

# Does Infant Carrying Promote Attachment? An Experimental Study of the Effects of Increased Physical Contact on the Development of Attachment

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ANISFELD, ELIZABETH; CASPER, VIRGINIA; NOZYCE, MOLLY; and CUNNINGHAM, NICHOLAS. *Does Infant Carrying Promote Attachment? An Experimental Study of the Effects of Increased Physical Contact on the Development of Attachment*. CHILD DEVELOPMENT, 1990, 61, 1617-1627. This study was designed to test the hypothesis that increased physical contact, experimentally induced, would promote greater maternal responsiveness and more secure attachment between infant and mother. Low-SES mothers of newborn infants were randomly assigned to an experimental group ( $n = 23$ ) that received soft baby carriers (more physical contact) or to a control group ( $n = 26$ ) that received infant seats (less contact). Using a transitional probability analysis of a play session at 3½ months, it was demonstrated that mothers in the experimental group were more contingently responsive than control mothers to their infants' vocalizations. When the infants were 13 months old, the Ainsworth Strange Situation was administered. Significantly more experimental than control infants were securely attached to their mothers. We infer from these results that for low-income, inner-city mothers, there may be a causal relation between increased physical contact, achieved through early carrying in a soft baby carrier, and subsequent security of attachment between infant and mother.

This article reports an experimental investigation of the effects of physical contact on the development of attachment between mother and infant. The amount of physical contact was experimentally regulated by randomly assigning mother-infant pairs right after the infant's birth to one of two groups: a group that received soft baby carriers that afford more physical contact, or a group that received infant seats that afford less physical contact. The two groups were later compared on measures of maternal responsiveness and attachment. Previous correlational and observational studies have identified close physical contact as an antecedent to attachment (Ainsworth, 1967; Ainsworth, Blehar, Waters, & Wall, 1978; Egeland & Farber, 1984; Grossmann, Grossmann, Spangler, Suess, & Unzner, 1985).

Bowlby's attachment theory (Bowlby, 1969) places central importance on close prox-

imity between mother and infant during the first months of the infant's life. Bowlby postulated that infants have in their repertoire certain instinctive (genetically programmed) behaviors (e.g., crying and smiling) that have as their goal the promotion of proximity to and close physical contact with the caregiver (Ainsworth, Bell, & Stayton, 1974). Through the exercising of these behaviors and the proximity thus achieved, infants gradually develop an attachment to their caregivers. Recent theoretical formulations (Main, Kaplan, & Cassidy, 1985) suggest that the manner in which the caregiver responds to the infant's attempts to seek and maintain proximity largely determines the nature of the attachment relationship formed.

In her classic studies in Uganda and the United States, Ainsworth found that the amount of time mothers held their infants was related to the security-of-attachment rating

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## 1618 Child Development

that the infants received (Ainsworth, 1967). Mothers who in the first months of life held their infants for relatively long periods and were tender and affectionate during the holding had infants who, at 12 months of age, had developed secure relationships with them (Ainsworth et al., 1978). In contrast, if mothers were inept in handling their infants and provided them with unpleasant experiences during holding, the infants developed an anxious-ambivalent pattern of attachment. Several studies (Egeland & Farber, 1984; Main, 1977; Main & Stadtman, 1981) have found that mothers of avoidant infants had rejected or sought to minimize physical contact with their infants. Thus, there is evidence that the amount and quality of physical contact between mother and infant is related to security of attachment. By increasing the quantity of physical contact, the experimental treatment may afford the mother opportunities to show affectionate and tender behavior, thus affecting the quality of interaction.

A variety of factors could explain how close body contact might have an effect on the infant, the mother, and the mother-infant relationship. Investigators with diverse approaches have underscored the key role of contact comfort (Harlow & Mears, 1979), early tactile experiences (Frank, 1957; Montagu, 1971), vestibular-proprioceptive stimulation (Gregg, Haffner, & Korner, 1976; Korner & Thoman, 1972), and kinesthetic stimulation (Yarrow, Rubenstein, & Pedersen, 1975) in promoting healthy social and emotional infant development. Infants carried in soft baby carriers are exposed to all these types of stimulation. The increased and more varied time spent by the carried infant in close contact with the mother may affect certain infant behaviors, such as crying, smiling, and vocalizing, that were identified by Bowlby as related to the development of attachment.

