by haloperidol. *Research Communications in Psychology, Psychiatry and Behavior,* 1976, *1*:125–142.

Nash, L. T. Troop fission in free-ranging baboons in Gombe Stream National Park, Tanzania. *American Journal of Physical Anthropology,* 1976, *44*:63–77.

Negayama, K. Maternal aggression to its offspring in Japanese monkeys. *Journal of Human Evolution,* 1981, *10*:523–527.

Nicolson, N. Weaning and the development of independence in olive baboons. Unpublished Ph.D. dissertation, Harvard University, Cambridge, 1982.

Packer, C. Inter-troop transfer and inbreeding avoidance in *Papio anubis. Animal Behaviour,* 1979, *27*:1–36.

Packer, C. Male care and exploitation of infants in *Papio anubis. Animal Behaviour,* 1980, *28*:512–520.

Popp, J. L. Male baboons and evolutionary principles. Unpublished Ph.D. dissertation, Harvard University, Cambridge, 1978.

Quaitt, D. Aunts and mothers: Adaptive implications of allomaternal behavior. *American Anthropologist,* 1979, *81*:310–319.

Redican, W. K., and Taub, D. M. Male parental care in monkeys and apes. *In* M. E. Lamb, Ed., *The role of the father in child development.* NY: Wiley, 1981, pp. 203–258.

Rhine, R. J., Norton, G. W., Roertgen, W. J., and Klein, H. D. The brief survival of free-ranging baboon infants (*Papio cynocephalus*) after separation from their mothers. *International Journal of Primatology,* 1980, *1*:401–409.

Ruppenthal, G. C., Arling, G. L., Harlow, H. F., Sackett, G. P., and Suomi, S. J. A 10-year perspective of motherless mother monkey behavior. *Journal of Abnormal Psychology,* 1976, *85*:341–349.

Sackett, G. P. Receiving severe aggression correlates with fetal gender in pregnant pigtailed monkeys. *Developmental Psychobiology*, 1981, *14*:267–272.

Schlemmer, R. F., Jr., and Davis, J. M. LSD-induced behavioral changes in selected members of a primate social colony. *Federation Proceedings*, 1981, *40*:306.

Scraggs, P. R., and Ridley, R. M. Behavioural effects of amphetamine in a small primate: Relative potencies of the *d*- and *l*-isomers. *Psychopharmacology*, 1978, *59*:243–245.

Seyfarth, R. M. Social relationships among adult male and female baboons. II. Behaviour throughout the female reproductive cycle. *Behaviour*, 1978, *64*:227–247.

Shopland, J.M . An intergroup encounter with fatal consequences in yellow baboons (Papio cyncocephalus). *American Journal of Primatology*, 1982, *3*:263–266.

Silk, J. B., and Boyd, R. Female cooperation, competition, and mate choice in matrilineal macaque groups. *In* S. K. Wasser, Ed., *Social behavior of female vertebrates*. NY: Academic Press, 1983, pp. 315–347.

Silk, J. B., Clark-Wheatley, C. B., Rodman, P. S., and Samuels, A. Differential reproductive success and facultative adjustment of sex ratios among captive female bonnet macaques (*Macaca radiata*). *Animal Behaviour*, 1982, *29*:1106–1120.

Silk, J. B., Samuels, A., and Rodman, P. S. The influence of kinship, rank, and sex upon affiliation and aggression among adult female and immature bonnet macaques (*Macaca radiata*). *Behaviour*, 1981, *78*:112–137.

Smith, E. O., and Begeman, M. L. BORES: Behavior observation recording and editing system. *Behavior Research Methods and Instrumentation*, 1980, *12*:1–7.

Smith, E. O., and Byrd, L. D. Studying the behavioral effects of drugs in group-living nonhuman primats. *In* K. A. Miczek, Ed., *Ethopharmacology: Primate models of neuropsychiatric disorders*. NY: Alan Liss, 1983, pp. 1–31.

Smith, E. O., and Byrd, L. D. Contrasting effects of *d*-amphetamine on affiliation and aggression in monkeys. *Pharmacology Biochemistry and Behavior*, 1984, *20*:255–260.

Spencer-Booth, Y. The relationship between mammalian young and conspecifics other than mothers and peers: a review. *In* D. S. Lehrman, R. A. Hinde, and E. Shaw, Eds., *Advances in the study of behaviour*, vol. 3. NY: Academic Press, 1970, pp. 120–180.

Stein, D. M. The nature and function of social interactions between infant and adult male yellow baboons (*Papio cynocephalus*). Unpublished Ph.D. dissertation, University of Chicago, Chicago, 1981.

Suomi, S.J., and Ripp, C. A history of motherless mother monkey mothering at the University of Wisconsin Primate Laboratory. *In* N. Caine and M. Reite, Eds., *Child abuse: The nonhuman primate data*. NY: Alan Liss, 1983, pp. 49–78.

Taub, D. M., Ed., *Primate paternalism*. NY: Van Nostrand Reinhold, 1984.

Trivers, R. L. Parental investment and sexual selection. *In* B. G. Campbell, Ed., *Sexual selection and the descent of man*. Chicago, IL: Aldine, 1972, pp. 136–179.

Troisi, A., D'Amato., Fuccillo, R., and Scucchi, S. Infant abuse by a wild-born group-living Japanese macaque mother. *Journal of Abnormal Psychology*, 1980, *91*:451–456.

van Lawick-Goodall, J. Mother-offspring relationships in free-ranging chimpanzees. *In* D. Morris, Ed., *Primate ethology*. Chicago, IL: Aldine, 1967, pp.

Wilson, M. C., Bailey, L., and Bedford, J. A. Effects of subacute administration of amphetamine on food competition in primates. *In* K. A. Miczek, Ed., *Ethopharmacology: Primate models of neuropsychiatric disorders*. NY: Alan Liss, 1983, pp. 293–305.

Wolfe, L. D. A case of male adoption in a troop of Japanese monkeys (*Macaca fuscata fuscata*). *In* A. B. Chiarelli and R. S. Corruccini, Eds., *Primate behavior and sociobiology*. Berlin: Springer-Verlag, 1981, pp. 156–160.

Wrangham, R. W. An ecological model of female-bonded primate groups. *Behaviour*, 1980, *75*:262–300.