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Adult Male-Immature Interactions in Captive Stumptail Macaques *(Macaca arctoides)*

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INTRODUCTION

Alloparental care is limited to the most advanced animal societies and is most richly expressed among the primates (Wilson, 1975). There is considerable inter- and intraspecific variability in alloparental care among the primates, ranging from brief, sporadic encounters to prolonged association. As Wilson (1975) notes, alloparental care can be divided into two aspects: allomaternal and allopaternal. Although allomaternal behavior is far more common, allopaternal interactions do indeed occur. Because of the pervasiveness, complexity, and importance of mother-young interactions in understanding certain aspects of nonhuman primate sociality, only recently have researchers become interested in the role of males in the development and socialization of young. When compared to mother-young interactions in most primate societies, male-young interactions are subtle and infrequent and exhibit high interanimal variability. (See Hrdy, 1976; Mitchell, 1969, 1977; Redican and Taub, 1981; Spencer-Booth, 1970; and chapters 14 and 15 for reviews of male-infant interactions.)

Among one cercopithecoid genus, *Macaca*, considerable variability in male-immature interactions has been observed (see chapter 15). This variability ranges from the extensive male care system of Barbary macaques (Burton, 1972; Deag and Crook, 1971; Taub, 1980; Whiten and Rumsey, 1973) to the very restricted male care of free-ranging rhesus macaques (cf. Lindburg, 1971; Makwana, 1978; Southwick et al., 1965; Taylor et al., 1978; chapter 5).

Of particular interest for this paper were the interactions between adult male and immature stumptail macaques *(Macaca arctoides)*, since males of this species have been characterized as exhibiting high levels of paternalistic interactions with immatures (Brandt et al., 1970; Estrada and Sandoval, 1977; chapter 3). As such, it was an interesting species for investigating the parameters of male-immature interactions. Therefore, the specific objectives of this study were: (1) to determine the nature and types of adult male-immature interactions in a captive stumptail macaque group; (2) to examine the effects of certain variables on these interactions; and (3) to identify specific patterns of interactions among adult male-immature dyads.

In both free-ranging (Estrada and Sandoval, 1977) and captive (Hendy-Neely and Rhine, 1977) groups of stumptail macaques, adult males have been observed to carry, cradle, retrieve, groom, and touch infants. Rhine and Hendy-Neely (1978) noted that adult males and infants (individuals under 60 days of life) engaged in behaviors commonly seen in mother-young pairs. Adult males interacted significantly more often with infants than did immatures or adult females other than the mother. Bernstein (1970) noted considerable interest in infants among male stumptail macaques; Jones and Trollope (1968) also found that adult male stumptail macaques were very aware of infants and would even lip-smack to color pictures of infants. Conversely, infants also show interest in males and often seek their proximity (Bertrand, 1969; Estrada et al., 1977). On the other hand, Bertrand (1969) noted that zoo-reared male stumptail macaques may attack and bully infants. From these scattered reports of interactions between adult male and immature stumptail macaques, some of the salient features of the relationship might be identified, but more data are required to precisely delineate their nature.

METHODS

Study Group and Housing

The subjects of this study were a captive group of stumptail macaques *(Macaca arctoides)* housed at the Yerkes Regional Primate Research

Center Field Station near Lawrenceville, Georgia. The group was housed in a 28.4 × 32.7 m. outdoor enclosure attached to 4.4 × 12.2 m. indoor quarters via two metal tunnels (Fig. 4-1).

The group consisted initially of 36 animals: 4 adult males (classification based on full dentition, developed temporal musculature, and general physical conformation), 18 adult females (cycling, at approximately 4 years of age), 1 subadult male (4 to 5 years old), 3 subadult females (3 to 4 years), 3 juvenile males (2 to 4 years), 2 juvenile females (2 to 3 years), 3 immature males, and 2 immature females (birth to 2 years). See Table 4-1 and Figure 4-2 for the genealogies and birth dates of individuals in the study group (3 deceased animals were not included).

