Factors Contributing to Premature Maternal Rejection

and its Effects on Offspring

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ABSTRACT

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Typically, rhesus mothers begin rejecting their infants' attempts to nurse when the infants are approximately three months of age in order to begin the process of weaning. A small subgroup of mothers begin rejecting their infants earlier, at one or two months of age, typically before infants seek and maintain independence from their mother. The effects of this early maternal rejection on the development of infants and some potential factors that contribute to premature maternal rejection were explored in this study. Infants who were rejected early were hypothesized to subsequently spend less time in positive contact with their mother, have lower activity levels, were groomed less by their mother and, as a consequence of the maternal rejections, display a higher frequency of aggression toward other group members when compared to infants experiencing maternal rejection after the age-typical, three months of age. Mothers who were primiparous and/or had a poor early-rearing experience were hypothesized to be more likely to reject their infants prematurely. Consistent with these hypotheses, infants who were rejected early spent less time on their mother's ventrum and were groomed less by their mother, suggesting that early maternal rejection may lead to less positive mother-infant interactions and a more distant mother-infant relationship. Infants rejected early were also more likely engage in aggression. Given the punitive nature of the maternal rejection, the results suggest that aggression is transmitted from mother to infant through their interactions. Prematurely rejected infants were found to spend significantly more time in a passive, withdrawn behavioral state. When assessing the causes of premature rejections, primiparous mothers were not more likely to prematurely reject their infants, indicating that premature rejection was not simply a lack of experience with an infant. There was evidence that the mothers engaging in early rejection had poor early-rearing experiences, with surrogate-peer-reared mothers showing more early rejections than those who were reared by an adult female, and with mothers who were peer-reared having higher rates of rejection overall. The present results suggest that early rejection is

associated with more difficult mother-infant relationships and may lead to increased likelihood of aggression in infants.

ACKNOWLEDGMENTS

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Factors Contributing to Premature Maternal Rejection and its Effects on Offspring

Nonhuman primates have been used extensively to investigate many human psychopathological conditions. This is largely because of their similarities to humans both at the genetic and central nervous system (CNS) levels. Perhaps as a consequence of this close genetic relatedness and comparable CNS, nonhuman primates live in complex social environments and exhibit many behavioral traits similar to humans (Barr et al., 2003). Also, for primate species like rhesus macaques, mothers are the primary caregiver, and infants show a long-term extended dependency on their mother. As with human societies, the social group of a rhesus monkey generally consists of closely bonded females (sisters, grandmothers, aunts) who are quick to support one another during social challenges. Males, on the other hand, are less closely bonded to kin and leave their natal troops at puberty to join new social groups (Suomi, 2005c). In another illustration of the similarities, juvenile monkeys show sex differences in the types of play observed in human children. Boys, for example, are more likely to engage in rough-and-tumble play, as are juvenile male monkeys (Roney, 2003), whereas juvenile females show more interest in infants and alloparenting, or acting in a parental role towards an infant (Fairbanks, 1993).

A major advantage in using nonhuman primates to model human behavior is that longitudinal studies can be completed in considerably shorter time than with human subjects. In addition, the rearing of nonhuman primates can be carefully controlled in a manner not possible in humans (Barr et al., 2003). Although ethical standards do not allow researchers to conduct evasive studies with human subjects, nonhuman primates are often an acceptable substitute.

For several reasons, rhesus monkeys are the most widely studied nonhuman primate. They are the only nonhuman primate besides the chimpanzee whose genome has been

sequenced, and, among the nonhuman primates, rhesus behavior and CNS has been extensively researched, allowing for a better understanding of the mechanisms underlying behavioral similarities and differences to humans. Of particular relevance to the present study, rhesus macaques show a relatively high base rate of aggression when compared to other macaques and many other nonhuman primates (Higley, 2003).

Family Structure

The family structure of the rhesus monkey typically includes the infant and its mother and several other closely-related mother-infant pairs (Smith, 2005). Within the natural social group, the infant's mother is almost always its primary caregiver (Smith, 2005). After an infant is born, it is of great interest to the other members of the social group, particularly to young females (Smith, 2005). Nevertheless, mothers remain the primary caregivers for their infants until they are weaned. The time spent in contact with the mother steadily decreases across the first few months. The has yearling achieved relative independence, often marked by the mother becoming pregnant (Hinde & Spencer-Booth, 1967). Mothers, however, still provide social support to their offspring until adolescence, which for rhesus macaques begins between two and three years of age for females, and about a year later for males.

Maternal Care

During the first few months of an infant's life, its mother is involved in nearly all of its activities. Infants spend almost all of their time clinging to their mother's ventrum in the first few weeks following their birth (Hinde & Spencer-Booth, 1967; Suomi, 2005c). Because of their motor immaturity, the mother is an infant's primary means of getting from one place to another (Higley & Suomi, 1986). During this period, mothers tend to be protective, frequently restraining the infant's attempts to explore his or her environment, and maintain close proximity

to the infant (Hinde & Spencer-Booth, 1967). By six months, rhesus mothers regularly contribute to mother-infant independence by rejecting the infant's attempts to nurse.

