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INFANT ABUSE RUNS IN FAMILIES OF GROUP-LIVING PIGTAIL MACAQUES

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Abstract—Objective: The aims of this study were to investigate genealogical and demographic influences on maternal abuse and neglect of offspring in pigtail macaques and identify some maternal and infant characteristics that may be risk factors for abuse or neglect.

Method: Infant abuse and neglect were investigated in five large families of group-living pigtail macaques over a period of 33 years (5–7 generations). The data were obtained from the Animal Records of the Yerkes Regional Primate Research Center.

Results: Abuse and neglect are likely to be two distinct phenomena in pigtail macaques. Neglect was mostly limited to first-born and newborn infants. Abuse was more likely to occur in some families than in others, and within abusive families, it was more likely to occur among closely-related females than among distantly-related females. Infants whose siblings had previously been abused were themselves especially at risk of abuse. Maternal health and infant sex were not risk factors for abuse.

Conclusions: This study provides the first evidence of genealogical effects on infant abuse in nonhuman primates. Several characteristics of infant abuse in socially living macaques suggest that this phenomenon could represent a good animal model for studying the etiology of child abuse and neglect. © 1997 Elsevier Science Ltd

Key Words—Infant abuse, Intergenerational transmission, Nonhuman primates, Animal models.

INTRODUCTION

IN RECENT YEARS little research has been conducted with animal models of child abuse and neglect. The studies of rhesus monkey (*Macaca mulatta*) “motherless mothers” conducted by Harlow and colleagues reported that females separated from their mothers at birth and reared in social isolation were subsequently likely to neglect or abuse their infants (Harlow & Seay, 1966; Ruppenthal, Arling, Harlow, Sackett, & Suomi, 1976). The observation of rhesus motherless mothers suggested that lack of contact with conspecifics during development, and in particular lack of opportunity to learn mothering skills from adult models, was an important determinant of infant abuse and neglect. A number of other primate studies, however, suggested that infant abuse and neglect were more likely to result from the restricted housing conditions

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of mothers and infants than from the mothers' developmental history (see Maestripietri & Carroll, submitted, for review).

Although several researchers and clinicians emphasized the relevance of primate social deprivation studies to child abuse and neglect (Horenstein, 1977; Reite & Caine, 1983; Suomi, 1978), the social deprivation paradigm has several important limitations. For example, the magnitude of the trauma associated with early separation and rearing in social isolation is rarely, if ever, experienced by humans. Moreover, separation from the mother and rearing in isolation resulted in extensive social pathology not limited to parenting (Suomi, 1978). Therefore, early social deprivation provides a model for social pathology and not one specific to child abuse and neglect.

Social deprivation studies are not the only source of information about infant abuse and neglect in primates. The spontaneous occurrence of infant abuse in group-living monkeys is a phenomenon that shares many similarities with child abuse and neglect in humans and could represent a "natural" primate model for the study of pathological parenting (Maestripietri & Carroll, submitted). An observational and manipulative research approach focused on the determinants of abnormal maternal behavior in monkeys living in their species-typical social environment could make a significant contribution to understanding the etiology of child abuse and neglect.

Macaque mothers who are born and live in relatively undisturbed social groups in captivity and in the wild occasionally abuse and neglect their infants (Hiraiwa, 1981; Maestripietri, 1994, in press; Troisi & D'Amato, 1984). Abusive mothers typically alternate competent caregiving behavior with abnormal patterns such as dragging the infant by its tail or legs, or crushing the infant against the ground with their hands or body. With the exception of a few observational studies of macaques, however, virtually nothing is known concerning the occurrence of spontaneous infant abuse and neglect for a nonhuman primate population (see Maestripietri, Wallen, & Carroll, in press).

The present study reports information on the spontaneous occurrence of infant abuse and neglect in a large population of group-living primates over the course of several generations. The goal of this study was to investigate possible genealogical influences on the occurrence of infant abuse and neglect in pigtail macaques, as well as the role of some variables that are known to affect child abuse and neglect in humans.

