COMPENSATION IN ABNORMAL CONDITIONS OF INFANT CARE IN THE COMMON MARMOSET *(Callithrix jacchus)*

Maria Emilia Yamamoto, Maria de Fátima Arruda,
Universidade Federale do Rio Grande do Norte
and Orlando F. A. Bueno
Escola Paulista de Medicina

SUMARIO: Filhotes do sagui comum *(Callithrix jacchus)* são cuidados pelo pai e pela mãe durante as primeiras semanas de vida, com predominância do cuidado pelo pai. Algumas famílias, no entanto, não seguem este padrão, e seu estudo permite uma melhor compreensão das alternativas à diminuição de cuidado aos filhotes. Três famílias de sagui comum (pai, mãe e gêmeos recém-nascidos) nas quais o pai mostrava níveis diminuídos de cuidado, e duas famílias que apresentavam o padrão usual de cuidado, foram observadas. Em duas das famílias de cuidado diminuído e uma das famílias normais, o pai foi removido 15 dias após o nascimento dos filhotes; nas outras duas famílias o pai foi removido 30 dias após o nascimento. Dados referentes à duração do cuidado pela mãe, cuidado pelo pai, e contato físico entre os gêmeos foram coletados do nascimento até dois dias após a separação. Embora as mães compensassem pelo cuidado diminuído dos pais, a quantidade total de cuidado não diferiu daquela apresentada na família normal, no caso das famílias de 15 dias. Já nas famílias de 30 dias, o tempo total de cuidado foi menor na família com baixos níveis de cuidado do pai quando comparado ao da família normal. O tempo de contato entre os gêmeos também diferiu entre as famílias de 15 e de 30 dias. Os resultados indicam que o cuidado compensatório pode ser induzido no sagui comum.

ABSTRACT: Callithrix jacchus (common marmoset) young receive care from mothers and fathers during early stages of development. In order to evaluate the compensatory care given by mothers when fathers were not giving their usual care, three families of marmosets, in which the fathers evidenced low levels of care from the time of the birth of the young, and two families in which the level of paternal care giving was normal were studied. In two of the low care families, and one of the normal families, the father was removed at 15 days after birth; in the other two families the fathers were removed at 30 days after birth. Data as to duration of care giving by the mother, care giving by the father, and contact between the two offspring (typically the

Correspondence should be sent to Dr. M. E. Yamamoto, Setor de Psicobiologia, Universidade Federal do Rio Grande do Norte, Caixa Postal 1511, 59000 Natal RN, Brazil, or Orlando F. A. Bueno, Departamento de Psicobiologia, Escola Paulista de Medicina, Rua Botucatu, 862—V. Clementino, 04023 São Paulo SP, Brazil.

Acknowledgements, the authors wish to express their thanks to Dr. Neil R. Chalmers for reading and providing valuable suggestions for the manuscript and for improvement of the English. Also to Neuciane Gomes da Silva for helping with statistics and preparation of the figures. This study was supported by grants from FINEP, CNPq, and UFRN.

common marmoset gives birth to twins) were recorded from the time of birth through two days after separation. Although the mothers compensated for the low levels of care given by the fathers, the total amount of time spent in care giving did not differ from that of the normal families, in those cases where separation took place at 15 days. In the case of the 30 day separation families, the total time of care giving in the low-care family was lower than that of the normal family. Contact time between twins also differed between the 15 and 30 day separation families. The results indicate that compensatory care giving can be induced in the common marmoset.

In the study of relationships between infants and their caregivers much attention has been directed lately to the *Callitrichidae* family, of the New World monkeys that show co-operative infant care (Epple, 1970, 1975; Hershkovitz, 1977; Hoage, 1981). Observations of the common marmoset (*Callithrix jacchus*) in captivity have shown that infants are cared for by all members of the family (Ingram, 1977; Locke-Haydon & Chalmers, 1983; Arruda, Yamamoto & Bueno, 1986), and the amount of care provided by each member varies with an infant's age (Locke-Haydon & Chalmers, 1983). However, there have been conflicting reports about the extent to which family members compensate for each other's behavior with respect to the infant. In particular, Ingram (1975), cited by Locke-Haydon (1984a, p. 806), reported that when one parent carried the infant for less time than usual, the other parent would compensate by carrying more. Locke-Haydon (1984a), by contrast found that mothers did not compensate when fathers had been given a tranquilizing drug. Locke-Haydon (1984a) also developed a model predicting the conditions under which compensation would be expected to occur, and under which conditions it would not.