The actual physical presence or proximity of the infant may have effects on the mother, making her more aware of and thus more responsive to her infant's needs and states. A mother can more easily recognize prodromal signs of hunger or discomfort in a carried infant than in an infant in a crib or stroller at some distance from her. Several previous studies have identified maternal responsiveness or sensitivity as an antecedent to secure attachment (Ainsworth et al., 1978; Ainsworth, Bell, & Stayton, 1972; Clarke-Stewart, 1973; Egeland & Farber, 1984; Grossmann et al., 1985).

From a theoretical point of view, and on the basis of observational studies, it thus

seems likely that close physical contact in the early months of life plays a major role in the formation of healthy, responsive relationships between mothers and infants. This article reports an experimental study of that concept in a low socioeconomic (SES) sample, which can be expected to have a range of social risk factors influencing the development of attachment (Spieker & Booth, 1988) and to benefit from attachment-bolstering experiences. The design took into account other factors known to affect the development of attachment. These factors include neonatal irritability and infant temperament (Crockenberg, 1981; Grossmann et al., 1985; Waters, Vaughn, & Egeland, 1980) as well as the mother's social support and the household composition (Chisholm, 1983; Crittenden, 1985; Konner, 1977; Munroe & Munroe, 1971).

The main hypotheses of the study were that: (1) mothers who carry their infants in soft baby carriers during the first months of the infants' lives will be more responsive and sensitive to their infants at 3½ months than will mothers who use infant seats; (2) at 13 months, the carried infants will be more securely attached to their mothers than will the control infants; and (3) maternal responsiveness at 3½ months will be related to security of attachment at 13 months. In addition, it was hypothesized that infant behaviors such as vocalizing and looking will be influenced by the experience of being carried in a soft baby carrier.

### Method

#### *Subjects*

Women who delivered on the ward service of a large inner-city hospital were potentially eligible for participation in the study. These women come from a low-income clinic population that is predominantly Hispanic and black. Approximately 30% do not have telephones.

To participate in the study, women had to be 18 to 37 years of age, with a parity from 1 through 4. They had to be accessible by telephone and able to speak conversational English. Other criteria were that the women had received prenatal care, had vaginally delivered a full-term, healthy infant, were enrolled in a hospital-based pediatric practice for medical follow-up of the infant, and were planning not to return to work or school for at least 3 months after delivery.

The final sample consisted of 23 women in the experimental group (out of 30 who enrolled) and 26 women in the control group (out of 30 who enrolled). These women had

completed all assessments during the 13 months of the study. Of those lost to follow-up, one infant died, one mother had brain surgery, one mother-infant pair could not be located, and the remaining families moved out of the area.

For the purposes of the study, extended families were considered to be ones in which a relative other than the infant's father lived in the household. Nuclear families were defined as families composed of a mother, father, and their children, or as mothers living alone with their children. Mothers' educational level was rated on a scale in which 4 = some high school, 5 = completed high school, and 6 = some college. Hollingshead scores are based on a 7-point scale in which a higher score indicates a higher SES level (Hollingshead, 1975).

Of the mothers in the experimental group, 30% were primiparous; 35% were black, 65% Hispanic; 52% were married or living with the infant's father and 35% were living in extended families (as determined by the 2-month questionnaire); 74% were receiving public assistance. The mean age of women in this group was 23.7 years. Their mean educational level was 5.0, and their mean Hollingshead score was 1.8.

Of the women in the control group, 58% were primiparous; 62% were black, 38% Hispanic; 61% were married or living with the infant's father, while 31% were living in extended families; 70% were receiving public assistance. The mean age for this group was 24.5 years. The mean educational level was 5.2, and the mean Hollingshead score was 2.0.

