

Infant Signaling: An Environmental Stimulus for Maternal Care

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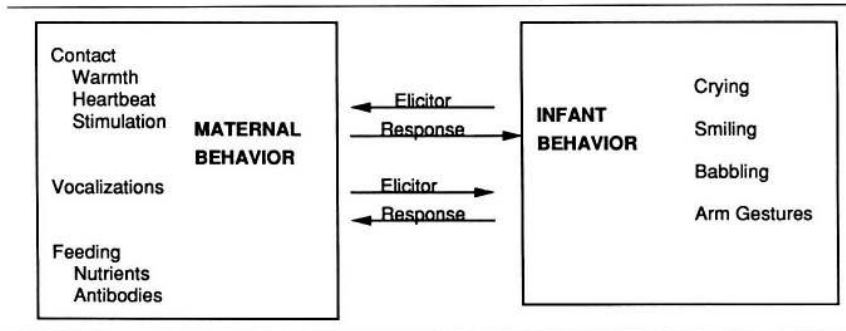
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Abstract: None available.

Full Text: Headnote ABSTRACT: Decades of research on child development has confirmed that infants use specific behavioral signals to elicit maternal responses. This research has also demonstrated the importance of a fit between maternal and infant behavior for optimal psychological and cognitive development of the infant. There is now evidence from animal behavioral studies that neuroendocrine and hormonal mechanisms mediate this link between infant signaling and maternal responsiveness. This paper discusses these recent findings in the context of Bowlby's evolutionary theory of attachment, and proposes a biosocial model for studying cross-cultural and intra-cultural variation in maternal care. Anthropologists have taken radically different approaches to understand the determinants of maternal care, from critical medical anthropology to parent-offspring conflict. However, detailed observational studies of mother-infant interactions have been primarily by developmental psychologists studying the attachment relationship. Although attachment theory, as developed by Bowlby, provides a useful framework to study the link between maternal solicitude and infant outcome, the concept of attachment as defined and operationalized by developmental psychologists is too narrow to be useful to anthropologists other than those interested in the infant's psychological and cognitive development. Suggested here is an expanded attachment paradigm that provides a better working model for investigations of phenomena of anthropological interest such as the conundrum of differential care; that is, why parents nurture their offspring sometimes and sometimes not. Central to this expanded approach to the study of maternal care is the concept of infant signaling. Our understanding of the infant as an active participant in the development and maintenance of the mother-infant relationship is to a large extent due to John Bowlby's (1969) ethological evolutionary theory of attachment (Figure 1). It is this theory that has guided years of research into identifying the factors that tie infants and mothers together emotionally and mediate the mother's response to the needs of her infant. Bowlby was the first to propose a theory of attachment based on Darwinian evolutionary principles. For instance, he proposed that an attachment system was naturally selected in the environment of our evolutionary past because it promoted proximity between mothers and infants and thereby enhanced infant survival. The attachment system that Bowlby conceptualized consisted of biobehavioral mechanisms operating in both mothers and infants that act in synchrony with one another to sustain the care of offspring throughout the immature period. Bowlby proposed that the infant is equipped with certain instinctive behaviors which function to signal the mother and activate a response either to feed or to promote and maintain close infant-mother contact. Likewise, he proposed that hormones are part of the behavioral equipment of mothers that potentiate certain behavioral systems that function to achieve the contextual needs of the infant.