Locke-Haydon's and Ingram's studies both involved families in which all members were allowed to remain in the group. By contrast, Arruda et al. (1986) carried out an experiment in which they removed the father from the family. Under such circumstances the mother compensated for the father's absence by increased amounts of carrying. Since removal of the father disturbs the family group far more extensively than merely drugging him, this compensatory response might have resulted from the disruptive effects of his removal rather than the absence of paternal carrying. To test whether the mother would compensate for a low level of paternal care when the father was present in the cage, parental groups in which paternal care was at a low level were studied.

METHOD

Animals

Five families of *Callithrix jacchus* from the Center of Primatology of Universidade Federal do Rio Grande do Norte, consisting of a reproductive pair and newly-born twins were observed. The parents were all wild-born and first-

time parents in captivity. Each family lived in cages (60 x 75 x 100 cm) in a room with controlled temperature and a 12 h light/dark cycle. Animals were fed twice a day, at 0900 and 1500, one meal consisting of fresh fruits and the other of a protein mixture. Animals were not manipulated, except for washing of cages, every three days, when they were removed for a few hours.

Three of those families presented an unusual pattern of infant care, in that the father provided very little care to the infants. The reason for this lack of caregiving by the father was not quite clear to us, and was investigated separately (Silva, Yamamoto & Arruda, 1987). The two other families were considered normal because the levels of infant carrying by the father did not differ from those in the majority of families in our laboratory (Arruda et al., 1986) and those reported by Ingram (1977). In these families, the levels of father carrying were also higher than that of the mothers' in the first weeks of the infants' lives, as was found by Locke-Haydon and Chalmers (1983).

Procedure

In order to evaluate compensation by the mother for the diminished care in the father's absence, data were gathered during the father's presence and during periods of separation. So that the results could be compared with an earlier experiment (Arruda et al., 1986) the fathers were removed for either 15 or 30 days. Two low-care families (LC1 and LC2) and one normal family (NC1) had their fathers removed for 15 days; the third low-care family (LC3) and the other normal family (NC1) had the fathers removed for 30 days.

Families were observed from the birth of infants until two days after the return of the father. Behaviors observed were:

1. the time the infants were carried by the mother (time on m) or by the father [time on p];
2. the time the infants were not being carried [time off];
3. the time the infants were in physical contact with each other during time off.

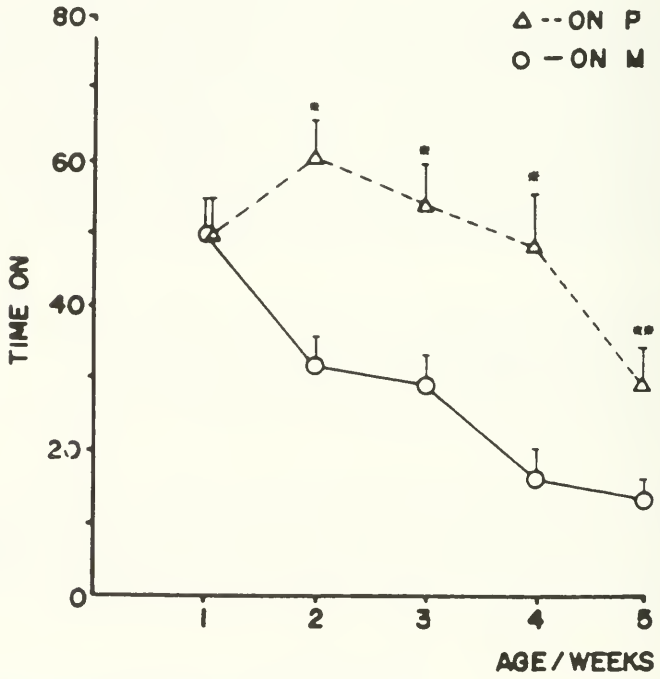
Animals were observed three days a week, for 30 m sessions, except at preseparation (two days), separation (three days) and post-separation (two days), when they were observed twice a day, for 30 m sessions. Observations were made between 0800 and 1800, the first in the morning, the other in the afternoon.