Fifty-seven percent of the infants in the experimental group were males. The infants in this group had a mean birthweight of 3,333.5 grams; 48% were breast fed. In the control group, 50% of the infants were males. The group had a mean birthweight of 3,255.7 grams and 38% of the infants were breast fed.

#### *Intake Procedures*

On the day after giving birth, women who met the recruitment criteria were read a list of different baby items and asked whether or not they would use each of the items if it were given to them as a gift. Embedded in the list were a soft baby carrier and an infant seat. Those who had already decided to use a soft carrier (14%) or who would not consider using one (46%) were eliminated from consideration. The study was explained in detail to those women who indicated that they were willing to use *either* a soft baby carrier or an infant seat. Only 5% of these women refused

to participate. It was stressed that if they agreed to be in the study, they would be expected to use whichever product they received by chance and not use the other. In this way, we tried to ensure that women in both groups would initially have similar attitudes to soft baby carriers and infant seats.

On the second day after giving birth, women who signed the Informed Consent were officially enrolled in the study. Background information was obtained from the mother, and she completed (if necessary, with the help of the research staff) the short form of the Maternal Attitude Scale (Cohler, Weiss, & Grunebaum, 1970). On the second or third day of the infant's life, one of the authors who had received training in Boston administered the Brazelton Neonatal Behavioral Assessment Scale (NBAS) (Brazelton, 1973) according to standard procedures.

The mother was randomly assigned (stratified by sex of infant) to the experimental (soft baby carrier) group or the control (infant seat) group. The product was given to the mother while she was still in the hospital and the manner of its use demonstrated. Mothers in each group were asked to use the product every day. In order to obtain an objective estimate of the amount the soft baby carriers were used, pedometers were sewn inside them.

The soft baby carriers used were "Snugglis," commercial versions of cloth carriers derived from those used in many parts of Africa. Infants are carried in an inner pouch that is supported by the adult's upper torso. Adult and infant are chest to chest, creating a secure and protective environment that allows the baby to be with the parent in a wide variety of activities.

Plastic infant seats can be used for carrying babies from place to place or for positioning an infant near its mother. They do not, of course, involve close physical contact. Infant seats were not considered to constitute an intervention; they are ubiquitous in this culture and are not thought to exert a powerful influence on attachment.

#### *Follow-up Assessments: Introduction*

To insure objectivity of measurement, two teams of researchers were employed. Team A did the recruiting and follow-up interviews and knew which product each mother received. Team B administered all the standardized tests, did the videotaping and coding, and were "blind" as to group membership of the dyads. Team A kept in touch with the mothers and gathered information on

## 1620 Child Development

product use via phone calls and through short interviews with the mothers when they returned for well-baby checkups.

### *Follow-up at 2 Months*

At the clinic visit nearest to 2 months after each infant's birth, two questionnaires were administered to the mother. Lifestyle Questionnaire I documented the exposure of the infant to different situations and people, the infant's biorhythms and habits, the age of onset of social smiling, the amount of the infant's crying, and the relative amount of time (rank ordered) that the infant spent in various locations during the day (crib, stroller, infant seat, sofa, bed, arms or lap, soft baby carrier). The lowest number (i.e., 1) was assigned to the location where the infant spent the most time. Questions were also included about sleeping arrangements and household composition at 2 months.

The Product Use Questionnaire asked the mother under what circumstances she used the product and who else used the product with the baby. Daily and weekly patterns of product use were ascertained. Pedometer mileage readings were also recorded on this form by a Team A member.

### *Assessment at 3½ Months*

This assessment consisted of four parts: Bayley Scales (Mental and Psychomotor) of Infant Development (Bayley, 1969), the videotaping of a mother-infant play session, the Carey Infant Temperament Scale (Carey, 1973), and the Product Use Questionnaire.