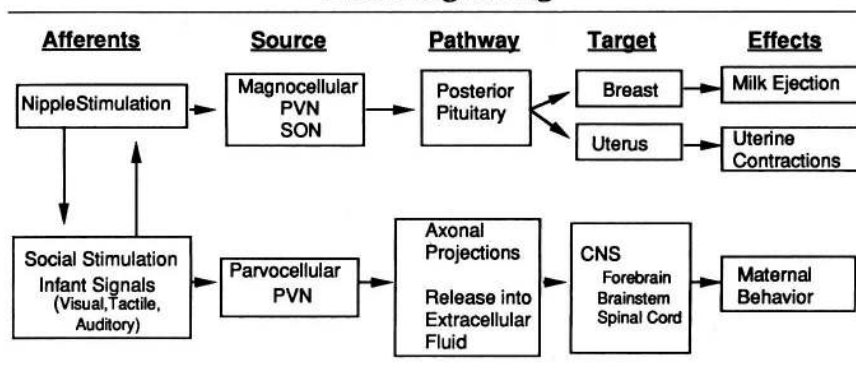
Figure 1
Infant Signalling



Studies of maternal physiology as well as mother-infant interaction lend support to the evolutionary theory of attachment by demonstrating an attachment behavioral system mediated by maternal responsiveness to infant signaling. I would first like to consider the biological processes that relate to this behavioral system. The significance of breastfeeding for early survival makes it an important biocultural adaptation (Figure 2). However, only recently have studies shown that the hormones responsible for lactation also have a dual function related to maternal behavior. The hormone oxytocin, that is responsible for the milk ejection reflex, has also been found to influence affiliative behavior which is mediated within the central nervous system (Insel, 1992). The discovery of two separate pathways of oxytocin production and release was important in our understanding of the dissociation of the peripheral and central effects of this hormone. Oxytocin is produced in the hypothalamus in the supraoptic and paraventricular nuclei. Oxytocin produced in the magnocellular neurons of these nuclei travels to the posterior pituitary and then to the peripheral circulation. It is this pathway that is responsible for the milk ejection reflex and uterine contractions. The parvocellular neurons, however, also produce oxytocin, but release it into various areas of the central nervous system including the forebrain, the brainstem, and the spinal cord. It is this central pathway that has been implicated in the important although less understood mediation of maternal behavior (Dawood et al., 1981; Demitrack & Gold, 1989; Insel, 1992).

Figure 2

Infant Signalling



The dual pathway model has important implications for maternal attachment since the mediating processes of the two pathways can be quite distinct. Therefore, discerning the mediators of the central pathway is crucial to our understanding of the biological considerations of attachment. Although the stimulation for central oxytocin release is less well understood, studies indicate that it is associated with infant signaling, including tactual, visual, and auditory stimuli (Herbert, 1989; Insel, 1992; Keverne, 1988; McNeilly et al., 1983; Noel et al., 1974).

Presence of these dual pathways implies that central and peripheral effects of oxytocin may be dissociated. That is, a mother may show adequate milk let down but failure of the attachment system. Because the central effect of oxytocin is dependent on a certain hormonal milieu as well as various sites within the central nervous system, disruption of the attachment system may be related to processes affecting other behavioral systems involving hormones or central target sites that have dual roles in the attachment system (Insel, 1992). Although studies suggest biological mediators of human maternal behavior involving oxytocin (see: Amico et al., 1981; Burbach et al., 1983; de Kloet, 1986; Fahrbach et al., 1984; Insel, 1992; Johnston et al., 1990; McCarthy, 1990; McNeilly et al., 1983; Noel et al., 1974; Pedersen & Prange, 1985; Petersen et al., 1991; Samson et al., 1986; Stern, 1986, 1989), it is difficult to foresee a design for a definitive human study of the mediating role of oxytocin on maternal behavior because of the following factors (Table 1):

Table 1

**Limitations of Hormonal Studies
of Human Maternal Behavior**

-
- Central oxytocin levels are not necessarily reflected in plasma levels.
 - Function of oxytocin is related to number, quality, and location of receptors.
 - Oxytocin is part of a complex hormonal system.
 - Other cognitive inputs influence maternal behavior.
-

1. Measurement of oxytocin levels that indicate central synthesis and release are not necessarily reflected in plasma levels; therefore, there is no practical way to obtain samples such as from cerebral spinal fluid that would reflect the hormonal milieu of the central nervous system (Herbert, 1989; Kastin et al., 1992; Keverne, 1988; Richard et al., 1991) 2. Even if one could measure central levels of oxytocin, this may correlate little with function since function may be more a result of number, quality, and location of receptors; i.e. little change in oxytocin concentration may have a profound effect if receptor concentration or affinity changes (deKloet et al., 1986) 3. Oxytocin is only a part of the hormonal influence of maternal behavior; timing and levels of various other hormones are also critical to understanding the behavioral response (Insel, 1992; Pedersen & Prange, 1985) 4. The effects of other cognitive inputs that influence maternal behavior must also be considered when evaluating the mediating role of the hormonal system A basic tenet of attachment theory is that attachment is mediated by the responsiveness of the mother to her infant's signals (Figure 3). Attachment has been defined and operationalized in terms of the infant's psychological well-being. According to theory, a securely attached maternal-infant relationship is an important determinant of the infant's ability to explore his environment by having a secure-base from which to operate and a favorable model on which to form other social bonds (Ainsworth, 1973, 1977). However, we also know that a mother's response to her infant has valuable biological benefits as well (Figure 4). For example, from his studies of the !Kung, Konner (1977) described accelerated infant neuromotor and cognitive performance that may be mediated by the indulgent care-taking practice involving almost constant mother-infant contact and instantaneous response to infant signaling. Over the past several years, various studies of preterm, low-birth-weight infants have demonstrated the positive growth and development effects of tactile/kinesthetic stimulation. For example, a recent experimental study by Schanberg and Field (1987) of low-birth-weight preterm neonates demonstrated greater weight gain, alertness, and motor ability in infants who received daily stroking and kinesthetic stimulation.