RESULTS

For comparative purposes, Figure 1 presents the mean percentage of time on m and time on p for 11 families in our colony, per 7-day observation period. A fuller description of these 11 families and the procedure used to observe them are described elsewhere (Arruda et al., 1986). Levels of father's and mother's care and infants' contact in families LC1, LC2, and LC3 (Fig. 2) were compared with those of standard families NC1 and NC2 (Fig. 3).

Time on p and time on m are similar in the first week, but from the second to the fifth weeks time on p is significantly higher than time on m. Most of the families in our laboratory show a similar pattern of care, as shown in families NC1 and NC2 (Fig. 3). Prior to separation in these families, time on p was higher or at least equivalent to time on m. This result is characteristic of the prevalence of care by the father at the beginning of life. A completely different pattern, though, is presented by the "abnormal" families LC1, LC2, and LC3 (Fig. 2) in which the relationship between behavior by the father and mother was inverted, particularly in the first three weeks of life. This inversion was attributable to a decrease in father carrying, which in some cases was nil.

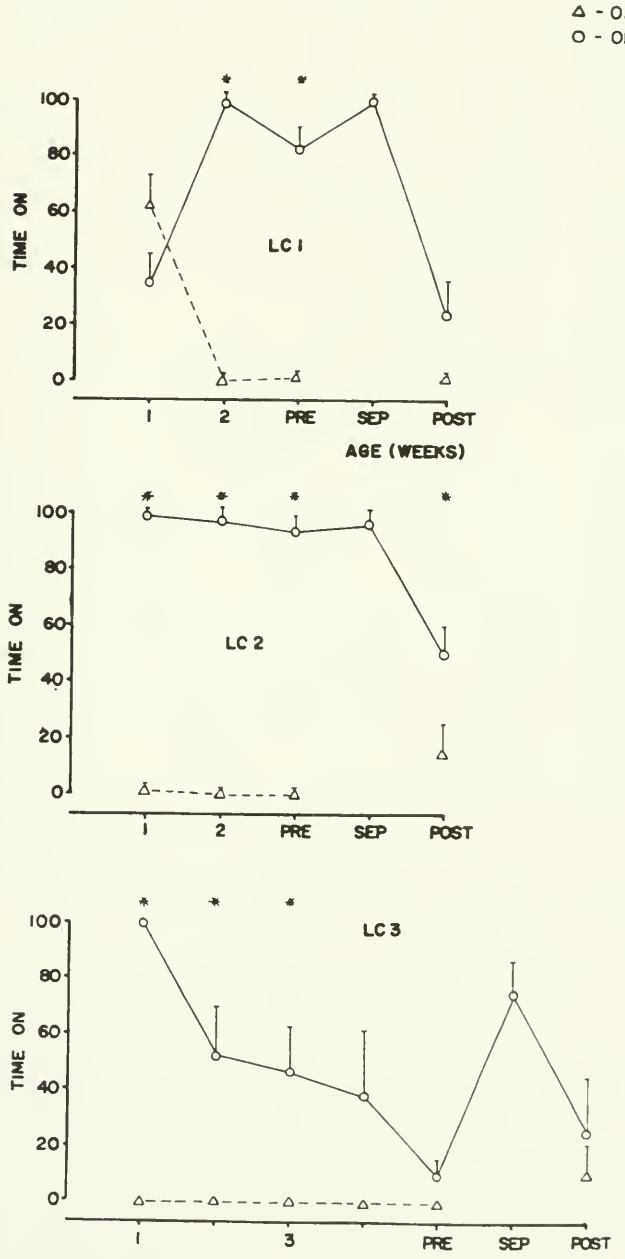
FIGURE 1. Mean percentage of time on p (father) and time on m (mother) for families LC1 (top), LC2 (middle) and LC3 (bottom); preseparation, separation, and postseparation periods. Vertical lines represent 1 SEM.