Videotaping was done with the mother sitting on a mattress on the floor with her infant propped up on a pillow facing her. A large mirror placed behind the infant's head allowed for a clear view of both the infant's face and the mother's face. Mothers were asked to play with their infants the way they would at home for about 15 min. They were asked not to use toys. In order to minimize distractions for the infant, the testing room walls were unadorned and the room was furnished with only a small testing table and chairs.

Three different analyses of the videotapes were undertaken. In each case, the first minute of the tape was dropped to allow the mother to adapt to the taping situation. The next 10 min were analyzed.

*Looking behavior.*—The tapes were coded for the direction of the infant's gaze in relation to the mother's face, according to the following system (Beebe & Gerstman, 1980):

60 = mother's and infant's faces lined up, eyes in contact,  
50 = mother's and infant's faces lined up, eyes not in contact,  
40 = infant looks at mother's hand or at some object she is holding,  
30 = infant partially averts his head from mother's face,  
20 = infant totally averts his head from mother's face,  
0 = uncodable.

Each second of the 10 min of tape was assigned a position code, producing a maximum of 600. The percentage of time the infant spent in each position was calculated. Scores on Looking At (60) and Looking Away (20) were compared.

*Vocalization.*—Analyses of the vocalization data were based on the methods of Bakeman and Brown (1977). As the 10 min of tape were played, an event recorder was used to record simultaneously whenever the mother or infant vocalized. One coder recorded maternal vocalizations and one recorded infant vocalizations. Each 2-sec interval was then assigned a code according to what occurred during that interval: M—mother vocalized alone, I—infant vocalized alone, C—both mother and infant vocalized, Q—neither mother nor infant vocalized. For each mother-infant pair, the percentage of time in each dyadic state was calculated to determine the amount of time that the mother vocalized alone (%M), the infant vocalized alone (%I), etc. As a reliability check, a systematic subsample of 10 tapes was recoded by two other coders. The mean percent agreement between the two sets of coders was 79 overall (M—92%, I—73%, C—75%, Q—75%).

A second analysis of the vocalization data was done to determine whether or not the experimental intervention affected the mothers' tendency to respond contingently to their infants' vocalizations. Through sequential analysis of the 2-sec intervals already coded, transitional probabilities were generated that denote the likelihood of one specific vocal event following another. These were averaged for each group separately to see whether the two groups differed on the transitional probabilities following an infant-alone (I) vocalization.

A measure of maternal vocal responsiveness, labeled Maternal Responsivity, was devised by adding together the proportion of mother-alone (M) following infant-alone (I) vocalizations, and co-acting (C) following infant-alone (I) vocalizations. There were some

mother-infant dyads for whom it was not possible to compute this measure because they did not have enough intervals of infant alone (2% or more) to be included.

*Global ratings.*—Crnic's system (Crnic, Ragozin, Greenberg, Robinson, & Basham, 1983), which involves rating maternal and infant affect on three 5-point scales, was used for the third analysis. Specifically, the scale that rates the mother's sensitivity to the baby's cues, state, and rhythm was used. For the purposes of the study, this was labeled the Maternal Sensitivity Scale. A graduate student in psychology who was blind to the mothers' group assignment rated all the tapes. In addition, two undergraduates rated 50% of the tapes. Intercoder reliability, using Cohen's weighted kappa, was .55 for agreements within 1 scale point.

#### *Assessment at 13 Months*

The final assessment consisted of three parts: the Ainsworth Strange Situation (Ainsworth et al., 1978), the Lifestyle Questionnaire II, and the Product Evaluation Questionnaire. The first of these, the Strange Situation procedure, was administered according to the guidelines in *Patterns of Attachment* (Ainsworth et al., 1978). This situation activates the infants' attachment systems by putting them through a series of separations from and reunions with their mothers and a stranger. The procedure was videotaped in a laboratory in the hospital. The average age of the infants at testing was 13.5 months.