METHOD

Subjects

Infant abuse and neglect were studied in five large families of pigtail macaques (*Macaca nemestrina leonina*) living in social groups at the Field Station of the Yerkes Regional Primate Research Center of Emory University in Lawrenceville, Georgia. The data were obtained from the Yerkes Animal Records and span a period of 33 years, from 1962 when the first birth in one of these five families was recorded, to 1995. The five families were founded by five matriarchs, genetically unrelated to each other, that were part of a stock of pigtail macaques purchased from different sources by the Yerkes Center in the late 1950s–early 1960s. The records concerning other females from the original stock are incomplete or missing, but it was estimated that these five families account for 80–90% of all the *Macaca nemestrina leonina* individuals that were born at the Field Station of the Yerkes Center in the last 33 years. Over the years, the females have lived in several different multi-male multi-female social groups, housed in outdoor-indoor compounds. Individual housing in a cage was limited to short periods during acute medical treatment. Females were first bred with independently purchased males

and, in subsequent years, with males born at the Center and rotated among groups. However, since mostly locally born males were used for breeding for a long period, some degree of inbreeding is present in the population. Altogether, the five matriarchs left 394 descendants over a period of 5–7 generations. This is an underestimate of the actual number of births, as some of the animal record files for the 1960s and early 1970s were incomplete, and every year there has always been a small number of dead newborns whose origins remain unidentified.

Data Analysis

Data analysis focused on events that occurred in the first year of infant life. The Yerkes Animal Record files contain information on the clinical and reproductive history of all monkeys and the results of necropsies of all infant deaths performed by the Yerkes Pathology Division. In most cases, the identity of the males who sired infants was not known. When infant death or removal from the group for medical treatment was directly related to antecedent events observed by the Yerkes caretaker, veterinary, or scientific personnel, these events were reported in the animal's file. The causes of infant death or removal for medical treatment were classified into one of the following categories:

1. *stillbirth*, when the infant was found dead on the first day of life and was never observed alive;
2. *illness*, when a specific clinical condition was unequivocally diagnosed during medical examination of the infant or during necropsy;
3. *neglect*, when the Yerkes caretaker, veterinary, or scientific personnel observed the mother actively rejecting and abandoning her infant prior to infant death or removal, and the infant's subsequent medical examination or necropsy did not reveal any clinical condition other than starvation and/or dehydration;
4. *abuse*, when the personnel observed that the mother physically abused her infant prior to infant death or removal and the infant's subsequent medical examination or necropsy did not reveal any clinical condition other than physical trauma. The following maternal behavior patterns were considered abuse: stepping, sitting, or jumping on the infant, dragging and crushing the infant on the ground, hitting or biting, dangling the infant from a branch and then dropping it, causing lacerations of the infant's skin with mouth or fingers.
5. *kidnapping*, when the infant died because of prolonged kidnapping by another group member, typically a nonlactating adult female;
6. *unknown*, when the cause of infant death or of the deterioration of its health condition was not unequivocally ascertained.

The strict and conservative criteria for assessment of neglect and abuse differentiate the present study from previous analyses of primate medical records, in which maternal abuse was only inferred from injuries suffered by infants in unknown circumstances (Caine & Reite, 1983; Schapiro & Mitchell, 1983).

The characteristics of infant abuse and neglect were compared among and within families with the chi-square test, regression analyses, and one-way factorial Analyses of Variance (ANOVA). Prior to ANOVA, data were log-transformed to meet assumptions of normality of distribution and homogeneity of variance required by parametric statistics. Bonferroni/Dunn tests were used as post-hocs.

RESULTS AND DISCUSSION

Eleven cases of infant neglect and 37 cases of infant abuse were reported. The other cases of infant death or removal for medication were distributed as follows: 42 stillbirth, 47 illness,

46 unknown, and 4 kidnapping. Infant neglect or abuse occurred in four families, and both neglect and abuse in only two families (Table 1). Six mothers displayed neglect only, 12 mothers displayed abuse only, and five mothers displayed both neglect and abuse, though with different infants. Overall, the five families differed significantly in the proportion of abused infants ($\chi^2 = 20.88$, $df = 4$, $p = .0003$), and in the proportion of mothers who displayed neglect ($\chi^2 = 12.15$, $df = 4$, $p = .01$) or abuse ($\chi^2 = 13.38$, $df = 4$, $p < .01$). These findings represent the first quantitative evidence that infant abuse and neglect run in families of group-living monkeys. Mothers were more likely to be neglectful in Ka's family than in B's, Ga's, and N's families (all probabilities are $< .05$). Mothers were more likely to be abusive in N's, Ka's, and Na's families than in the other two families (all probabilities are $< .05$ or lower). Infants were more likely to be abused in N's, Ka's, and Na's families than in the other two families (all probabilities are $= .01$ or lower). The families with infant abuse did not differ significantly among themselves in the proportion of neglectful/abusive mothers or neglected/abused infants.