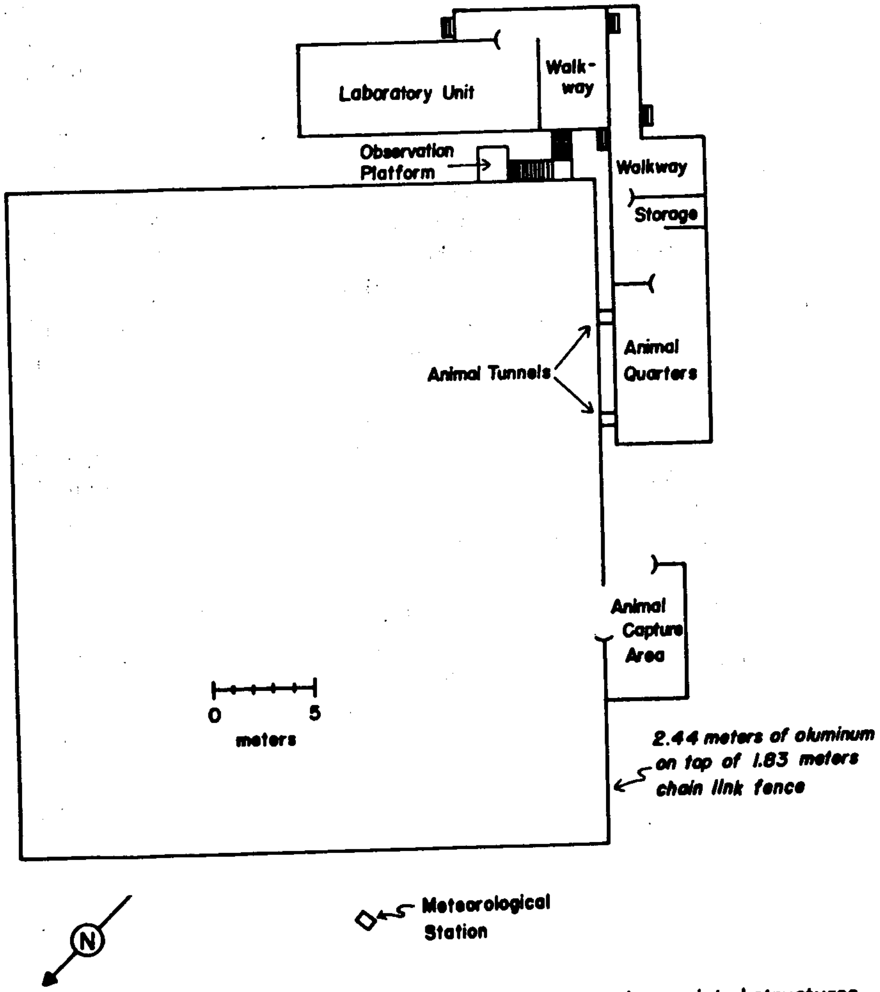
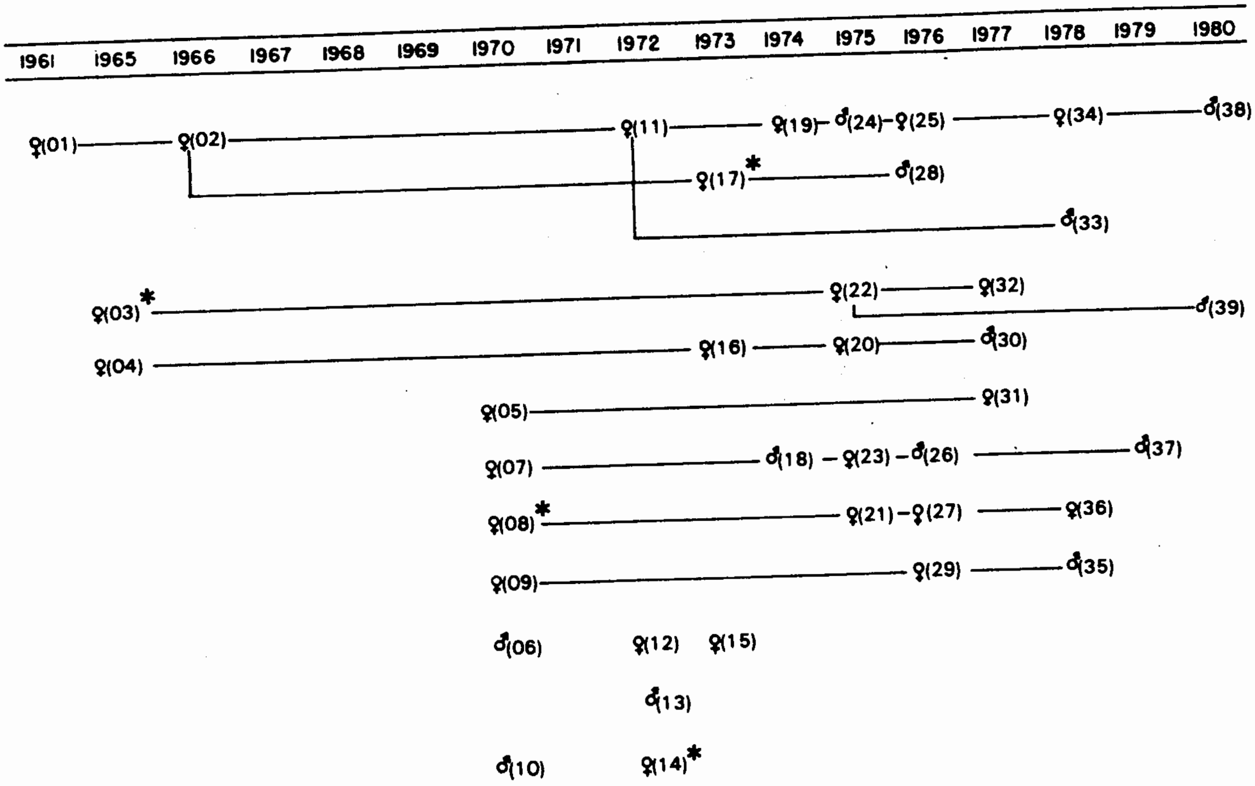


Fig. 4-1. Schematic view of the animal enclosure and associated structures.

During the course of the study, there were seven changes in the demography of the group, including: (1) two births, (2) permanent removal or death of three adult females, and (3) maturational changes of one male and two females. Methodological problems associated with maturation of group members are discussed later. The demography of the group and the associated changes during the study are detailed in Table 4-2.

Table 4-1. Birthdates of Group Members.

Males		Females	
Code	Birthdate	Code	Birthdate
06	1970	01	1961
10	2/04/70	02	4/29/66
13	9/16/72	03	1965
18	2/15/74	04	1965
24	8/11/75	05	1970
26	11/12/76	07	1970
28	12/24/76	08	1970
30	7/04/77	09	1970
33	3/04/78	11	6/06/72
35	8/05/78	12	8/28/72
37	1/22/79	14	12/14/72
38	6/12/80	15	1/01/73
39	7/09/80	16	1/22/73
		17	6/18/73
		19	9/19/74
		20	2/20/75
		21	3/06/75
		22	3/18/75
		23	7/13/75
		25	7/05/76
		27	12/16/76
		29	12/31/76
		31	9/09/77
		32	9/20/77
		34	3/22/78
		36	8/10/78



*DECEASED

Fig. 4-2. Genealogical relationships of members of the study group.

Table 4-2. Demographic Changes in the Study Group.