The videotapes were scored using Ainsworth's global scoring technique by one of the authors (V.C.), who was blind to the group assignment of the mother-infant pairs. The scoring system assigns infants to one of three basic patterns of attachment based on their behavior throughout the Strange Situation, with particular emphasis on their behavior during the reunion episodes. The three patterns are: securely attached (labeled B), insecurely attached-avoidant (labeled A), and insecurely attached-resistant/ambivalent (labeled C). A reliability check with an experienced Strange Situation rater (Dr. E. Waters) on 10 of the tapes revealed a 90% agreement rate on major group (i.e., A, B, or C) assignments.

The Lifestyle Questionnaire II elicited information on various aspects of the dyad's life 1 year after the infant's birth. The points covered included the mother's work status, relation to significant other, perceived social support, current welfare status, as well as

household composition and the infant's sleep patterns.

The Product Evaluation Questionnaire asked mothers in each group to indicate the age of the infant when they stopped using the product and how frequently they had used it during the period when it was most useful. In addition, control mothers were asked whether they had used soft baby carriers (of any sort) and how much.

#### *Product Use*

*Experimental group.*—At 2 months, 86% of the experimental group mothers reported that their infants spent some time in soft baby carriers. At 13 months, in response to the question about how frequently the mothers had used the soft carrier during the time when it was most useful, the following results were obtained: daily, 48%; two to three times a week, 48%; less than two to three times a week, 4%. The average length of use was 8.5 months. The shortest period of use was 4 months. At 13 months, four mothers were still using the carrier.

Information from the pedometer readings, the Product Use Questionnaire (at several time points), and the Product Evaluation Questionnaire (at 13 months) was combined to categorize the experimental group mothers as high users (16) or moderate/low users (7). All the high users used the carrier every day during the time it was most useful to them or had a pedometer reading of over 9 miles at 3 months. One moderate user used the carrier every day (pedometer reading 3); the others used it only two or three times a week.

*Control group.*—At 2 months, 96% of the control infants spent some time during a typical day in the infant seat. At 13 months, the control mothers reported the following amounts of use during the time when the infant seat was most useful to them: daily, 72%; two to three times a week, 20%; less than two to three times a week, 8%. The average length of use was 5.3 months.

Another consideration concerning use of the product was the issue of cross-contamination. Our primary concern was the use of soft baby carriers by control mothers. Four control group mothers used a soft baby carrier. Most started to use it later than the experimental group mothers (e.g., at 2 months). Because of the randomized trial design, it was necessary to leave these mothers in the control group for the statistical analyses. (Three of the four infants were securely attached to their mothers.)

## Results

To confirm that the random assignment had resulted in similar groups, we compared the experimental and control groups on relevant variables. They were similar on all demographic characteristics except parity and ethnicity ( $p < .10$  by  $\chi^2$  analysis), the control group having more primiparous and more black dyads. No differences were found (using  $t$  tests and  $p < .25$ ) between the experimental and control groups in two analyses of the NBAS data, one a cluster analysis as per Lester, Als, and Brazelton (1982) and the other an analysis of the number of nonoptimal scores (Waters et al., 1980). No differences were found between the two groups on any factor of the Maternal Attitude Scale (Casper, 1985).

### Major Outcome Variables

A series of analyses was carried out to test for possible associations between each dependent/outcome measure and each of the following independent variables: sex, parity, ethnicity, household composition, mother's education, perceived social support, method of feeding, Maternal Attitude Scale, neonatal characteristics such as irritability (measured by the NBAS), and infant temperament at 3½ months. The subjects' scores on the independent variables were categorized for these analyses. Chi-square analysis was used for comparisons involving security of attachment, and  $t$  tests were used for Maternal Responsivity and Sensitivity. (All chi-squares were calculated with Yates's correction for continuity, when necessary.) Method of feeding (i.e., breast or bottle) was not related to Maternal Sensitivity or attachment (Cunningham, Anisfeld, Casper, & Nozyce, 1987), but showed a slight association with Maternal Responsivity ( $.20 > p > .10$ ).

Five variables (parity, ethnicity, household composition, Maternal Attitude Scale Factor 1 and Factor 3) were related to one or more of the dependent variables ( $p < .25$ ). They were therefore entered as covariates in two ANCOVAs (for Maternal Responsivity and Sensitivity) and in a logistic regression analysis (for attachment classification) to test the relation between treatment condition and the dependent variables.