Figure 3
Infant Signaling

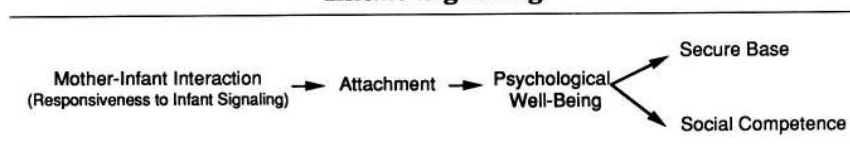
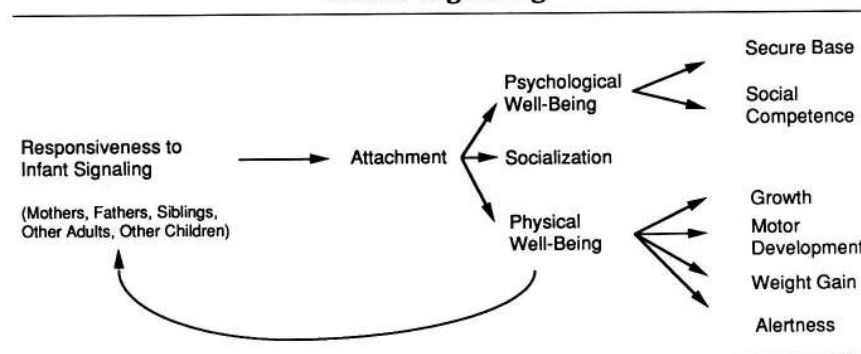


Figure 4
Infant Signaling



Studies have also shown that infant signaling mediates maternal interest in child care which subsequently affects the physical wellbeing of the infant. For example, in her study of selective neglect among women of Alto do Cruzeiro, Scheper-Hughes (1985) states that the factor most significant in determining which infant was neglected was related to the activity of the infant. A baby who was active, playful, and developmentally precocious was preferred to the quiet, inactive, developmentally delayed. Although she continues to state that attachment theory has no relevance in this population, clearly the determinants of attachment-infant signaling and the maternal response-are quite relevant. In this population, maternal cognitions about certain infant behaviors (i.e. inactivity, weakness) mediate the response, diminishing the investment in less active offspring. Similarly, in a study in Mozambique involving mothers and lowbirth-weight babies, investigators found that mothers were unwilling to care for their infants and had a passive and fatalistic notion about infant survival when their infants were weak and passive. In an intervention called the kangaroo-mother method, infants were literally tied between their mothers' breasts and mothers were required to provide constant stimulation. Infants gained weight and became more alert and active, and mothers' attitudes changed with increased infant activity. Mothers became more willing to care for their infants and relinquished the passive and fatalistic notion that the infant was too weak to survive (Colonna et al., 1990). These studies suggest that an infant who is inactive for reasons of illness or, simply, temperament, may have reduced survival in some societies. The presence or resumption of infant activity mediates maternal responsivity, attachment, and the physical well-being of the infant. Therefore, the attachment paradigm requires expansion beyond the interests of the infant's psychological well-being to include the relationship between attachment and physical well-being as well. These studies suggest that observations of maternal-infant interactions are useful in identifying the proximate determinants of infant survival; that is, infant characteristics that, through culturally-derived maternal perceptions and evaluations, result in particular maternal responses. Anthropological studies in non-Western, preindustrial societies suggest another way in which the psychobiological model of attachment should be broadened. Attachment theory has focused on a very narrow caregiving environment, where the mother is the only significant caretaker. However, studies among preindustrial societies, (such as among the Aka, the Efe, and the !Kung), suggest that individuals other than mothers have significant roles in the care of infants (Hewlett, 1991).