Time Block	Dates	Adult Male	Adult Female	Subadult	Juvenile	Immature	Reason for Change
1	12/17/79-12/21/79	4	18	4	5	5	
2	12/22/79-3/3/80	4	17	4	5	5	Permanent removal, adult female 08
3	3/4/80-3/12/80	4	17	4	6	4	Maturation, 33
4	3/13/80-3/21/80	4	16	4	6	4	Death-adult female 03
5	3/22/80-6/11/80	4	16	4	7	3	Maturation, 34
6	6/12/80-7/4/80	4	16	4	7	4	Birth, 38
7	7/5/80-7/8/80	4	17	3	7	4	Maturation, 25
8	7/9/80-8/7/80	4	16	3	7	5	Birth, 39 Permanent removal, adult female 17

Procedures

Data were collected from 17 December, 1979, to 7 August, 1980, using a microprocessor-based data collection device, the Datamyte 900 (see Smith and Begeman, 1980, for details). Data were collected on the interactions of the four adult males with other group members using the focal animal observation technique (Altmann, 1974); 173.5 hours of focal adult male data were obtained totaling 46,053 male-initiated interactions (Table 4-3). Data were collected at preselected time periods throughout the day in a randomized block design so that subjects were observed equally for all time periods over several days. Focal tests lasted 15 minutes per subject; observation sessions typically involved two to three tests in succession. Observations were made from a platform located 4.27 m. above the enclosure substrate (see Fig. 4-1). Complete visual access to the group during observation sessions was maintained by restricting the animals' movements to the outdoor enclosure.

A total of 120 different types of behaviors was scored during observation sessions. The behavioral inventory utilized was influenced by the work of Bertrand (1969) and Chevalier-Skolnikoff (1974), but was primarily developed during a previous study conducted on another stumptail macaque group at the study site (Peffer-Smith, 1978). For a complete discussion of the behavioral inventory, see Smith and Peffer-Smith (unpub. ms.).

Based on previous observations of stumptail macaques and for the purpose of developing a broader perspective on group interactions, the behavioral inventory was organized into seven functional and analytical classes of behavior (Rosenblum, 1978):

1. *Aggressive:* behaviors that cause actual physical injury or signal the potential for harm—also, behaviors that result in preferential access to incentives.
2. *Submissive:* behaviors that are a reaction to a real or perceived possibility of bodily injury.
3. *Affiliative:* any positive behavior that does not involve bodily harm or that is an attempt to safeguard another.
4. *General social:* any behavior that is social because it involves another individual, but carries no specific social messages (e.g., approach, watch, look at, move off from).
5. *Play:* vigorous, exaggerated but relaxed movements; structurally similar behaviors seen in aggressive and submissive behavior, but contact is less forceful, is silent, and the roles of the interactants are frequently reversed.
6. *Sexual:* behaviors regularly a component of heterosexual mating; however, may be scored regardless of the reproductive potential of the participants.
7. *Self-directed and maintenance:* any behavior directed toward self.

Behaviors included in each of these seven categories were mutually exclusive: i.e., they could be scored in one, and only one, functional class.

For purposes of this study, only data from the four adult males were analyzed; furthermore, only the interactions they initiated to other group members were used for most analyses. Although this approach does not allow for the complete analysis of the male-immature interactional system, it provides insight into some of its key features.

RESULTS

Demographic Characteristics

Before examining adult male-immature interactions in detail, the distribution of male-initiated acts to all age-sex classes must be considered to determine if frequency of interaction might be a function of the number of available partners. Put differently, can the observed distribution of behaviors initiated by adult males simply be accounted for by the composition of the group? The distribution of male-initiated interactions to all group members during the 8 time blocks comprising the entire study period is shown in Table 4-3. Could the high frequency of initiation of interactions to adult females (41% of the total) be because there were more adult females available in the study group? The question was further complicated when we considered the demographic changes of the study group, which obviously affected the number of available interactants in any age-sex class. Therefore, the hypothesis that the distribution of male-initiated acts was simply a function of the number of available partners must be considered.

When these data were analyzed using the technique presented by Altmann and Altmann (1977, pp. 365-66, case two example), theoretically expected values for the frequency of interactions between adult males and all other age-sex classes were derived. Given the number of individuals in any age-sex class and the duration of that sample period as a proportion of the total available animal hours during the study, theoretically expected values for each behavior class for each age-sex class were calculated.

Data were analyzed in a similar manner for each of the separate behavior classes and the theoretically expected frequencies were derived (Table 4-4). Table 4-4 also shows the results of a Chi-square analysis for each behavior class, as well as total social interactions. Significant differences ($p \leq .05$) between observed and expected frequencies were found for total social interactions, as well as for each of the six constituent behavior classes. These data indicated that factors other than simple group demography must be implicated in the distribution of adult male interactions.

Table 4-3. Distribution of Adult Male-Initiated Social Interactions to All Group Members.

Time Block		Adult Male*	Adult Female	Subadult	Juvenile	Immature	Total
1	No. of individuals	4	18	4	5	5	36
	Observed frequencies	921	940	189	156	154	2360
	Sample time, 9 hrs						
2	No. of individuals	4	17	4	5	5	35
	Observed frequencies	1925	3909	753	736	948	8271
	Sample time, 31 hrs						
3	No. of individuals	4	17	4	6	4	35
	Observed frequencies	302	676	137	157	248	1520
	Sample time, 6 hrs						
4	No. of individuals	4	16	4	6	4	34
	Observed frequencies	436	620	148	179	182	1565
	Sample time, 6 hrs						
5	No. of individuals	4	16	4	7	3	34
	Observed frequencies	3837	7523	2065	2988	2194	18607
	Sample time, 74 hrs						
6	No. of individuals	4	16	4	7	4	35
	Observed frequencies	767	1582	499	761	456	4065
	Sample time, 15.5 hrs						
7	No. of individuals	4	17	3	7	4	35
	Observed frequencies	108	459	134	183	69	953
	Sample time, 4.5 hrs						
8	No. of individuals	4	16	3	7	5	35
	Observed frequencies	1463	3349	777	1808	1315	8712
	Sample time, 27.5 hrs						
	Total Observed Frequencies	9759	19058	4702	6968	5566	46053
	(% Total)	21.19	41.38	10.21	15.13	12.09	

*All four males pooled as subjects.