Nearly all mothers adequately care for their infants, but mothers vary in the quality of care they provide. Several factors can influence individual differences in maternal solicitude. The mother's parity, or the number of offspring borne by a female, is a principal factor influencing maternal skillfulness, with primiparous mothers showing less maternal adroitness and solicitude. Perhaps as a result, primiparous mothers have an increased rate of infant death (Higley & Suomi, 1986). Fairbanks (1996) found that the age and health of the mother affect how well she cares for her infant. Environmental factors can also influence maternal care. In situations where infants are at a greater risk for danger, mothers are found to be more protective of their infants (Fairbanks, 1996). Temperament also plays a role in the type of care an infant receives. Mothers may have difficulty caring for their infants when the mother's and the infant's temperaments do not match (Smith, 2005). Conflict may ensue, for example, when an overly anxious mother struggles to restrain her less timid infant (Smith, 2005). This is consistent with the model proposed by Thomas and Chess (1977), who argued that similarities in temperament between mother and infant lead to a better "goodness of fit," that is, more adaptive functioning of the relationship as a result of the match between the infant's temperament and the rearing environment.

Besides nourishment, monkey mothers provide their infants with the emotional security to successfully navigate the world in which they live. Indeed, among primates, a mother's principal function is to facilitate social competence and emotional stability. Mothers do this by providing their infant with contact comfort, which provides the security needed to explore the world, and they also model behaviors helpful in social interactions (Harlow & Harlow, 1965; Harlow & Zimmermann, 1958) The advantages to the rhesus infant of this relationship generally

exceed those from any other relationship (Ainsworth, 1989). On the other hand, inappropriate maternal responsiveness or insensitive punishment of the infant, particularly when the infant especially dependent on its mother, can lead to an anxious attachment relationship and behavioral pathology (Andrews & Rosenblum, 1991; 1993; Rosenblum & Paully, 1984).

Rejection in Weaning

Shortly after infants reach three months of age, most rhesus mothers initiate the process of weaning. Rejection is the principal means weaning. When the infant approaches the mother to nurse or to initiate physical contact, she may reject the infant's request by turning her back to the infant, pushing or restraining, hitting, or, in extreme cases, biting the infant (Hinde & Spencer-Booth, 1967; Strier, 2007). Maternal rejection is a stressful event for infant monkeys, particularly when they are younger (Higley & Suomi, 1986). Infants who experience high levels of punitive maternal rejection are likely to exhibit elevated levels of anxiety later in life and may act more aggressively when they interact with other group members (Maestripieri, et al., 2006). Rowell and Hinde (1962) observed that, when infants were rejected by their mothers, they frequently exhibited tantrums, that involved screaming and jerking of the body.

Some mothers are less skillful at the process of weaning, and a small group of mothers may begin the process prematurely at one or two months of age. This is not considered typical, particularly given that the infant is still dependent on its mother for nourishment, immature in its motor capacity, and dependent on mother for emotional support (Harlow & Harlow, 1965; Harlow & Zimmermann, 1958). Additionally, some researchers have found that the timing and severity of the rejections may be dependent in part upon the mother's health and the availability of resources. Mothers in poor health or with few resources may begin to reject their infants earlier or more frequently or both (Fairbanks & McGuire, 1995).

Aggression

Early rejection could be considered a form of mother-infant aggression and potentially lead to aggressive tendencies in the infant. Although individual differences in aggressiveness are stable across time (Gosling, Lilienfeld, & Marino, 2003), average rates of aggression vary developmentally, with younger animals exhibiting and receiving less aggression (Higley, 2003). Aggression may also vary from species to species. Maestripieri (1994) found rhesus macaques to be more aggressive than pigtail and stumptail macaques in terms of mother-infant behavior and mothers' reactions to attempts by other troop members to handle the infant.

Aggressive behavior first appears late in infancy at low rates, increases through adolescence, and then peaks or may even decrease in adulthood (Bernstein, Williams, & Ramsay, 1983; Cross & Harlow, 1965). Sackett (1967) found that monkeys who had received hostile treatment from their mothers in the first 2-3 months of their lives exhibited high rates of aggression as four-year-olds.

As adults, males and females show aggressive behavior at similar rates, although males are more likely to engage in aggression that results in trauma and severe injury (Higley, 2003). Infants are not usually targeted for aggressive acts by adult monkeys (Bernstein & Ehardt, 1985; Harlow & Harlow, 1965). In fact, the presence of an infant has been shown to reduce aggression between adult females (Erwin & Flett, 1974). When it comes to an aggressive interaction between an infant of approximately 20 weeks old or less and an older sibling, a mother will usually intervene on behalf of her infant (Hinde & Spencer-Booth, 1967). When mothers act aggressively toward their infants, Hinde and Spencer-Booth (1967) found that the majority of maternal aggression towards infants occurred when the infant appeared to be engaging in activities such as jumping on the mother or pulling her tail. Many mothers use punitive measures

to discipline their infants, particularly during weaning. Some mothers are skilled at weaning, seldom use punitive measures, and begin the weaning process later, when the infant moves about on its own and is more socially skilled. Other mothers are punitive and begin the weaning process earlier (Higley & Suomi, 1986).

