
Biological Bases of Maternal Attachment

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Abstract

In recent years, there has been growing interest in investigating the processes affecting caregiving behavior. Recent studies of human and nonhuman primates have suggested that hormones can account, at least in part, for changes in caregiving motivation during pregnancy and the postpartum

period and for variability in caregiving motivation and behavior among individuals. Although hormones may not be the primary determinants of caregiving, future research cannot afford to overlook the contribution that biological processes can make to normative and pathological attachment and parenting.

Keywords

attachment; caregiving; hormones; primates

In 1969, Bowlby published the first volume of his trilogy on *Attachment and Loss*. In it, he laid out the basic principles of a new theory aimed at explaining the nature of the social bond between infants and their caregivers, most notably their mothers. After 30 years of research focused on the processes associated with the formation, maintenance, and breaking of infants' bonds with their caregivers, psychologists are now turning their attention to attachment from the care-

giver's perspective (George & Solomon, 1999).

Maternal attachment can be viewed as a set of behaviors whose function is to maintain proximity and interaction with the infant. As the early conceptualizations and empirical studies of infant attachment were informed by research with nonhuman primates (hereafter, primates), so the recent research on maternal attachment has been informed by primate studies. For example, both primate and human studies have recently investigated whether motivation for caregiving changes across pregnancy in relation to hormonal changes, whether the first few postpartum days are a sensitive period for this motivation, and whether hormonal variables predict differences in caregiving motivation and behavior among individuals. In this article, I review some recent findings in these three areas of research and discuss similarities and differences between primate and human data.

CHANGES IN CAREGIVING MOTIVATION DURING PREGNANCY

In group-living macaques, caregiving motivation during pregnancy can be measured by the frequency with which females touch, hold, groom, or carry other females' newborn infants. Interactions with young infants are by no means limited to pregnant females. Macaque females of all ages and reproductive stages show some interest in young infants and attempt to interact with them. This suggests that in primates, just as in humans and other mammals, pregnancy hormones (such as estradiol and progesterone) are not necessary for the expression of caregiving motivation. The question addressed by recent primate studies, however, is not whether hormones are neces-

sary for caregiving motivation, but whether the hormonal changes underlying pregnancy enhance caregiving motivation.

A recent study of pigtail macaques reported that the frequency of interaction with infants increased during late pregnancy and peaked the week before birth (Maestriperieri & Zehr, 1998). The increase in caregiving motivation during late pregnancy was correlated with an increase in the concentrations of estradiol in the blood and in the estradiol-to-progesterone ratio. This correlational evidence that hormones can affect caregiving motivation was corroborated by experimental manipulations. Rhesus macaque females whose ovaries had been removed increased significantly their frequency of interactions with other females' infants after receiving estradiol in doses similar to those of middle-late pregnancy (Maestriperieri & Zehr, 1998). Furthermore, nonpregnant marmoset females treated with estrogen and progesterone in concentrations similar to those of late pregnancy showed a significantly higher motivation to interact with infants than nontreated females (Pryce, Döbeli, & Martin, 1993).

Human pregnancy is characterized by hormonal changes very similar to those occurring in primates and other mammals. Both longitudinal and cross-sectional studies of women in their first pregnancy have shown that, in most cases, women experience increased maternal feelings toward their own fetus at about 20 to 24 weeks of gestation (Corter & Fleming, 1995). Changes in maternal feelings during pregnancy do not appear to be correlated with changes in concentrations of hormones such as estradiol, progesterone, prolactin, or cortisol (Corter & Fleming, 1995). However, it is possible that if changes in maternal attachment during pregnancy were assessed with behavioral and psy-

chophysiological measures (e.g., heart rate responses to infant cries) instead of women's self-reports on their feelings of attachment, an association between changes in caregiving motivation and hormones would become apparent.

IS THERE A POSTPARTUM SENSITIVE PERIOD FOR CAREGIVING MOTIVATION?

Klaus and Kennell (1976) hypothesized that there may be a sensitive period shortly after birth during which it is necessary for mothers to be in close contact with their infants for later child development to be optimal. Many subsequent studies of bonding concluded that the evidence for such a sensitive period was at best equivocal and, consequently, research on bonding was abandoned. Although the concept of mother-infant bonding was extrapolated from animal research, what most human studies attempted to demonstrate (i.e., that slight differences in time spent in contact during the postpartum period would have long-lasting consequences for the parent-child relationship) has never been demonstrated in animals either. In fact, a recent reanalysis of the primate data has provided some evidence that the postpartum period may be a sensitive period for caregiving motivation, but not necessarily for infant attachment or development (Maestriperieri, 2001).

Naturalistic observations of macaques have shown that a mother whose infant dies shortly after birth may kidnap a newborn from another new mother and adopt it. Occasionally, a new mother with a live infant may adopt another newborn and raise both infants as if they were twins. Interestingly, although infant mortality is by no means limited to the early postpartum period, all cases

of newborn adoption have been reported to occur within the first 2 postpartum weeks, suggesting that the potential for adoption is highest during this period.

Experimental studies in which infants have been swapped between mothers also suggest that there is a postpartum sensitive period for caregiving motivation (Maestripieri, 2001). In particular, the evidence suggests that (a) when mother and infant are separated during the sensitive period, the mother is likely to accept her own infant or an alien infant with similar characteristics if reunion occurs before the end of the sensitive period; (b) when mother and infant are separated during the sensitive period, the mother is likely to reject her own infant and any other infant if reunion occurs after the end of the sensitive period; and (c) when mother and infant are separated after the sensitive period and later reunited, the mother is likely to accept her own infant but reject any other infant. These findings are unlikely to be accounted for by learning processes related to recognition of offspring. Rather, they suggest that the physiological changes associated with childbirth and early lactation may be associated with a period of heightened responsiveness to infant stimuli and motivation for caregiving behavior.