Table 4-4. Observed and Expected Frequencies for Male-Initiated Interactions by Behavior Class and Age-Sex Class.

Behavior Class	Frequency	Adult Males	Adult Females	Subadults	Juveniles	Immatures	χ^2
Total social Interactions	Observed	9759	19058	4702	6968	5566	4385.73*
	Expected	5325	21758	5080	8614	5276	
Aggressive	Observed	186	601	185	361	171	42.80*
	Expected	174	711	166	281	172	
Submissive	Observed	198	88	24	66	87	503.54*
	Expected	54	219	51	87	53	
Affiliative	Observed	2347	3702	867	876	1118	2143.51*
	Expected	1030	4210	983	1667	1021	
General social	Observed	7021	14341	3581	5636	4188	2647.92*
	Expected	4020	16426	3835	6503	3983	
Play	Observed	0	0	0	14	2	46.16*
	Expected	2	8	2	3	2	
Sex	Observed	7	326	45	15	0	227.55*
	Expected	45	187	43	74	45	

*Significant $p \leq .05$.

The distribution of theoretically observed and expected acts was then examined for each age-sex class separately to see if there were significant departures. In order to evaluate each cell in our Chi-square table, a procedure outlined in Bishop et al. (1975, pp.136–37) was employed that allowed us to compute standardized cell residuals and compare derived values to the appropriate Chi-square distribution.[1] Specifically, it was found that adult males initiated significantly more ($p \leq .05$) interactions with immatures than expected. These interactions included significantly more ($p \leq .05$) submissive behavior, general social behavior, and affiliative behavior, although they initiated significantly less ($p \leq .05$) sexual behavior than expected (an expected result due to the maturational status of the immatures). No significant departures from theoretically expected values were found for aggressive behavior or play.

Figure 4-3 shows a comparison of the types of behaviors that adult males exhibit toward all age-sex classes. From a qualitative point of view, the adult males were consistent in exhibiting different types of behaviors across age-sex classes, initiating general social and affiliative behaviors predominantly to all age-sex classes. Specific behaviors that adult males were observed to initiate to immatures included a variety of types of threat faces, displace, hit, push, grab, pin, bite, chase, jerk, avoid, approach, proximity, look, watch, inspect, behind lift (called bridging in Estrada and Sandoval, 1977), groom, touch, hold, grasp, huddle, pout face, pull in, lip-smack, gutteral, dorsal and ventral hold, dorsal and ventral carry, play face, play mouth, and play grapple. When the observed and expected percentiles of different classes of interactions were graphically depicted across age-sex classes, significant departures in all age-sex classes were found for at least one behavior class (Figure 4-4).

Intermale Variability

As has been shown, males directed a disproportionately large number of interactions toward immatures. The next question was to look at each of the four adult males to see if there were individual differences in rates of interaction with immatures, as compared to their frequency of interaction. To examine specific rates of interaction, individual rates of interaction for each adult male-immature dyad were compared. Since maturation and birth affected the composition of the immature age class during the study, we based our calculation of rates on the number of hours each immature was available for interaction with a given male. Therefore, rates were expressed as a frequency of acts per immature hour for a specific dyad. This then allowed the utilization of all the data from immatures who, during the course of the study, graduated from the immature age class, and the data from immatures born during the study. Table 4-5 shows the average rate of interaction per immature hour during the study for total social interactions and four behavior classes (play and sexual behavior could not be analyzed because of their low frequency of occurrence). Significant differences ($p \leq .05$) among the four males were found for affiliative behavior, general social behavior, and total social interactions. As can be seen qualitatively, male 10 was the most predominantly involved of all four males in positive interactions with immatures.

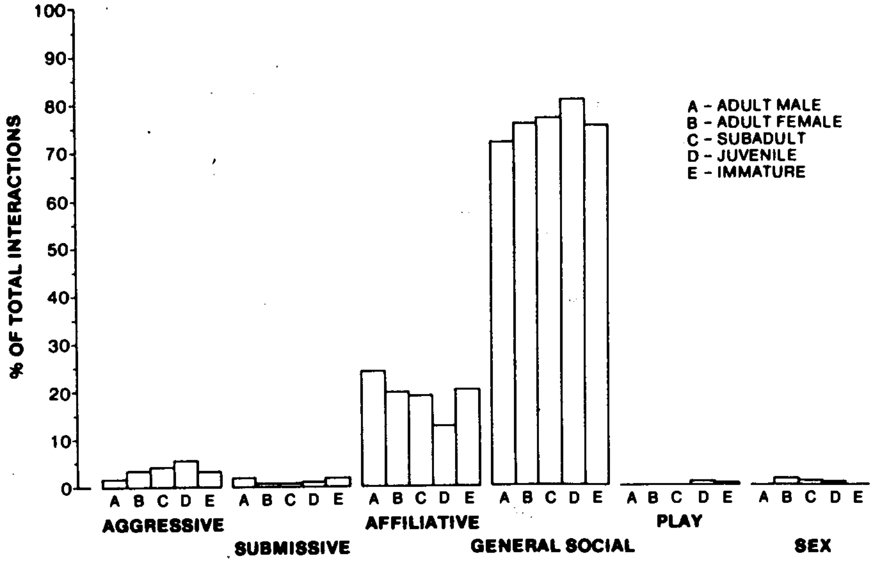


Fig. 4-3. Adult male-initiated behaviors to all age-sex classes.