This study assessed the effects of variations in mothering behavior in order to further examine a mother's contribution to her offspring's behavior. Specifically, I tested whether premature agonistic infant rejections by the mother may be related to the infant's displays of aggression and to the overall relationship between the mother and infant. Normally, mothers begin to reject their infants' requests to nurse or make contact around three months of age. Some infants experience rejection earlier, when the infant is clumsy and not socially skilled, which may have a negative impact on the infant, especially when the rejections are more punitive in nature.

Hypotheses

1. Infants who are rejected earlier than normal (between one and two months of age) are hypothesized to display more aggression during the first six months of life than those infants who begin to experience rejection at the normal time, around three months of age.

2. Infants rejected earlier were hypothesized to have a more distant or less intimate relationship with their mothers, as measured by less close contact between mother and infant and less grooming of the infant by its mother.

3. Infants rejected prematurely were hypothesized to exhibit less activity, as measured by less time in locomotion and more time in passive postures.

4. Because monkeys with an impoverished early-rearing experience have been shown to be less capable as mothers (Harlow & Harlow, 1965; Seay, Alexander, & Harlow 1964), the early-

rearing experiences of the mothers were hypothesized to lead to differences in rejection. Specifically, mothers who were reared without their own mothers (peer-reared or surrogate peer-reared), were hypothesized to prematurely reject their own infants.

5. Furthermore, mothers with poor early-rearing experiences were hypothesized to have a more distant relationship with their infant, as measured by less time in mutual ventral contact and less time spent grooming the infant.

6. Also, multiparous mothers have been shown to be more skilled at infant handling and rearing. It was hypothesized that primiparous mothers were more likely to prematurely reject their infants than multiparous mothers.

7. Lastly, peer-reared mothers and surrogate-peer-reared mothers were hypothesized to become more skilled with successive infants, as measured by more time in mutual ventral and more time spent grooming their infants, as well as lower rejection rates in the first few months.

Method

Subjects and Data Collection

Subjects. Infant rhesus macaques (total $N = 224$) were reared in indoor-outdoor enclosures with their mothers in mixed-sex social groups containing two adult males and six to eight adult females with their infant offspring at the National Institutes of Health Animal Center in Poolesville, MD. The conditions approximated on a smaller scale those found in the wild. All data were obtained from an archival database using 13 birth-year cohorts, or groups assigned by birth-year, that were housed at the facility between 1991 and 2005.

Rearing. Based on due dates for birth, infants were pre-assigned to one of two rearing conditions: Mother-reared (raised by their biological mother) or adopted (raised by an unrelated,

lactating foster mother). All procedures were approved by the NIH Animal Care and Use Committee.

Mothers' rearing histories and parity were also known. They had been reared in one of two conditions: Mother-Reared (raised by their biological mother—$n = 94$); Peer-Reared (raised without a mother but with constant access to four other same-aged subjects in peer groups—$n = 48$), or Surrogate Peer-Reared (raised with a surrogate cloth mother with limited peer-group interaction—$n = 33$). Parity of the mothers (primiparous, $n = 67$ vs. multiparous, $n = 110$) as well as the mother's rearing background were obtained from the colony records. Some subjects lacked one or more data points due to illness or equipment failure and were removed from the data set.

Behavioral scoring was performed in 5-min sessions, two times a week for the first 24 weeks of life and then once daily for the 2 weeks preceding a 6-month mother-infant separation. The bi-weekly scores were averaged to create one score per month per subject for each of the behaviors for the first 6 months of life, with 40 minutes of data going into each of the monthly means. The behaviors that were recorded as well as their definitions are shown in Table 1. All behaviors were scored for duration, with the exception of rejection and aggression, which were scored for frequency. Behavioral observations were made by multiple observers, who achieved inter-observer reliabilities of at least 85%. In rare instances, data were not obtained because of a necessity to remove an animal from the group for medical observation or because of equipment failure.

Table 1

Behavior Definitions

Behavior	Definition
Aggression	Includes chasing and threats, as well as bites, slaps, etc.
Passive Behavior	Absence of directed movement, social behavior, environmental exploration. No other simultaneously scoreable behavior.
Locomotion	Any self-induced change in location, by means of walking, running, etc.
Receive Groom Mother-Infant	Cleaning and/or grooming of infant by mothers, which can include scratching, biting, licking, etc.
Mutual Ventral	Infant is belly to belly with the mother or on the nipple. Infant cannot be in social contact with others or locomote, but mother can be in social contact.
Rejection	Mother rejects approaches made by infant for mutual ventral contact.