The five families did not differ significantly in the birth order (first-born vs. later-born) of neglected and abused infants (neglect: $\chi^2 = 1.49$, $df = 2$, ns ; abuse: $\chi^2 = .32$, $df = 2$, ns) or in their age (neglect: $F(2, 8) = 1.03$, ns ; abuse: $F(2, 31) = 1.28$, ns). First-born infants were significantly at risk for neglect but not abuse, as 7 of 11 neglected infants were first-born compared to only 5 of 37 abused infants ($\chi^2 = 11.36$, $df = 1$, $p = .0007$). Neglected infants were also more likely to be first-born than ill infants (7 of 47; $\chi^2 = 11.56$, $df = 1$, $p = .0007$) and than infants that survived the first year without complications (39 of 205; $\chi^2 = 12.39$, $df = 1$, $p = .001$). In contrast, birth order was not significantly different among abused, ill, and surviving infants ($\chi^2 = .94$, $df = 2$, ns). Neglected infants were significantly younger than abused and ill infants (mean age in days + SE , neglect: $7.73 + 2.30$; abuse: $34.17 + 10.04$; illness: $58.96 + 12.97$; $F(2, 89) = 3.22$, $p < .01$; post-hocs: neglect-abuse, $p < .05$, neglect-illness, $p = .01$). Infant age did not differ significantly between abused and ill infants (post-hoc: ns). All of the 11 neglectful mothers neglected only one infant whereas 11 of the 17 abusive mothers abused more than one infant ($\chi^2 = 11.72$, $df = 1$, $p = .0006$).

Altogether, these results strongly suggest that infant abuse and neglect are different phenomena, probably determined by different etiological factors (see also Maestripieri et al., in press). Infant neglect primarily occurs in reproductively inexperienced mothers dealing with their first-born infants and is most likely to occur in the first days of infant life. Reproductive experience dramatically reduces the risk of infant neglect. Infant abuse, on the other hand, is found in a small proportion of first-born and newborn infants and appears to be unrelated to maternal experience. For example, 23 of 37 abused infants had at least one older sibling that

Table 1. Summary of Data

Matriarch's Code	B	Ga	N	Ka	Na
Time Span of Births	62-95	65-95	66-94	64-95	64-95
Number of Generations	6	6	5	5	7
Number of Births	90	42	76	73	113
Sex Ratio at Birth (% Males)*	53%	58%	41%	48%	45%
Number of Cases of Neglect	2	0	0	5	4
Number of Cases of Abuse	0	0	10	11	16
Sex Ratio of Neglected Infants (% Males)	50%	—	—	40%	75%
Sex Ratio of Abused Infants (% Males)**	—	—	37%	64%	25%
Number of Mothers	18	8	14	11	20
Number of Neglectful Mothers***	2	0	0	5	4
Number of Abusive Mothers	0	0	5	5	7

* The sex of 23 infants is unknown.

** The sex of 2 infants in N's family and 1 infant in Ka's family is unknown.

*** Three mothers in Ka's family and 2 mothers in Na's family displayed both abuse and neglect.

had survived the first year of life without being abused. Therefore, in the majority of cases, abusive mothers had previously demonstrated competent mothering skills. In contrast, infants whose older siblings had been previously abused were themselves especially at risk of abuse.