Dominance Rank

Given that significant differences existed among the adult males in the rate of interaction with immatures, data were analyzed to determine if

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[1] Standardized cell residuals (Z_i) were calculated as follows:

$$Z_i = \frac{o_i - e_i}{e_i}$$

where o_i = observed value and e_i = expected value. Then the absolute value of the square of the standarized cell residuals was compared to the square root of 5% significance level of the appropriate Chi-square distribution divided by the number of cells. See Fagen and Mankovich (1980) for a review of problems associated with this type of analysis.

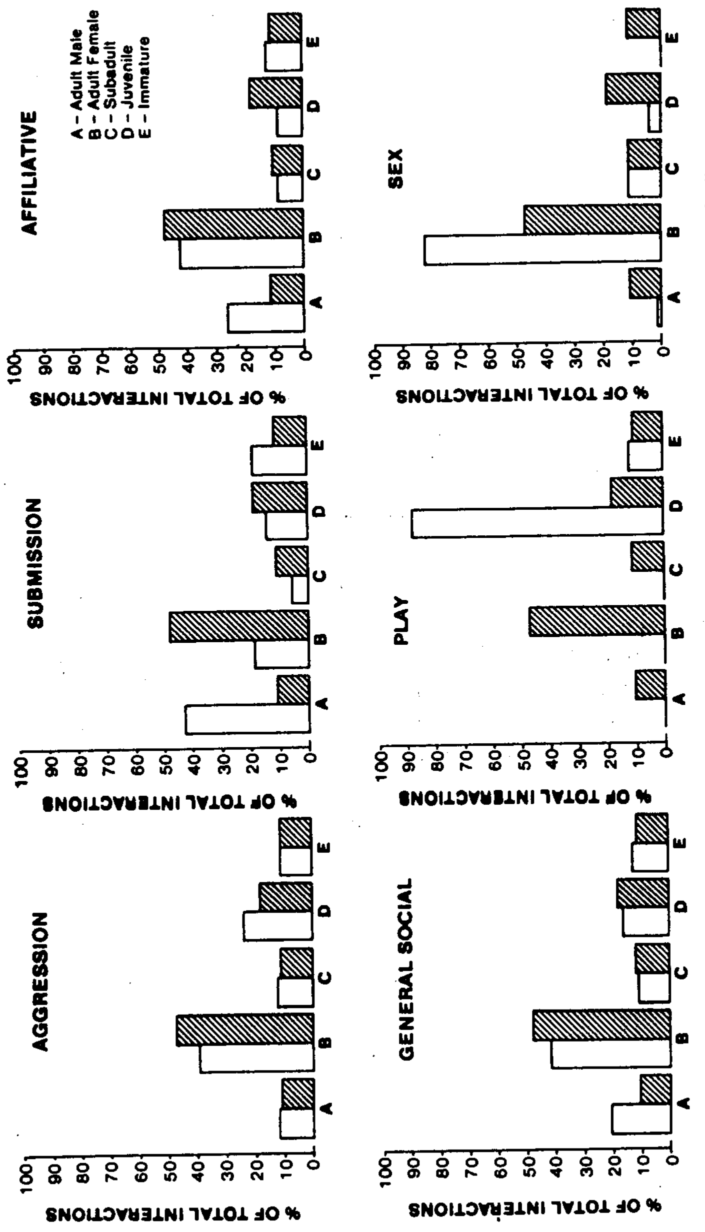

Fig. 4-4. Comparison of observed and theoretically expected percentages of all behavior types by age-sex class. Crosshatched bars indicate theoretically expected values.

Table 4-5. Adult Male Rates of Interaction Initiated to Immatures (Frequency/Immature Hour) for Four Behavior Classes and Total Social Interactions.

Behavior Class	Adult Male 06	10	13	18	χ^2
Aggressive	0.22	0.46	0.13	0.18	0.257
Submissive	0.03	0.17	0.09	0.22	0.164
Affiliative	0.38	5.49	0.23	0.43	12.185*
General social	3.52	11.87	5.79	3.22	7.925*
Total social interactions	4.15	17.99	6.24	4.05	16.454*

*Significant $p \le .05$.

dominance rank might account for this variability. The adult males were ranked based on the outcome of aggressive and submissive interactions for each of the eight separate blocks of the study, and Kendall's Coefficient of Concordance for these ranks was calculated ($W = 0.9125$, sig. $p \le .001$) (Siegel, 1956, p. 231) to determine the consistency of rank across the study. Given the high degree of similarity across the blocks, the males were then ranked according to their frequency of inititation of each behavior class that could be analyzed, as well as total social interactions. Spearman rank order correlation coefficients for the rate of total social interactions and rate of all behavior classes were not significant with dominance rank ($p \le .05$). Therefore, it was concluded that dominance rank of the adult male was not an important factor in accounting for the intermale variation.[2]

Individual Male-Immature Dyads

In order to precisely delineate the nature of the adult male-immature interactions, the rates of interaction between each of the adult males and each immature were calculated. Aggressive and submissive interactions, as well as play and sexual behavior, were not analyzed in this manner because of their infrequent occurrence (see Table 4-6). For total social interactions, males 06 and 10 showed significant deviations ($p \le .05$) from expected rates for total social interactions when the observed individual rate for each male was compared to the average rate for each male with all immatures combined. Further examination of the data presented in Table 4-6 revealed that male 06 initiated over 2.5 times as many social interactions to immature 39 than

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[2] In a previous study (Peffer-Smith, 1978), however, high-ranking males were found to interact significantly more ($p \le .05$) with immatures than low-ranking males. This could possibly be explained by the association between kin and rank in the study group.