Data Analysis

  Premature Maternal Rejection. In order to examine the effects of premature maternal rejection on the infants' overall behavior, a mixed-model repeated-measures analysis of variance (ANOVA) was performed for each of the behaviors in Table 1. It included a between-subjects measure where the infants were categorized as rejected prematurely (early) or as rejected during the expected time period (normal). Infant months of life (1-6) was the repeated measure. To examine the impact of premature maternal rejection on the mother-infant relationship, the dependent measures were the amount of time the mother groomed the infant, and the amount of time the infant spent with its mother in mutual ventral contact, and less intimate social contact.

  A parallel set of analyses measured activity and tested the effects of premature rejection on the infants' locomotor behavior, and time spent in a passive behavioral state.

  To evaluate the impact of premature maternal rejection on the infant's display of aggression, the frequency of the infant's aggression toward other group members was analyzed according to a similar design. Table 2 provides a concise description of the analyses with their corresponding hypotheses.

  Other analyses measuring mothers' differential tendency to exhibit early rejection. Mothers' rearing – Using the same sets of behaviors as described in Table 1, additional analyses were performed. As the early-rearing experience of the mother may have influenced her own mothering behavior, and specifically her timing of infant rejection, a three-way mixed-model repeated-measures ANOVA was performed. Two between-subjects measures were included: mothers' rearing (surrogate peer-reared [SPR] and peer-reared [PR] vs. mother-reared [MR]) and rejection time (premature vs. expected). Months of infant life was the repeated measure.

If both groups of mothers had similar distributions of early and expected rejections, a second set of analyses was performed to describe the overall effects of differential mothering. To determine if the mother's parity influenced premature rejection, a three-way mixed-model repeated-measures ANOVA was performed for each behavior, with the mother's parity (primiparous vs. multiparous) and rejection time (premature vs. expected) as the between-subjects factors. Month of infant life was the repeated measure.

Additionally, to determine if mothers' skills improve with successive infants, a three-way mixed-model repeated-measures analysis of variance was performed using the time spent in mutual ventral behavior, the time spent grooming the infant, and the rejection rates, with the mother's parity (primiparous vs. multiparous) and rearing (MR,PR, SPR) as the between-subjects factors. Month of infant life was the repeated measure. Refer to Table 2 below for a concise description of the analyses with their corresponding hypotheses.

Overall, multiple mixed-model repeated-measures ANOVAs were conducted using the archival data set to determine contributing factors to premature maternal rejection in rhesus macaques, as well as the effects that premature maternal rejection may have had on the infants who experienced premature maternal rejection. The details of each analysis are discussed below. Subjects with missing data were excluded from the analyses. The confidence intervals used for all analyses were 95%.

Table 2

Hypotheses and Corresponding Analyses

Hypothesis	Analysis	Behavior(s)
Infants rejected prematurely will show more aggression during the first 6 months of life than infants rejected at the normal time.	Mixed-model repeated-measures ANOVA Between-subjects measure: Rejection (early vs. normal) Repeated measure: months of life	Aggression
Infants rejected prematurely will spend less time in close contact w/ their mother, be groomed less by their mother over the first 6 months of life.	Mixed-model repeated-measures ANOVA Between-subjects measure: Rejection (early vs. normal) Repeated measure: months of life	Mutual ventral, receive groom mother-infant
Infants rejected prematurely will exhibit less activity (less time in locomotion, more time in passive).	Mixed-model repeated-measures ANOVA Between-subjects measure: Rejection (early vs. normal) Repeated measure: months of life	Locomotion, passive
Mothers who had a poor early rearing experience are more likely to prematurely reject their infants.	Mixed-model repeated measures ANOVA Between-subjects measures: Rearing of mother, Rejection (early vs. normal) Repeated measure: months of life	Rejection
Mothers who had a poor early-rearing experience will spend less time in mutual ventral with their infant, and will groom their infants less.	Mixed-model repeated-measures ANOVA Between-subjects measures: Rearing of mother, Rejection (early vs. normal) Repeated measure: months of life	Mutual ventral, receive-groom mother-infant
Primiparous mothers are more likely to prematurely reject their infants.	Mixed-model repeated-measures ANOVA Between-subjects measures: Rejection (early vs. normal), Mother 's parity (primiparous vs. multiparous) Repeated measure: months of life	Rejection
Mothers' skills are hypothesized to improve with successive infants.	Mixed-model repeated-measures ANOVA Between-subjects measures: Mothers' rearing (MR, PR, SPR), Mother 's parity (primiparous vs. multiparous) Repeated measure: months of life	Rejection, receive groom mother-infant, mutual ventral

Results

Hypothesis 1

The initial analysis showed that infants who were rejected prematurely had higher rates of aggression in the first six months of life when all infants were compared (those who showed aggression as well as those who did not), $F(1, 177) = 5.283$, $p = 0.023$, than infants who began to experience maternal rejection around three months of age, see Table 4.