The five families did not differ significantly in the infant sex ratio at birth ($\chi^2 = 5.78, df = 4, ns$) nor in the sex ratio of neglected infants ($\chi^2 = 1.12, df = 2, ns$). The sex ratio of abused infants in the three abusive families was not significantly different from that expected by chance (N's: $\chi^2 = .25$; Ka's: $\chi^2 = .8$; Na's: $\chi^2 = 1.29, ns$). Maternal infirmity was not a risk factor for infant abuse as 4 of 17 abusive mothers had a history of chronic illness (e.g., chronic bacterial infection) or a permanent physical handicap due to injury during the years of reproductive activity compared to 15 of 54 nonabusive mothers ($\chi^2 = .12, df = 1, ns$). Similarly, a history of being abused did not predict infant abuse as only 1 of 17 abusive mothers was herself abused as an infant. Two other mothers who were abused as infants never abused or neglected their own infants.

In N's family, the coefficient of maternal relatedness (coefficient of relatedness calculated with the assumption that all infants were sired by the same male) between abusive mothers was significantly higher than that between all of the other mothers ($\chi^2 = 16.39, df = 3, p < .001$; Table 2). In this family, all of the five abusive mothers were sisters. The same pattern was also found in the other two families in which abuse occurred, although the difference failed to reach statistical significance (Ka's family: $\chi^2 = 4.52, df = 2, p = .1$; Na's family: $\chi^2 = 9.0, df = 5, p = .1$; Table 2). These results support the initial finding of differences between families in the frequency of abuse in suggesting that genetic relatedness or shared environment with other abusive individuals is an important risk factor for infant abuse (see also Maestriperieri et al., in press).

The three abusive families differed in the effects of birth cohort size on infant abuse and in the physical patterns of abuse. In N's family, the proportion of infants abused every year in the period 1975–1995, that is, the period in which the files were most accurate, increased linearly with birth cohort size ($r = .51, F 1, 13 = 4.45, n = 15, p = .05$). No significant relationship between proportion of abused infants and birth cohort size was found in Ka's ($r = .25, F 1, 17 = 1.09, n = 19, ns$) and Na's family ($r = .07, F 1, 18 = .09, n = 20, ns$). Abusive mothers consistently displayed one of two patterns of physical maltreatment: 10 mothers dragged infants across the ground or crushed their head or body on the ground; seven mothers chewed their infant's fingers or tail and/or compulsively groomed the area around their infant's eyes causing severe damage including blindness. All abusive mothers in Ka's family displayed dragging/crushing, whereas four of five abusive mothers in N's family displayed the chewing/grooming pattern ($\chi^2 = 6.67, df = 1, p < .01$). In Na's family, four dragging/crushing mothers and three chewing/grooming mothers were present. Altogether, the differences between abusive families in the average relatedness between abusive mothers,

Table 2. Frequency Distribution of Coefficients of Maternal Relatedness (r) Between Abusive Mothers (AM) and Between Other Mothers (OM) in Three Families

(r)	N's		Ka's		Na's	
	AM	OM	AM	OM	AM	OM
0.5	10	37	7	23	8	36
0.25	0	38	3	25	7	46
0.12	0	14	0	7	2	44
0.06	0	2	—	—	3	41
0.03	—	—	—	—	1	19
0.01	—	—	—	—	0	4

in the effect of birth cohort size, and in the physical pattern of abuse suggest that infant abuse is not a unitary phenomenon and that different subtypes of abuse may exist depending on the genetic characteristics of the individuals involved and/or the local social environment, perhaps including the infant's characteristics.

Overall, this study showed that infant neglect in pigtail macaques is largely confined to first-time mothers and may be specifically related to the mechanisms by which macaque females acquire experience with infants. Because parental neglect of human children is a highly heterogeneous phenomenon that is not necessarily related to parental experience (Cantwell, 1980), the relevance of macaque infant neglect to understanding the human phenomenon is unclear. The spontaneous occurrence of infant abuse in macaques, however, is a phenomenon that bears many resemblances to the phenomenon of child abuse. Like human child abuse (e.g., Belsky, 1993; Rogosch, Cicchetti, Shields, & Toth, 1995; Wolfe, 1987), macaque infant abuse runs in families and is likely to be repeated with successive offspring, abusive mothers may be otherwise normal individuals (Maestripieri, 1994, in press), abuse can be associated with different personality traits and parenting styles (Maestripieri, 1994, in press; Troisi & D'Amato, 1984), and social stress can play an important role in precipitating abuse (Maestripieri, 1994). Altogether, the characteristics of infant abuse in macaques suggest that the study of this phenomenon could provide important insights into the etiology of child abuse in humans.