Table 4-6. Adult Male Rates of Interaction to Immatures for Total Social Interactions, Affiliative, and General Social Behavior.

Adult Male	33	34	35	36	37	38	39	$\overline{X}$	χ^2
	Immature								
				Total Social Interactions					
06	2.00	1.46	5.36	2.99	4.51	2.92	11.86	4.44	18.25*
10	9.00	8.69	10.34	36.23	17.16	8.77	2.81	13.29	48.62*
13	6.80	6.31	5.40	6.76	5.31	9.33	7.71	6.80	2.22
18	0.60	1.77	2.84	4.25	5.83	5.87	5.19	3.76	6.52
				Affiliative					
06	0.30	0.23	0.51	0.39	0.25	0.00	1.29	0.42	2.72
10	2.40	1.62	1.23	16.32	3.10	0.17	0.00	3.55	40.85*
13	0.50	0.00	0.16	0.39	0.14	0.42	0.00	0.23	1.10
18	0.00	0.15	0.12	0.53	0.79	0.60	0.30	0.36	1.27
				General Social					
06	1.30	1.08	4.57	2.39	40.20	2.57	9.86	3.68	15.57*
10	6.40	6.69	8.81	18.87	13.62	6.47	2.81	9.10	19.13*
13	6.30	5.92	5.08	6.18	5.06	8.00	7.43	1.11	1.58
18	0.60	1.15	2.36	3.47	4.76	3.40	4.74	1.64	5.18

*Significant $p \le .05$.

would be theoretically expected (sig. $p \le .05$).[3] Also, male 10 directed over twice the expected rate of total social interaction to infant 36. In both cases, theoretically expected rates were the average for each male across all immatures.

When total social interactions were partitioned into the major behavior classes (affiliative and general social behavior), no significant differences were found in the distribution of affiliative acts among the immatures by male 06, although immature 39 received over 2.5 times more affiliative behavior than the next highest immature. Male 10, however, showed significant variation among infants, with infant 36 receiving over six times the rate of affiliative behavior for any other immature (sig. $p \le .05$). In fact, immature 36 received almost twice the rate of interactions of all other infants combined. For general social behavior, the pattern persisted; namely, the unusually high rate of interaction between animals 06 and 39, and 10 and 36 (all sig. $p \le .05$). These results suggested some sort of special relationship between these particular male-infant dyads.

To further clarify the nature of these relationships and to assess the possibility that these males were initiating behaviors to these immatures in order to associate with the immatures' mothers, we examined the interactions between these two males and the mothers of the respective infants. Figure 4-5 shows the rate of interaction between male 06 and all females with infants. Of special interest, of course, is the rate of interaction between male 06 and female 22, mother of immature 39. Clearly, male 06 had, prior to the birth of immature 39, a consistently high interaction rate with female 22, except for the time block immediately preceding the birth of immature 39. When male 06's rate of interactions was compared across all females (both with and without infants), it was found that his rate of interaction with female 22 was the fourth highest overall, suggesting that the relationship formed with immature 39 was a byproduct of an existing strong, positive relationship to female 22.[4]

The interactions between adult male 10 and immature 36 presented an entirely different picture. Figure 4-6 shows the hourly rate of interaction between male 10 and immature 36 across time blocks. The significant point was the marked increase in the rate of interaction in block 2 and the consistently high rate thereafter. It should be noted that the demographic change demarcating block 2 was the permanent removal of adult female 08, mother of immature 36. From the data presented in Figure 4-6, it was clear that the permanent removal of immature 36's mother significantly altered the pattern of interactions initiated by adult male 10 to immature 36.

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[3] Individual male-immature dyads were analyzed in the manner noted on pages 95 through 98.

[4] Similar results were noted in a previous study (Peffer-Smith, 1978).

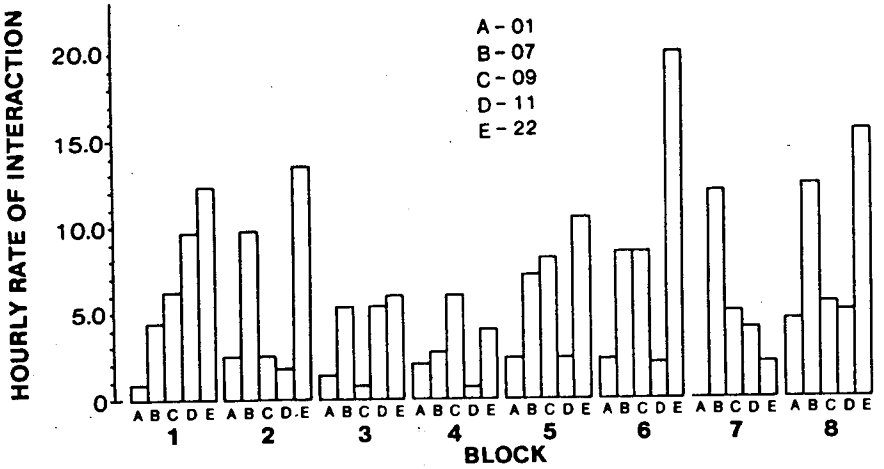

Fig. 4-5. Rate of interaction between male 06 and all adult females with infants across each of the eight time blocks of the study.