*Security of attachment.*—There were significantly more securely attached (B) infants in the experimental group (83%) than in the control group (38%), according to logistic regression analysis. The regression coefficient was significantly different from zero ( $\beta = 1.93$ ,  $SE = .82$ ,  $Z = 2.35$ ,  $p = .019$ ) in a

model that included the five covariates. Because of small numbers in some of the cells, the two types of insecure attachment, insecure avoidant (A) and insecure resistant (C), were combined (Table 1).

To determine whether differences in product use within the experimental group were related to security of attachment, we compared high and moderate/low users. Fifteen of the 16 high users had infants who were securely attached. Of the seven moderate/low users, four were securely attached,  $\chi^2(1, N = 23) = 2.35$ , N.S.

Whether insecurity of attachment might be related to use of the infant seats was assessed by examination of the mean rank order assigned to the use of infant seats by control mothers whose infants became securely attached (mean = 2.9), insecure avoidant (mean = 3), and insecure resistant (mean = 4). This analysis indicates that less frequent infant seat use (i.e., higher rank) was associated with more insecure attachment.

*Maternal responsivity.*—The ANCOVA on the Maternal Responsivity score showed that the experimental group mean (.61) was significantly higher,  $F(1,31) = 6.57$ ,  $p < .02$ , than the control group mean (.44). Experimental mothers responded significantly more often within 2 sec of an infant-alone vocalization, either by vocalizing alone or by joining with the infant in vocalizing (i.e., co-acting), than did control mothers. For the control group, an infant vocalization was more likely to be followed by another infant vocalization or by quiet. It is known that infants interpret a response that follows within 2 sec of their own behavior as being contingent on their behavior (Millar, 1972). For this reason, it is argued that the experimental mothers were more contingently responsive than the control mothers to their infants' vocalizations (Nozyce, 1985).

In addition, experimental mothers were more likely to vocalize following quiet (Q) than were control mothers. In the control group, an interval of quiet was more likely to be followed by another interval of quiet. Thus, experimental mothers were more likely to initiate a vocal interchange following quiet and to respond to the infant's vocalization by joining in during the succeeding interval.

*Maternal sensitivity.*—Experimental mothers received higher ratings on the Maternal Sensitivity Scale at 3½ months than did control group mothers. However, this difference fell short of significance in the covariance

TABLE 1

DISTRIBUTION OF EXPERIMENTAL AND CONTROL INFANTS IN STRANGE SITUATION CATEGORIES AT 13 MONTHS

GROUP	THREE-WAY CLASSIFICATION					
	Secure (B)		Insecure-Avoidant (A)		Insecure-Resistant (C)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Experimental .....	19	83	3	13	1	4
Control .....	10	38.5	10	38.5	6	23
Total .....	29	59	13	27	7	14

  

GROUP	TWO-WAY CLASSIFICATION <sup>a</sup>			
	Secure (B)		Insecure (A & C)	
	<i>n</i>	%	<i>n</i>	%
Experimental .....	19	83	4	17
Control .....	10	38	16	62

<sup>a</sup>Z = 2.35, *p* = .019. Z is based on logistic regression analysis that included five variables (parity, ethnicity, household composition, Maternal Attitude Scale factors 1 and 3) in the model.

analysis: experimental group mean = 3.43, control group mean = 2.81,  $F(1,42) = 2.96$ , *p* = .09.

Of the various independent variables that were tested, only household composition was found to be significantly related to Maternal Responsivity and Maternal Sensitivity. Further analysis revealed that the overall effect was due to a significant relation within the control group: Maternal Responsivity,  $t(20) = 2.25$ , *p* < .05, and Maternal Sensitivity,  $t(24) = 2.73$ , *p* < .02. Within the experimental group, the association did not reach significance. Control group mothers who lived in extended families were more likely to respond contingently to their infants' vocalizations and to react sensitively to their infants during the 3½-month video than were mothers living in nuclear families, confirming previous findings (Chisholm, 1983; Konner, 1977; Munroe & Munroe, 1971).