Evidence that infant abuse is familial raises the possibility of investigating the etiology of abuse in ways not possible in humans. For example, infants can be cross-fostered between abusive and nonabusive individuals to assess the relative contribution of genetic and experiential factors in the etiology of abuse, and families with abusive individuals can be screened for the presence of genetic markers or abnormal endocrine or neurochemical functioning under carefully monitored conditions.

This study illustrates the power of longitudinal records to identify family relationships not evident in acute studies. Any retrospective study of infant abuse and neglect using long-term colony records, however, suffers from the risk that data may be missing or inaccurate. Moreover, our data analysis was biased towards severe cases of abuse and neglect. It seems likely that detailed behavioral information will be necessary to identify predictors of infant abuse and that individuals' developmental histories should be integrated with information on their temperamental profile, parenting style, and social interactions with other group members to better understand variability in infant abuse typologies between individuals and families. Evidence that infant abuse is familial allows the targeting of such labor-intensive behavioral studies to populations with a reasonable probability of producing infant abuse. Knowledge of the determinants of infant abuse in socially living monkeys could provide a meaningful animal model of infant abuse and significantly enhance our understanding of the etiological factors involved in human child abuse and neglect.

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Résumé—Objectif: Le but de ce travail a été d'investiguer les influences démographiques et généalogiques sur l'abus et la négligence de leurs petits par de mères Macaques à queue de cochon et d'identifier certaines caractéristiques maternelles et infantiles pouvant être des facteurs de risque d'abus ou de négligence.

Méthodes: L'abus et la négligence des petits ont été étudiés dans 5 grandes familles de Macaques à queue de cochon vivant en colonie au cours d'une période de 33 ans (5 à 7 générations). Les données ont été obtenues à partir des dossiers des animaux du Centre Régional de Recherche sur les Primates de Yerkes.

Résultats: Les abus et la négligence sont probablement deux phénomènes distincts chez les macaques à queue de cochon. La négligence est la plupart du temps limitée aux premiers nés et aux premiers âges. L'abus avait plus tendance à se produire dans certaines familles que dans d'autres et à l'intérieur des familles abusives, il avait tendance à se produire plutôt parmi des femelles proches que parmi des femelles moins apparentées. Les petits dans la fratrie qui avaient été maltraités précédemment étaient eux-mêmes plus exposés à un abus. La santé maternelle et le sexe du petit n'étaient pas des facteurs de risque de maltraitance.

Conclusion: Cette étude démontre pour la première fois les effets généalogiques dans les abus des petits chez des primates non humains. Plusieurs caractéristiques de la maltraitance des petits chez des Macaques vivant en société suggèrent que ce phénomène pourrait être un bon modèle animal pour l'étude de l'étiologie de la maltraitance et de la négligence.

Resumen—Objetivo: El objetivo de este artículo fue investigar las influencias genealógicas y demográficas en el maltrato y abandono maternal de su descendencia en macacos "pigtail" e identificar algunas características maternas y del niño que pueden ser factores de riesgo para el maltrato y el abandono infantil.

Método: El maltrato y el abandono infantil fue investigado en cinco amplias familias de macacos "pigtail" a lo largo de un periodo de 33 años (5–7 generaciones). Los datos fueron obtenidos de los Registros Animales del Centro Regional de Investigaciones de Primates Yerkes.

Resultados: El maltrato y el abandono parecen ser dos fenómenos distintos en los macacos "pigtail". El abandono estaba la mayoría de las veces limitado al primer nacimiento y a las crías recién nacidas. El maltrato físico ocurría más frecuentemente en algunas familias que en otras, y dentro de las familias maltratantes, era más probable que ocurriera entre las hembras con relación próxima que con relación más distante. Las crías cuyos hermanos habían sido previamente maltratados, estaban en riesgo especial de maltrato. La salud de la madre y el sexo de la cría no eran factores de riesgo para el maltrato.

Conclusiones: Este estudio proporciona la primera evidencia de efectos genealógicos en el maltrato infantil en primates no humanos. Varias características del maltrato a las crías en macacos que viven en sociedad sugieren que este fenómeno podría representar un buen modelo animal para el estudio de la etiología del maltrato y abandono infantil.