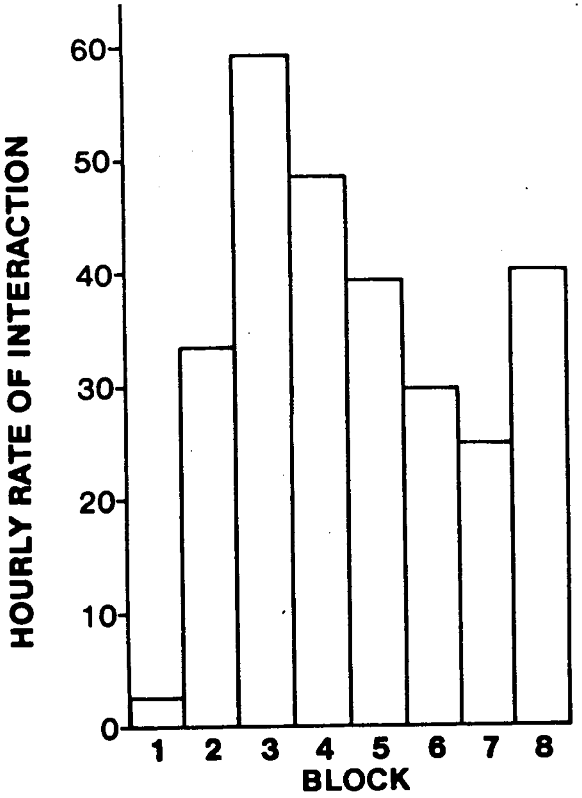

Fig. 4-6. Rate of interaction between adult male 10 and immature 36 across the eight time blocks of the study.

Given these data, the patterns of interactions initiated by immatures 36 and 39 toward the adult males were examined in order to determine if the special relationships could be characterized as symmetrical, i.e., immatures initiating interactions to the adult males as well as vice versa. Table 4-7 shows the rate immature 36 initiated interactions to each of the adult males. Given the null hypothesis of no significant differences among the adult males, a Chi-square analysis revealed significant differences ($p \leq .05$) for total social interactions, as well as affiliative and general social interactions. Adult male 10 received over six times as many social interactions from immature 36 as the next most popular male. Therefore, it was concluded that the relationship between male 10 and immature 36 was symmetrical and reflected clear preferences on the part of both members of the dyad.

To further examine the relationship between male 06 and immature 39, the rates of interaction initiated by immature 39 to each adult male were examined and no significant differences ($p \leq .05$) were found, given the same null hypothesis. These results tended to support the interpretation of the interactions between male 06 and female 22.

Finally, given the nature of the relationships between particular adult males and immatures, the total male rate of interaction for each immature was calculated. The possibility existed that even though a special relationship may have been noted for one male-immature dyad, other immatures may have received interactions from several males in such a manner that their cumulative rate of interaction would equal or exceed that of those immatures with special relationships. The cumulative distribution of rates of interaction with adult males for each individual immature is shown in Table 4-8. A

Table 4-7. Immature 36 Initiated Interactions to Adult Males.

	Adult Male				
Behavior Class	**06**	**10**	**13**	**18**	χ^2
Total social interactions	5.47	91.86	14.41	9.43	168.18*
Affiliative	1.45	42.96	0.83	1.60	111.22*
General social	3.84	45.94	12.51	7.70	63.79*

*Significant $p \leq .05$.

Table 4-8. Cumulative Rates of Interaction for Immatures with All Adult Males.

	Immature						
Adult Male	**33**	**34**	**35**	**36**	**37**	**38**	**39**
06	2.00	1.46	5.36	2.99	4.51	2.92	11.86
10	9.00	8.69	10.34	36.23	17.16	8.77	2.81
13	6.80	6.31	5.40	6.76	5.31	9.33	7.71
18	0.60	1.77	2.84	4.25	5.83	5.87	5.19
Total	18.40	18.23	23.94	50.23	32.81	26.89	27.57

Chi-square test revealed significant differences ($p \leq .05$) among the immatures, and indicated that immatures did not receive equivalent amounts of male interaction no matter how many males interacted with them. In fact, immature 36 received more interactions from male 10 than each of the other immatures received from all males combined.

DISCUSSION

Interactions between adult male and immature nonhuman primates present a fascinating area of inquiry in the study of social organization because of the implications of these interactions for both adult males and the immatures. To put these interactions in a broader perspective, we initially asked an important question concerning the overall pattern of male interactions in our captive stumptail group: Do adult males interact with immatures more or less frequently than would theoretically be expected based on the demography of the group? Our results indicated that adult male stumptails do, indeed, initiate more interactions with immatures than would theoretically be expected, and, excluding the adult males themselves, immatures are the only age-sex class that received more interactions than would theoretically be expected based on the demography of the group. In fact, when total social interactions were partitioned into the constituent behavior classes, males exhibited significantly more submissive, affiliative, and general social behavior to immatures than would be expected. This suggested that infants were a powerful feature of the social life of adult male stumptails, and that adult males may have important roles in the social development of the young.

Adult male-immature interactions can be generally characterized as positive and were composed primarily of general social interactions and affiliative behavior (95.3% of total). Brandt et al. (1970) found that 527 of 534 (98.6%) male-immature interactions in their stumptail group were positive social behavior; these could be accounted for predominantly by huddling, passive contact, and proximity. Comparatively little aggressive, submissive, or play interactions were initiated by the adult males to immatures. No sexual behavior was initiated by the adult males to the young. These results generally concur with other studies (Estrada, 1977; Estrada and Sandoval, 1977; Gouzoules, 1975; Hendy-Neely and Rhine, 1977).

Intermale Variability

It is clear, however, that individual adult males vary considerably in their rates of interaction with immatures. Hendy-Neely and Rhine (1977) also found significant differences among adult males in the amount of parental care exhibited. This was not unexpected, given intermale variability in other aspects of behavior. The individual variability was of interest, however, since one male in this study interacted with immatures more than all the other males combined did.

Since individual adult males can be differentiated in their overall rate of interaction with immatures, a careful examination of the relationship of each adult male with each immature was important. Our results indicated two interesting patterns emerging. Specifically, a significantly higher rate of male-initiated interactions between adult male 06 and immature 39, as well as male 10 and immature 36, was found. Bertrand (1969) also noted that some males developed special relationships with specific immatures. The "special relationship" was found for affiliative behavior and general social interactions for both male-immature dyads. This was important, since it demonstrated the potential for adult males to form distinct bonds with immatures who, as an age class, received considerable male attention.