#### *Relation between 3½-Month and 13-Month Measures*

To assess the association between maternal responsivity and sensitivity in the early months and subsequent security of attachment, the mean scores on the 3½-month measures (Maternal Responsivity and Maternal Sensitivity) for the secure and insecure dyads within each group were calculated. Because there were only four insecurely attached infants in the experimental group, no further analyses were done.

In the control group, a significant difference was found between the mean responsivity scores of the mothers whose infants later became securely or insecurely attached: secure group mean = .56, insecure group mean = .33,  $t(20) = 2.58$ , *p* < .02. Infants in the control group whose mothers were more vocally responsive to them at 3½ months were more likely to be securely attached to the mothers at 13 months. On Maternal Sensitivity, there was no significant difference between the control mothers whose infants were securely attached and insecurely attached: secure group mean = 3.00, insecure group mean = 2.50,  $t(24) = .93$ , N.S. Because of differences between this study and previous studies in the nature of the rating scale (5-point vs. 9-point, respectively), the basis for assigning the ratings (10-min video of play vs. extensive home observation, respectively), and the age at which the mother's sensitivity was rated in relation to the age at measurement of attachment (prospective vs. concurrent), no conclusions can be drawn from the present study about the relation of sensitivity to security of attachment.

The analyses up to this point indicate that the experimental mothers were more contingently responsive and their infants were more likely to be securely attached. Previous studies and results from the control group presented in the preceding paragraph indicate that maternal responsiveness is asso-

## 1624 Child Development

ciated with more secure attachment. To determine whether the differences in attachment between the groups were due solely to differences in Maternal Responsivity, a second logistic regression analysis was done, adding Maternal Responsivity to the model. The regression coefficient remained significantly different from zero ( $\beta = 2.02$ ,  $SE = 1.01$ ,  $Z = 2.00$ ,  $p = .045$ ), suggesting that the experimental treatment had an effect above and beyond that attributable to Maternal Responsivity.

### *Effects of Treatment on Other Outcome Measures*

Analyses of the play sessions videotaped at 3½ months showed that infants in the experimental group vocalized alone (*I*) significantly less than infants in the control group: experimental mean = 4.57%, control mean = 9.73%;  $t(47) = 2.95$ ,  $p < .01$ . Experimental infants scored above the median on Looking at Mother more frequently than did control infants,  $\chi^2(1, N = 49) = 4.65$ ,  $p < .05$ .

The ages of onset of social smiling as reported by the mothers at 2 months were compared. The experimental infants reportedly started to smile later (mean, 4.86 weeks) than the control infants (mean, 3.68 weeks),  $t(47) = 2.31$ ,  $p < .05$ . In addition, 52% of the control infants reportedly had a regular daily period of crying, whereas only 21% of experimental infants did so, yielding a  $\chi^2(1, N = 49)$  of 5.23,  $p < .05$ .

Carrying did not appear to have any effect on infant temperament as measured by the Carey Scale at 3½ months: there were four "difficult" infants in each group. In addition, there were no differences in early development between the two groups as measured by the Bayley Scale at 3½ months.

## Discussion

The results of this investigation support the hypothesis that increased physical contact achieved through the use of a soft baby carrier makes mothers more responsive to their infants and promotes the formation of more secure attachment between infant and mother at 13 months of age in a sample of low-income, inner-city mothers.

### *Maternal Behavior*

The finding that more experimental group mothers than control group mothers responded contingently to their infants' vocalizations at 3½ months cannot be explained by pre-existing differences between the groups. The effect of other possible contributing fac-

tors was controlled for in the analysis. Thus, the experimental condition, by promoting physical contact, appears to have made these mothers more contingently responsive to their infants.