* $p < 0.05$; Student's t-test for nonindependent groups

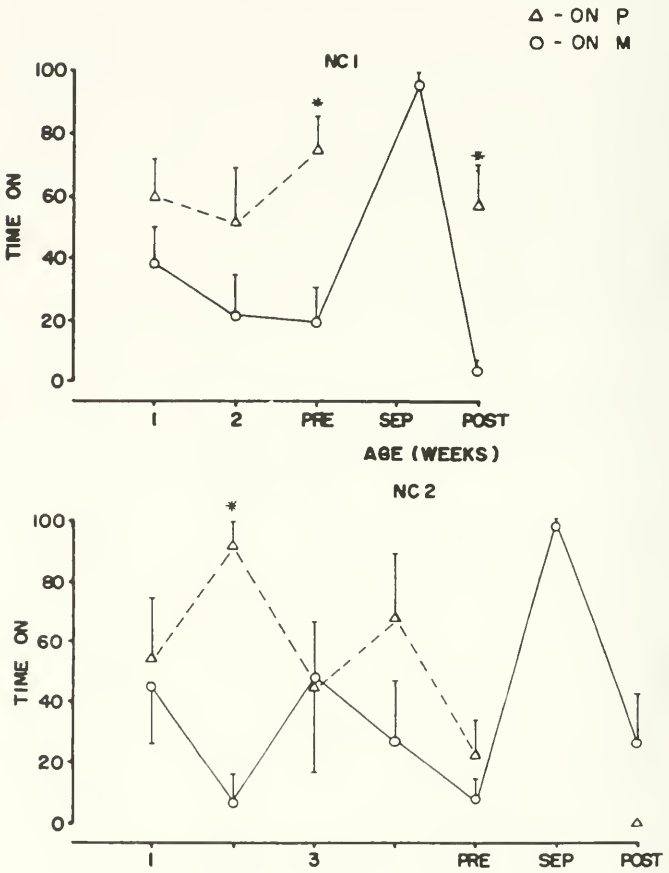
Diminished father care in the "abnormal" families was compensated for by augmented mother care in the second week and preseparation period in the LC1 family, and in the first and second weeks and preseparation and postseparation periods in the LC2 family, when compared to time on m in NC1 family; and in the first and second weeks in the LC3 family when compared to NC2 family (all differences are significant at the 0.05 level in student's t-test for independent groups).

FIGURE 2. Mean percentage of time on p (father) and time on m (mother) for families NC1 (top) and NC2 (bottom); preseparation, separation, and postseparation periods. Vertical lines represent 1 SEM.