To test whether the effects of early aggression increased the probability of aggression occurring or the overall rate of aggression in those subjects that exhibited it, two a posteriori analyses were performed with the aggression data in order to more closely examine the relationship between premature maternal rejection and infant displays of aggression. A mixed-model repeated-measures ANOVA was performed using only the subjects who exhibited aggression during the first six months of life. Rejection (early vs. normal) was the between-subjects measure, and months of life was the repeated measure. In this comparison of only the subjects that engaged in aggression, no significant differences were found between infants who were rejected prematurely and infants who experienced rejection starting at 3 months, $F(1, 35) = 0.939$, $p = 0.340$, indicating that early rejection did not increase the rate of aggression. A chi-square was also performed in order to assess the frequency of aggressive infants in relation to rejection (early vs. normal). Significant differences in the distribution were found, $\chi^2(1, 177) = 4.295$, $p = 0.038$, see Table 3. These findings showed that the number of subjects that engaged in aggression was equal to chance if the infants that were rejected at normal times, but that the number of subjects that engaged in aggression exceeded that which was expected by chance if the subjects were rejected early.

Table 3

Prevalence of Aggression in Infants During First 6 Months: Comparison by Rejection

		Early Rejection	Normal Rejection	Total
Aggression				
	Count	50	92	142
	Expected Count	55.4	86.6	142
	% within aggression	35.2%	64.8%	100%
	% within rejection	72.5%	85.2%	80.2%
	% of Total	28.2%	52.0%	80.2%
		Early Rejection	Normal Rejection	Total
No Aggression				
	Count	19	16	35
	Expected Count	13.6	21.4	35
	% within no aggression	54.3%	45.7%	100%
	% within rejection	27.5%	14.8%	19.8%
	% of Total	10.7%	9%	19.8%
	Total	69	108	177

Hypothesis 2

The results of the second hypothesis approached statistical significance, showing that infants who were rejected prematurely spent less time in positive close contact with their mothers, as measured by time in mutual ventral position, $F(1,177) = 3.774$, $p = 0.054$, and by the time their mothers spent grooming them, $F(1, 141) = 2.771$, $p = 0.098$. See Table 3.

Hypothesis 3

Mixed results were obtained. Infants who were rejected prematurely were not found to spend less time in activity, as measured by locomotion, $F(1, 177) = 0.206$, $p = 0.65$. They were

found to spend significantly more time in a passive, behaviorally withdrawn state, $F(1, 177) =$ 5.162, $p = 0.024$, see Table 4.

Table 4

Comparison of Early and Normal Rejections (Hypotheses 1-3)

Hypothesis/Behavior	Early Rejections	Normal Rejections	p Value
	M/SE	M/SE	
1 Aggression	0.014/0.003	0.006/0.002	0.023
2 Mutual Ventral	177.865/3.503	186.536/2.767	0.054
2 Mother Grooms Infant	15.712/1.617	19.429/1.539	0.098
3 Locomotion	15.162/0.700	15.566/0.553	0.65
3 Passive	21.402/1.046	18.374/0.826	0.024

Hypothesis 4

Mothers with a poor early-rearing experience were more likely to prematurely reject their infants, $F(2, 175) = 3.861$, $p = 0.023$. Specifically, PR mothers had the highest average rates of rejection, with a mean of 0.307. MR mothers had the second highest average rate of rejection, with a mean of 0.209. Surprisingly, SPR mothers had the lowest rates of rejection, with a mean of 0.205. However, they did show the highest rates of rejection in the first month of their infants' lives, with a mean of 0.263, while the other mothers hardly ever rejected their infants in the first month – MR and PR had means of 0.085 and 0.064, respectively, see Table 5 as well as Figure 1.

Given the seemingly higher rates of rejection in the SPR mothers during the first month, an a posteriori analysis was conducted in order to assess the differences in the rates of rejection between the rearing styles during the first month. A one-way ANOVA was conducted on the rejection rates for the first month, with the mothers' rearing (MR, PR, SPR) as the between-subjects factor. No significant results were found, $F(2, 175) = 1.682$, $p = 0.189$.

Table 5

Comparison of Rates of Early and Normal Rejection by Mothers' Rearing

Rearing of Mother	Early Rejection	Normal Rejection
	M/SE	M/SE
MR	0.328/0.035	0.142/0.027
PR	0.415/0.049	0.242/0.038
SPR	0.280/0.055	0.149/0.047