Therefore, understanding the mediating role of response to infant signaling on the psychological and physical well-being of infants may require observations of infant interactions with caretakers other than mothers. Cross-cultural comparisons have also shown that maternal response to infant signals differs today from our evolutionary past, elucidating the adaptiveness of infant behaviors and also providing practical information for care of infants. For instance, studies of response to infant crying indicate that response time typical in our evolutionary past was quite different from that in Western industrialized societies. In Murdock and White's sample of nonindustrial societies, immediate responses to crying were typical of foraging societies (Barr, 1990, p. 366). More detailed observational studies by Konner of the !Kung show an almost immediate response to infant crying and fretting, averaging a response time of 6 seconds. In fact, in the first three months of life, the response time to infant signaling among the !Kung is "within 10 seconds more than 90% of the time" (p. 366). Data on response time in Western societies indicate longer response times which may be related to more separation between infants and mothers and to the deliberate suppression of response due to beliefs about infant spoiling. For instance, studies in an American and Dutch sample report that mothers deliberately did not respond to approximately 45 percent of the cry episodes (p. 366). A study by Barr and colleagues of LaLeche League mothers shows the fallacy of the "spoiling" theory. Their study demonstrated that mothers with two month old infants who fed their infants more frequently and responded more quickly to their infants' cries, had less fretful babies (p. 374). In an experimental study, Barr and colleagues also demonstrated that crying bout length can be reduced by increasing the amount of time mothers spend holding and carrying their infants. For instance, increasing the carrying and holding time by merely 1.8 hours per day, reduced the duration of crying and fussing by a remarkable 43 percent, but did not decrease the frequency of crying (p. 371). From these studies, Barr suggests another means by which the crying signal was adaptive other than by enhancing proximity: the adaptiveness of crying may also be related to interbirth intervals. Mothers in our evolutionary past who responded to high frequency crying were more likely nursing more frequently and with shorter interbout intervals (pp. 379,380). This nursing pattern has been shown to be a major determinant of birth spacing (Konner & Worthman, 1980; Stern et al., 1986), and increased interbirth intervals have been found to be highly associated with lower rates of infant mortality (Chandran, 1989; Curtis & McDonald, 1991; Hanson & Bergstrom, 1990; Howie & McNeilly, 1982; Majumder, 1991). Cross-cultural studies by Richman and colleagues (1992) suggest that maternal-infant interactions not only mediate the psychological and physical well being of infants, but are also important mediators of the norms and values of their societies (Figure 4). For example, a study comparing mother-infant pairs among the Gusii of Southwest Kenya and Bostonians suggests that mothers in different cultures respond in different ways to particular infant signals, reflecting a difference in culturally prescribed maternal goals. Studies have also shown that variations in maternal responses are linked to variations in cultural factors such as ethnicity, socioeconomic status, and maternal education. As previously mentioned, one of the puzzles of human behavior that has been the focus of anthropological studies is why parents deny their offspring warmth, affection, and even the essentials of survival. To answer this question, anthropologists have often focused on populations exhibiting skewed post-natal sex ratios. Considerable ethnographic and ecological data have been collected to explain malebiased sex ratios by showing that expected preconditions exist for preferential male treatment. For example, one explanation for malebiased sex ratios is that male children are preferentially cared for over female children because males contribute substantially more calories to the diet than females. However, very few data are available to document that male children actually are treated preferentially (Hewlett, 1991, pp. 27-28). Documenting differential care and its affect on mortality, growth, and development is crucial to an understanding of how unbalanced sex ratios come about. Miller (1981, p. 83) identified three means by which this may occur: 1) allocation of food, 2) allocation of medical care, and 3) allocation of love. Perhaps the allocation of love is the least understood and where observations of the responsiveness to infant signaling can be most informative. It may be that a mother's attention to her male infant's cry for warmth, protection, or shelter makes his chance of survival and reduced

mortality better than that of his sister's. Similarly, the frequency and quantity of time spent holding or watching over the infant may be important correlates of infant outcome. In summary, depressed levels of maternal involvement may be the result of certain demographic, economic, or ecological factors interacting with particular inherent characteristics of the infant. Therefore, the maternal-infant interaction model can be useful in understanding differential care by identifying the proximate mechanisms that are the bases of differential investment. By documenting differences in care through behavioral observations, we can then characterize the specific contextual factors that enhance or impair the care of offspring. An anthropological approach should be useful in identifying cultural patterns and the underlying attitudes and cognitions that influence the evaluation and response to infant behavior. Recognizing the importance of the infant in the regulation of maternal care has important implications for health care professionals developing programs to reduce infant mortality, as well as for health care providers working directly with new mothers. Premature or ill infants, already at higher risk physiologically, may also be at higher risk for diminished maternal involvement. The findings thus far suggest that encouraging mothers to be more engaged with less active infants may augment their chance of survival as well as enhance the attachment relationship.

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