Adult Male-Adult Female Relationships

An adult male who associates closely with a female may have extensive interactions with her offspring. Nash and Ransom (1971) and Southwick et al. (1965) found this to be true with animals in consort. Altmann (1978; 1980, p. 117), Ransom and Ransom (1971) and Seyfarth (1978) also noted enduring social bonds between adult males and the immatures of favored females. Similarly, elevated levels of interaction between one adult male and female, and the subsequent involvement of the female's infant, were noted. It was suggested that the interactions between male 06 and immature 39 were a by-product of the relationship of male 06 and female 22 and were not the result of active development of social bonds to the immature. This view was further reinforced when the interactions initiated by infant 39 to all the adult males were examined. These results showed that infant 39 was not directing a significant proportion of his interactions toward male 06 nor any other particular adult male.

Male 10, on the other hand, presented a different picture in his relationship with immature female 36. Prior to the permanent removal of female 08 (mother of immature 36), male 10 initiated relatively little behavior toward immature 36 or any other immatures in the group. Removal of female 08 (the event which demarcated the second time block) brought a significant change in the relationship. From block 2 onward through the remainder of the study, male 10 and immature 36 maintained consistently high rates of interaction (see Fig. 4-6). (Alexander, 1970; Hasegawa and Hiraiwa, 1980; and Taylor et al., 1978 also observed intense male-young interactions with orphaned infants.)

The nature of this relationship was further revealed when the distribution of immature 36's interactions was considered. A statistically significant difference among the males in their rate of reception of interactions from immature 36 was observed. Clearly, immature 36 was directing her interactions preferentially toward adult male 10 and, unlike immature 39, demonstrated a symmetrical relationship with adult male 10.

To put the relationship between male 10 and immature 36 into a broader perspective, the total male interaction with each immature was examined. Interestingly, there were significant differences among the immatures, with immature 36 exceeding other immatures in rate of interaction with all males. It should be emphasized that although the relationship in one dyad stands out, all immatures received a considerable number of interactions from all of the males.

Adaptive Significance

The existence of a system of interactions of the magnitude outlined in this paper suggests certain implications for both the adult male and the immature. As described in this paper, adult male interactions with immatures may take several different forms. As such, adult males may have multiple roles in the socialization and development of young (Rowell, 1975). Two distinctly different types of interactions have been observed in the study group. On one hand, an adult male formed a close and intense association with an immature after the death of the immature's mother, while, on the other hand, an adult male associated with an immature as a byproduct of an ongoing relationship with the immature's mother. In either case, it may be argued that the net result was similar; the interactions with the adult may promote the welfare of the infant.

As Rosenblum and Coe (1977) point out, the socializing influence of a particular agent may not be a direct corollary of the frequency of interaction with that agent. A relatively infrequent experience with some class of individuals, such as adult males, may have a more significant impact on socialization than more frequent experiences with other classes of individuals. Infants may have received a different type of experience from the combined interactions with four adult males than the intense, prolonged interactions with a single adult female—mother.

The proximity of an adult male to an immature may have important consequences for predator protection under some circumstances and may also attenuate roughness from other group members (Hendy-Neely and Rhine, 1977). Bernstein (1976) noted that although male care of infants varies widely across species, in most cases, males are responsive to situations requiring the protection of infants in distress. Itani (1959) observed that among Japanese macaques, other group members treat an infant just as they do the adult male protector beside it. For example, an adult female does not take a choice piece of food from an infant when the infant is near an adult male. When situations like this have occurred several times, "the infant grows very strong willed . . ."; infants protected by adult males for a long time have "become more domineering than other infants of the same age" (Itani, 1959, p. 83). This male protector relationship was observed in the present study, and its ramifications in the socialization of one immature in particular will be a focus of continued investigation.

Adult males may also accrue advantages from the close proximity of an immature. Males may associate closely with an immature to stop attacks or to decrease the likelihood of aggression exhibited toward them (termed agonistic buffering; Deag and Crook, 1971; Gilmore, 1977; Gouzoules, 1975; Kummer, 1967; Nash and Ransom, 1971; Rowell, 1967; Stoltz, 1972; Stoltz and Saayman, 1970), to increase the likelihood that they will acquire or maintain high rank in the group (Deag and Crook, 1971; Nash, 1973; Russell and Russell, 1971), or to increase their own integration into the group (Itani, 1959; Poirier, 1969).Through their exploratory behavior, young develop new ways of interacting with the environment which can be transmitted to adult males. Itani (1958) described the probable routes of acquisition of a new food habit in *Macaca fuscata* and found that adult males could learn a new, and possibly beneficial, food habit from infants or from younger siblings.

It can also be argued, however, that male-immature interactions are merely the byproduct of the social nature of primates and are not, by themselves, adaptive. Rowell (1979) suggested that the variance in the expression of male-immature interactions can be explained as an example of cultural drift, with no adaptive significance under present conditions. Perhaps these interactions represent selection for tolerable social conditions and not the optimal, when intertwined with other features of the social organization. Alternatively, the interactions observed in this captive group may reflect the potential or capacity for parental care (Redican, 1978) not typically expressed by individuals in their undisturbed, free-ranging state.

CONCLUSION

We have demonstrated in this study that adult male stumptail macaques do not distribute their interactions within the group in a random manner that could be predicted based simply on the demography of the group. Adult males initiate more interactions to immatures than would be theoretically expected. Differences exist among the adult males in the amount of interactions they have with immatures, and certain males may form "special relationships" with immatures. Benefit to both the immatures and the adult males may accrue from these interactions and, as such, promote and foster the continuation of the bonds.

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