Rearing of Mother	*p* Values Rejection Condition	Rearing*Rej Cond
0.023	0.00	0.804
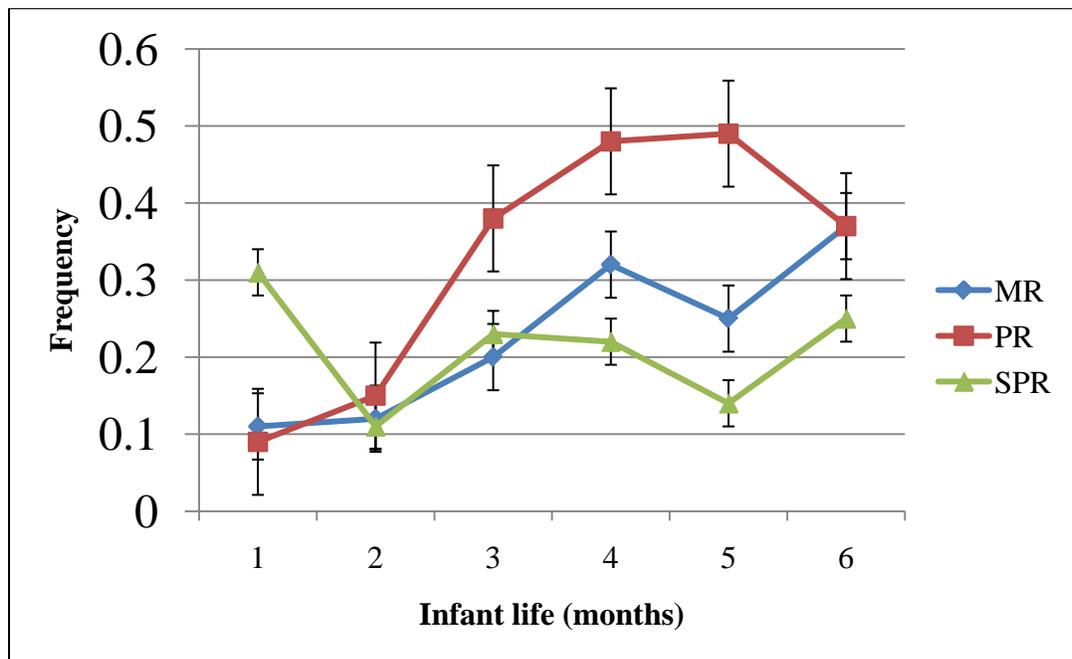
Figure 1. Mothers' rearing and rejection rates across the first 6 months of the infants' lives.

Hypothesis 5

Mixed results were obtained, as mothers with poor early-rearing experiences were found to have reduced time in mutual ventral contact with their infants, $F(1, 175) = 4.616$, $p = 0.011$,

but not in grooming their infants as compared to mothers with a more positive early-rearing experience, $F(2,139) = 0.078$, $p = 0.925$, see Table 6.

Table 6

Mothers' Rearing and Time Spent in Mutual Ventral and Grooming

Rearing of Mother	Time in Mutual Ventral	
	Early Rejection	Normal Rejection
	M/SE	M/SE
MR	182.027/4.842	183.834/3.645
PR	163.688/6.655	184.803/5.155
SPR	190.246/7.546	197.809/6.477
	p Values	
Rearing of Mother	Rej Cond	Rearing* Rej Cond
0.011	0.035	0.179
Rearing of Mother	Time Spent Grooming Infant	
	Early Rejection	Normal Rejection
	M/SE	M/SE
MR	16.519/2.280	17.808/2.216
PR	17.801/3.225	18.364/3.051
SPR	12.497/3.554	23.564/3.051
	p Values	
Rearing of Mother	Rej Cond	Rearing* Rej Cond
0.925	0.075	0.175

Hypothesis 6

Contrary to this hypothesis, primiparous mothers were not found to be more likely to prematurely reject their infants. Instead, multiparous mothers were more likely to reject their infants prematurely, although this result was only of marginal significance, $F(1, 177) = 3.210$, $p = 0.075$. Multiparous mothers had a mean rejection rate of 0.251 across the first six months of

their infant's life, while primiparous mothers had a mean of 0.213. There was a statistical

interaction between the mother's rejection (early vs. normal) and the mother's parity, F (1, 177)

= 4.752, p = 0.031, see Table7 and Figure 2.