* $p < 0.05$; Student's t-test for nonindependent groups

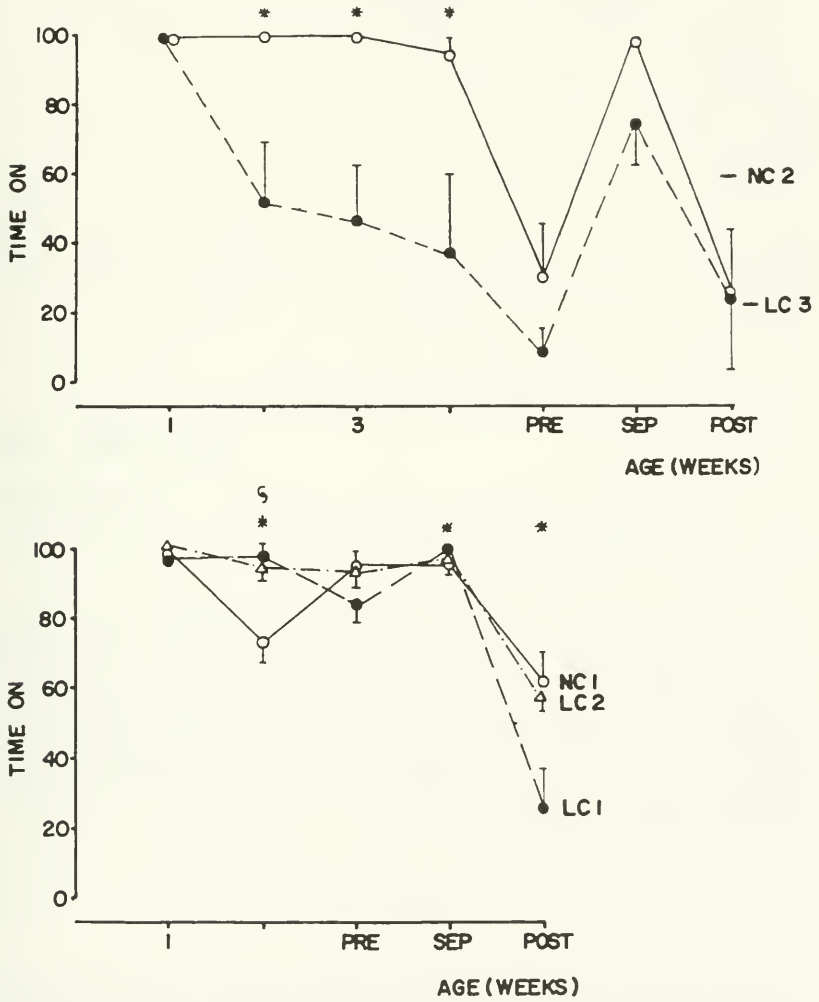
FIGURE 3. Mean percentage of time on p (father) and time on m (mother) for 11 families, from first through fifth week, per seven day observation period. Vertical lines represent 1 SEM.



* $p < 0.05$; Student's t-test for nonindependent groups
** $p < 0.01$

In spite of the differences in the sharing of father and mother carrying in the LC1 and LC2 families when compared to NC1, those differences were not apparent when the time mother carries is added to the time father carries the infants. As seen in Figure 4, the percentages of total time on (mother plus father) for families LC1, LC2 and NC1 are very similar. The significant differences, with one exception (LC1 in the postseparation period), occur surprisingly, when the "abnormal" families' mean exceeds the normal family mean. So, the differences between mother and father carrying with the 15-day separation in the normal and low-care families did not alter the total time the infants were carried.

FIGURE 4. Mean percentage of total time on (mother plus father) for families NC1, LC1 and LC2 (bottom) and for families NC2 and LC3 (top). Vertical lines represent 1 SEM.

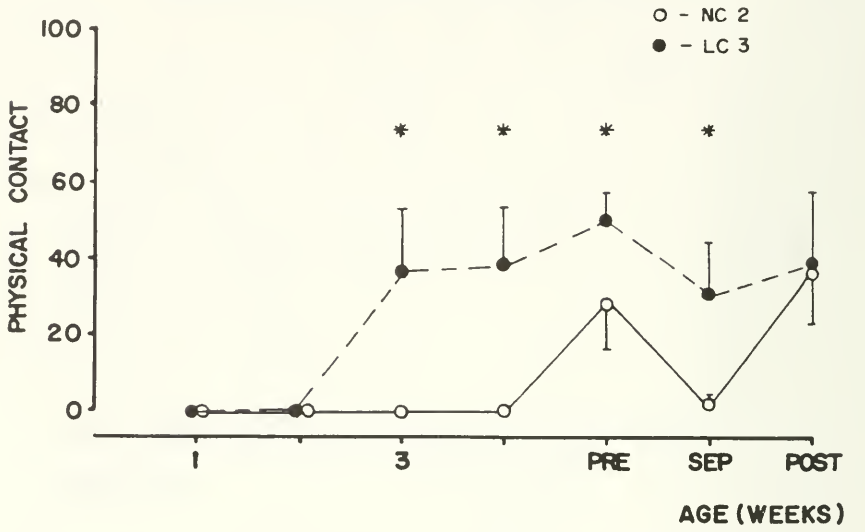


* $p < 0.05$; Student's t-test for independent groups

This was not found in regard to the 30-day separation. Figure 4 shows that the altered pattern of care in the LC3 family altered also the total time infants were carried when compared to NC2 family. The virtual lack of father carrying in LC3 family (Fig. 2) had a clear effect on total time on, from the second to the fourth weeks. In these weeks the infants in the NC2 family were carried significantly more than infants in the LC3 family.