Whether humans also have a postpartum sensitive period for caregiving motivation is not clear. Even if such a sensitive period were discovered, its implications for later parenting and child development would remain to be established. It is obvious that human adoption is the product of deliberate choice and that foster parents can provide excellent care. Nevertheless, the fact remains that if hormones and other biological variables have some effects on caregiving motivation, however small these effects might be, psychologists can no longer afford to overlook them.

INDIVIDUAL DIFFERENCES IN CAREGIVING MOTIVATION AND BEHAVIOR

Investigating whether differences in caregiving motivation or behavior among individuals are, at least in part, accounted for by hormonal or other biological variables is probably the greatest challenge for research on maternal attachment. This is because, in both primates and humans, individual differences in motivation and behavior are affected to a great extent by previous experience and the surrounding environment. Therefore, a full understanding of the causes of individual differences in caregiving would require knowledge of the complex interactions among biological, cognitive, and social processes.

Some of the most obvious individual differences in behavior are related to sex. In most mammalian species, there is a clear sex difference in caregiving motivation and behavior, with females being far more involved in caregiving than males. In only a few species of primates do males participate in caregiving, and these cases appear to reflect special reproductive and ecological circumstances. For example, in New World monkeys such as marmosets and tamarins, females give birth to twins and fathers share the energetic costs of infant carrying with mothers. In rhesus macaques, the sex difference in interest in infants appears in the 1st year of life and persists through adulthood. A rhesus macaque female begins handling newborn infants when she is only a few months old and barely big and strong enough to lift them off the ground. In contrast, males of the same age show little or no interest in interacting with infants. A similar sex difference in interaction with infants has been reported for

human children and adolescents in a number of cultures. In humans, such differences may, at least in part, be the product of socialization, and in particular the different expectations that parents in most cultures have for their sons and daughters in terms of child-care roles. In macaques, however, the sex difference in behavior toward infants is unlikely to be the product of socialization because there are no consistent differences in the way mothers, or other group members, interact with males and females during their 1st year of life (Fairbanks, 1996).

An alternative explanation has to do with prenatal hormones. In rhesus macaques, prenatal exposure to male hormones (androgens) is known to affect sex differences in play later in life, so that juvenile females prenatally exposed to excess androgens engage in the rough-and-tumble play that is typical of males (Goy & Phoenix, 1971). Unfortunately, no primate studies to date have investigated the relation between prenatal hormones and caregiving motivation. In a study with humans, however, girls affected by congenital adrenal hyperplasia (a common inherited syndrome in which the adrenal gland overproduces androgens) played less frequently with dolls than unaffected girls, suggesting that prenatal exposure to excess androgens may play a role in the development of sex differences in caregiving motivation (Geary, 1998).

Primate studies investigating differences in caregiving motivation or behavior among adult females have produced conflicting evidence. In a laboratory study of red-bellied tamarins, mothers that had poor parenting skills and whose infants did not survive had lower urinary concentrations of estradiol in the last week of pregnancy than mothers that had good parenting skills and whose infants survived (Pryce, Abbott, Hodges,

& Martin, 1988). This difference, however, was found only in females without previous caregiving experience, not in experienced mothers. In macaques, not all pregnant females are more interested in infants than nonpregnant females, and individual differences in behavior toward infants are not necessarily related to differences in hormone levels. Rhesus macaque mothers who physically abuse their infants interact more frequently with other females' infants than nonabusive mothers during both pregnancy and lactation. However, the hormonal profiles of abusive and nonabusive mothers are generally similar. Moreover, individual differences in parenting styles during early lactation are largely unrelated to the levels of estradiol and progesterone circulating in the blood of both abusive and nonabusive mothers (Maestriperri & Megna, 2000).

In recent studies of humans, mothers who maintained high levels of estradiol before and after childbirth had higher feelings of attachment to their own infants in the early postpartum days than women whose levels of estradiol were lower (Fleming, Ruble, Krieger, & Wong, 1997). Interestingly, the hormone that was most closely related to maternal behavior in the early postpartum period was not estradiol but the stress hormone cortisol. Higher salivary concentrations of cortisol were associated with more intense caregiving behavior in both first-time and experienced mothers (Fleming, Steiner, & Corter, 1997). Mothers with higher salivary concentrations of cortisol on the 1st day after childbirth were also more attracted to their own infants' body odor and better able to recognize their infants' odor than mothers with lower cortisol concentrations. Mothers' attraction to infant odors was also affected by previous experience with infants, and experience,

rather than cortisol, was the best predictor of individual differences in maternal responsiveness assessed with a questionnaire.

CONCLUSIONS

Taken together, these recent studies of primates and humans suggest that the study of hormonal correlates of individual differences in caregiving, and more generally of biological influences on maternal attachment, is an enterprise that is worth pursuing. Understanding the complex interaction among biological, cognitive, and social variables in the expression of caregiving behavior will not be an easy task. However, we already possess sophisticated theoretical models integrating multiple factors that may affect caregiving motivation and variability in caregiving across the life span and different individuals (e.g., Corter & Fleming, 1995; Pryce, 1995). Such models, along with comparative studies of animal parenting, can stimulate and inform future research on maternal attachment. There are still many important questions that remain to be addressed. Is there an interaction between prenatal hormonal influences and early postnatal experiences in the development of caregiving behavior? Are the influences of biological variables on caregiving mostly limited to first-time parents, or can these influences still be detected in reproductively experienced individuals? What are the specific similarities and differences between the processes affecting maternal and paternal attachment? Are there any biological correlates of neglectful or abusive parenting? Answering these questions will have important implications for understanding the normative processes underlying maternal attachment, as well as its pathologies.

Recommended Reading

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Note

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