Table 7

Comparison of Early and Normal Rejections by Mothers' Parity

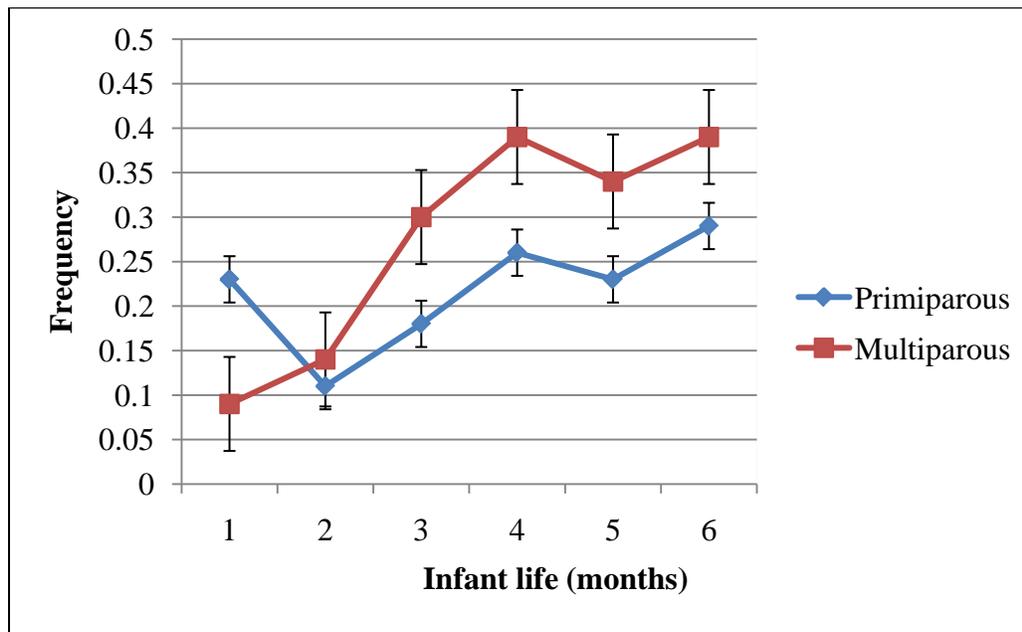| Mother's Parity	Early Rejectors	Normal Rejectors
	M/SE	M/SE
Primiparous	0.263/0.040	0.179/0.033
Multiparous	0.393/0.032	0.166/0.025
	p Values	
Parity	Rejection Cond	Parity*Rej Cond
0.075	0.00	0.031

Figure 2. Mothers' parity and rejection rates across the first 6 months of the infants' lives.

Hypothesis 7

No significant results were found for the interaction between mothers' rearing and parity in regards to rejection rate, F (2, 175) = 2.375, p = 0.96, time the mother spent grooming the infant, F (2, 139) = 0.918, p = 0.402, and time spent in mutual ventral contact, F (2, 175) = 1.692, p = 0.187.

Additional Analysis

In order to assess the independence of the variables of mothers' rearing condition and mothers' parity, a chi-square test was conducted. No relationship was found between the two variables, χ^2 (2, 175) =3.173, p = 0.205.

Discussion

For the most part, the overall hypotheses were confirmed, although there were several unexpected findings. The general aim of the study was to paint a picture of the impact of premature maternal rejection on infants, as well as of some of the contributing factors that lead mothers to prematurely reject their infants. As expected, the outcome for infants rejected prematurely overall appears to be less favorable and may have its roots in mothers' negative experiences in their own upbringing.

First, in the initial analysis comparing all infants (the small group that displayed aggression as well as those that did not), those who experienced premature maternal rejection were more aggressive in the first 6 months of life than infants who experienced rejection at the more age-appropriate time, beginning around three months of age. However, upon further evaluation with the a posteriori analysis of only those infants who show aggression, there were no significant differences in the rates of aggression between infants who were rejected prematurely and infants who were rejected at the expected time. Additionally, the results of the a

posteriori chi-square show that infants who were rejected prematurely were more likely to be in the small group of infants that exhibit aggression in the first 6 months. These findings suggest that infants who experience premature maternal rejection have a higher probability of being in the small group of infants that show aggression during the first 6 months than infants who experience rejection at the expected time. Furthermore, the findings suggest that when the prematurely-rejected infants do engage in aggression, it occurs at about the same rate as infants engaging in aggression who were not prematurely rejected. This is consistent with other research showing that difficulties in the mother-infant relationship can lead to higher probabilities of aggressive behavior on the part of the infant (Kalin, 1999; Seay et al., 1964).

Given that many rejections are punitive in nature, one might speculate that early aggression by mothers increases the probability of aggression in the offspring. Widom (2000) calls this the "cycle of violence," although it refers to more extreme cases of human children who were abused and grew up to abuse their own children. An alternative interpretation may be that the early-rejected infants become independent earlier, and because they are immature in their social skills and monitored less by their mother at this early age, they are more likely to engage in negative interactions with other group members.

Second, prematurely rejected infants were found to spend less time in positive contact with their mothers. This suggests that mothers who reject their infants early are less skilled. Positive, close physical contact has been found to be one of the defining characteristics of securely-attached capuchin mother-infant relationships (Weaver & de Waal, 2002), and Harlow's classic studies make it clear that close physical contact is the basis of a secure attachment in macaques (see e.g., Harlow & Harlow, 1965).

Third, the picture is less clear for overall activity. Prematurely rejected infants engaged in locomotion about as much as those who were not prematurely rejected. On the other hand, they spent more time in behavior. More research is needed in order to determine the relationship between activity level and premature maternal rejection. One might speculate that behavioral withdrawal may be a coping response by an immature infant faced with the complex challenges of early independence.