The data for physical contact between twins is also different in the 15 day and 30 day separation families. NC1, LC1 and LC2 families show

FIGURE 5. Mean percentage of twin physical contact for families NC2 and LC3. Vertical lines represent 1 SEM.



* $p < 0.05$; Student's t-test for independent groups

equivalent amounts of physical contact by the infants. Figure 5 shows that during the third and fourth weeks, and during the preseparation and separation periods, physical contact between the twins in the LC3 family was significantly higher than between the twins in the NC2 family. Figure 5 also shows that physical contact appeared earlier for the twins of the LC3 family, as the percentages for the NC2 family twins are zero until the preseparation period.

DISCUSSION

Our results show that during first and second weeks the mother compensates for the reduction in the father's care, at least at the beginning of an infant's life. It is important to note, though, that *Callithrix jacchus* families normally include more than one set of offspring, and care by older siblings could prevent compensation by the mother.

Our data are not quite compatible with the Locke-Haydon model (1984a) of care-giving/care-seeking balance in *Callithrix jacchus*; she believes that compensation is not expected to occur if the level of care-giving offered by parents falls below that sought by infants. We have no data on levels of care-seeking by the infants, and it is quite possible that the care offered exceeded the care sought, thus predicting compensation.

Given the rather drastic change in the mother's carrying behavior in the low-care families, we believe that she increased the amount of care she would usually offer. Evidence for a change in the mother's disposition to offer more care is given by Arruda et al. (1986) who report not only an increase in time on m when the father is removed, but also an increase in the mother's tolerance of the infants, which is indicated by a sharp reduction in rejection scores. So, it is likely that the removal of the father or the absence of care, as in the low-care families, alters the amount of care offered by the mother, thereby changing the balance of care-giving/care-seeking.

A fundamental variable concerning compensation is probably age of the infants. Locke-Haydon (1984a) drugged the father and siblings at 4 and 14 weeks respectively. Our study shows that compensation occurred mostly in the first two weeks. Alterations in care-giving patterns occur from the time of the infants' birth, and it is possible that compensation occurred in response to the father's behavior, and decrease in compensation from the third week on may represent an adaptation in the mother's behavior.

The first weeks of life seem to be very important in the relationship of father-mother and infants, and Ingram (1977), Locke-Haydon and Chalmers (1983) and Arruda et al. (1986) report that through the second week of life infants are carried most of the time by one or the other carrier, or both, except for brief periods. Thus, up to this age infants usually do not experience diminished care by one of the care-givers, but experience rather an increase in one or the other care-giver's carrying. At four weeks of age, and more clearly at 14 weeks, there is a decrease in care behavior, (Locke-Haydon 1984a); this probably is not a critical event, as the infant shows more diversified behavior allowing other kinds of compensation. Studies of the motor and social development of infant marmosets report that at four weeks they show good coordination and locomotory behavior, as well as complex social behavior mainly restricted to the twin (Stevenson & Rylands, in press; Yamamoto, Arruda & Bueno, 1986).

Physical contact seems to be a rather good substitute for reduced care. Locke-Haydon and Chalmers (1983) and Moreira (1986) report an increase in the time spent with the twin in infants with a highly rejecting father or mother. The same thing happened in family LC3, exactly at the time when the mother ceased to compensate for the father's diminished care. In Locke-Haydon's study (1984b) the drugged fathers, although more passive toward the young, did not show any decrease in the time they carried or spent with the infants. This finding suggests that some kind of physical contact was provided by the drugged fathers, and even though it may not have been qualitatively the same as that provided by normal fathers, it may have been sufficient to rule out the need for compensation by the mother. This situation resembles the cloth

substitute mother described by Harlow (1958, 1959), which, although passive, provided contact-comfort for the young macaques.