Not surprisingly, MR mothers were less likely to reject their infants than PR and SPR mothers. PR mothers more likely to reject their infants. This may in part be due to the constant clinging that PR infants exhibit well beyond the normal age of weaning, forcing PR infants to at times engage in aggressive behavior in order to break contact (Higley et al., 1996). Surprisingly, when averaged across months, SPR mothers were the least likely to reject their infants. However, SPR mothers rejected their infants at very high rates in the first month of life, a period when most normally-reared infants spend 90% or more of their time on their mother's ventrum. This finding is not altogether surprising, given that SPR mothers were deprived of ventral contact with their own mothers and in contrast to the PR monkeys who clung to each other a large portion of the day as they developed (Harlow & Harlow, 1965). These findings are contrary to those of Roma, Ruggerio, Schwandt, Higley, & Suomi (2006), who found almost no differences between PR, MR or SPR mothers in regards to mutual ventral contact and rejection, although their sample size was much smaller than that in the current study. Although there were no differences in grooming between those mothers who had poor early-rearing experiences and those who were reared by their own mothers, there was a slight difference for time in ventral contact.

Mothers who had poor early-rearing experiences spent less time in mutual ventral contact with their infants, and, although the results were not quite statistically significant, they still point to a trend of differences in mothering behavior between those who reject their infants too early and those who begin rejecting at the expected time. Such differences suggest that although the differences are subtle, early-rearing experiences leave more-or-less permanent effects on behavior, extending to the treatment of their own infants later in life. The finding is consistent with that of Maestripieri, Lindell, & Higley (2007), who looked at the behavior of females that were adopted as infants and measured their behavior later in life with their own infants. They found that rates of rejection were correlated with the adoptive mother's behavior and not with that of their biological mother. The findings of the present study are also consistent with the findings of Schapiro, Bloomsmith, Suarez, & Porter (1995), who found that primiparous mothers who had been socially restricted when they were young spent less time nursing their infants, spent less time in contact with their infants, and spent more time engaged in non-infant-related activities than primiparous mothers who were not socially restricted when they were young.

Primiparous mothers were found to be no more likely to prematurely reject their infants than multiparous mothers were. In fact, multiparous mother were found to be marginally more likely to reject their infants. This is consistent with Seay's (1966) research, which showed that primiparous and multiparous mothers were quite similar in their maternal behavior. However, other research has shown that first-time mothers may be less skilled in caring for their infants. Maestripieri and Carroll (2000) found that infants who experienced neglect were more likely to be raised by young, inexperienced mothers. Additionally, Fairbanks and McGuire (1995) found that vervet monkey mothers who were very young or very old were more likely to reject their

infants earlier and with greater frequency, which is consistent with the claim that primiparous mothers are more likely to reject their infants prematurely.

Lastly, mothers' skills were not found to increase with successive infants. This finding is consistent with Seay's (1966) finding mentioned above, namely, that multiparous and primiparous mothers demonstrated similar maternal behavior and that multiparous mothers were not demonstrably better mothers.

In conclusion, this study demonstrated a less favorable developmental outcome for infants who have less-skilled mothers. Lack of skill was displayed here as premature maternal rejection. Although some researchers have found that rejection increases infants' boldness in exploration (Fairbanks, 1996), the present results show that rejection experienced too early can be detrimental to the infant, in terms of increased aggression and an impoverished and possibly more conflicted mother-infant relationship. Maestripieri et al. (2006) found that abused infants were subjected to higher rates of maternal rejection and that these highly-rejected infants had lower serotonergic functioning than infants with lower rates of rejection. Furthermore, those females who were abused in infancy and went on to become abusive mothers themselves had lower serotonergic function than the abused females who did not become abusers. Maestripieri and his colleagues suggested that lower serotonergic functioning resulting from early rejection plays a role in the transmission of abuse from one generation to the next. This suggestion fits well with the current findings: Insensitive mothering can result in negative behavioral and social outcomes for the infant as well as that infant's eventual offspring. Along the same lines, Berman, Rasmussen, and Suomi (1997) found that infants' developmental outcomes have implications not only for themselves, but for the milieu of the troop as well.

The present results also highlight the importance of early experience and its role in an individual's own mothering behavior. The negative effects of poor early-rearing experiences may be carried into an individual's own parenting practices, as seen here with the PR mothers. Furthermore, the benefits of having positive early experiences with a caring and sensitive mother may also be carried into an individual's own child rearing , as seen in this study with the MR mothers. This is consistent with the findings of Fairbanks (1989), who observed that early experience in female vervet monkeys was a better predictor of adult mothering skills than social learning as a juvenile, similarities between mothers and daughters, or shared circumstances.

Additionally, the present findings have implications for human mother-infant relationships and developmental outcomes. Insensitive mothering may adversely affect the development of infants and be carried into adulthood. Beckwith, Cohen and Hamilton (1999) found that humans who received less sensitive maternal care as infants were more likely to deny or devalue the influence of their attachment relationships as adults. Conversely, good mothering can have positive effects on children. In a study conducted in an impoverished area in Chile, mothers who were available, accepting, and responsive in their care giving had children who were more adequately nourished, securely attached, and competent than children whose mothers were less sensitive (Valenzuela, 1997).

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