In conclusion, the present results suggest that with more critical reductions in care than those presented in Locke-Haydon's study (1984a), and at a more precocious age, it is possible to induce compensation in the common marmoset (CcF., Locke-Haydon, 1984a; and Arruda et al. 1986).

REFERENCES

Arruda, M. F., Yamamoto, M. E., & Bueno, O. F. A. (1986). Interactions between parents and infants, and infant-father separation in the common marmoset (*Callithrix jacchus*). *Primates, 27*(2), 215-228.

Epple, G. (1970). Maintenance, breeding, and development of marmoset monkeys (*Callithrix jacchus*) in captivity. *Folia Primatol, 12*, 56-76.

———· (1975). Parental behavior in *Saguinus fuscicollis ssp*, (*Callithricidae*). *Folia Primatologia Scientific, 24*, 221-238.

Harlow, H. F. (1958). The nature of love. *American Psychology, 13*, 673-685.

———· (1959). Love in infant monkeys. *Scientist American, 204*, 100-105.

Hershkovitz, P. (1977). *Living new world primates* (*Platyrrhini*), (Vol. 1). Chicago: University Chicago Press.

Hoage, R. J. (1981). The integration of captive and field research among nonhuman primates with special reference to marmoset and tamarin monkeys. *In* R. H. Landman, L. A. Bennet, A. Brooks & P. P. Chock (Eds.), *Anthropological careers: Perspectives on research, employment and training* (pp. 159-180). Washington: Anthropological Society.

Ingram, J. C. (1977). Interactions between parents and infants and the development of independence in the common marmoset (*Callithrix jacchus*). *Animal Behavior, 25*, 811-827.

Locke-Haydon, J. (1984a). Care-giving/care-seeking balance in captive common marmoset (*Callithrix jacchus*). *Animal Behavior, 32*, 806-815

———· (1984b). Injection of a neuroleptic produces changes in care-giver-infant interactions in marmosets. *Behavioral Processes, 9*, 261-269.

Locke-Haydon, J., & Chalmers, N. R. (1983). The development of infant-caregiver relationships in captive common marmosets (*Callithrix jacchus*). *International Journal Primatologia, 4*, 63-81.

Moreira, M. F. A. (1986). *Relações parentá*is no sagui comum *(Callithrix jacchus)* durante o primeiro mes de vida dos filhotes. Unpublished master of sciences dissertation. Escola Paulista de Medicina.

Silva, N. G., Yamamoto, M. E., & Arruda, M. F. (1987). O cuidado com a prole no sagui comum (*Callithrix jacchus*): uma comparacão entre animais capturados e nascidos em cativeiro. *Resumos. 39º Reunião Anual da Sociedade Brasileira para o Progresso da Ciência.* Brasilia, p. 926.

Stevenson, M. F., & Rylands, A. B. (in press). The marmoset monkeys, genus *Callithrix.* In A. F. Coimbra-Filho & R. A. Mittermeier (Eds.), *Ecology and behavior of neotropical primates*, (Vol. 2). Rio de Janeiro: Academy Brasil de Ciencias.

Yamamoto, M. E., Arruda, M. F., & Bueno, O. F. A. (1986). Desenvolvimento psicomotor do *Callithrix jacchus* no primeiro mes de vida. In M. T. Mello (Ed.), *A primatologia no Brasil.* Anais 2º Congr., Bras: Primatol. Campinas. pp. 59-68.

Acknowledgements, the authors wish to express their thanks to Dr. Neil R. Chalmers for reading and providing valuable suggestions for the manuscript and for improvement of the English. Also to Neuciane Gomes da Silva for helping with statistics and preparation of the figures. This study was supported by grants from FINEP, CNPq, and UFRN.