There were many fewer avoidant (A) babies in the experimental group than in the control group (13% vs. 38.5%). Main and her colleagues (Ainsworth et al., 1978; Main, 1977; Main & Stadtman, 1981; Main & Weston, 1982) have shown that mothers of avoidant babies often have an aversion to physical contact and may even reject their infants' approaches. Based on their studies with motherless monkey mothers, Harlow and Suomi (Harlow & Suomi, 1971; Suomi, 1973) suggest that potentially negative, rejecting maternal behaviors can be modified by close body contact. In the present study, it appears that the process of carrying a baby in a soft carrier enabled some mothers who might have had an initial aversion to physical contact to overcome it and form healthy relationships with their babies. The physical contact inherent in carrying seems to have brought out latent nurturing behavior in the low-income mothers in our sample. Whether the same effect would be achieved in a lower-risk sample is a question for future studies.

### *Infant Behavior*

The major consequence of the carrying intervention was that, in comparison with the control infants, significantly more of the carried infants developed secure attachment relationships with their mothers. The distribution of secure versus insecure experimental group infants did not differ significantly,  $\chi^2(1, N = 46) = 1.80$ , N.S., from that found by Ainsworth (Ainsworth et al., 1978) among a middle-class sample. Thus, the experimental condition appears to have dramatically improved the chances of infants in this study population becoming securely attached to their mothers.

The relatively high percentage of avoidant classifications within the control group resembles data from other inner-city, low-SES populations (Crittenden, 1985; Egeland & Sroufe, 1981; Gaensbauer & Harmon, 1982; Lyons-Ruth, Connell, Grunebaum, Botein, & Zoll, 1984; Schneider-Rosen, Braunwald, Carlson, & Cicchetti, 1985; Waters et al., 1980). In such populations, neglectful care has recently been associated with avoidant attachments (Spieker & Booth, 1988). In our clinic population, we see neglectful care ranging from insensitive caregiving to maltreatment. The predominant problem seems to be

a lack of appropriate stimulation and a lack of attention to the infant's needs and wants. However, there were no reported cases of neglect or abuse in the study sample, which was followed closely by a hospital pediatric continuity practice.

The differences in attachment behavior shown by the experimental and control infants at 13 months can be traced back to earlier differences in behavior patterns influenced by the close body contact provided by the soft carrier. Bowlby suggested that vocalizing, smiling, and crying are social releasers that infants use in early months to promote proximity to their mothers. The carried infants in this study vocalized alone less and started to smile socially somewhat later than the control infants. Moreover, fewer of the carried infants had regular periods of crying at 2 months. It may be that the carried infants had less need to activate these behaviors than control infants because they were already in close proximity to their mothers. Several studies provide support for this interpretation. Anderson, Vietze, and Dorechi (1978), Jones and Moss (1971), and Lewis and Freedle (1973) reported that at 3 months of age infants vocalized more when they were further away from the mother and less when they were close (e.g., on the mother's lap). Anderson et al. (1978) concluded that "from Bowlby's perspective a decrease in infant vocalization would be expected when the young infant has the closest possible physical contact with the mother" (p. 388). Hunziker and Barr (1986), in a randomized trial of soft baby carriers, reported that carried infants cried significantly less at 6 weeks than did control infants.

Our finding that control infants spent less time looking at their mothers' faces than did experimental infants could be related to the fact that their mothers were generally less responsive. This interpretation is supported by the studies of Brackbill (1958) and Watson (1972), which showed that unresponsiveness to infant face-to-face behaviors can lead to fussing and gaze aversion on the part of the infant. An alternative interpretation is that the carried infants may have had less opportunity for direct en face interaction and therefore now sought it out and found it rewarding.

In conclusion, the present experimental study indicates a causal relation between physical contact, achieved through carrying an infant in a soft baby carrier, and security of attachment between mother and infant within the present sample of low-SES dyads. The different ecology of interaction promoted by

the experimental intervention affected the behaviors of both mother and infant. The mothers became more contingently responsive to their infants, and the infants were more likely to develop secure attachments to their mothers. The process of being carried close to the mother seems to have had an effect on the infant's security of attachment above and beyond that attributable to increased maternal responsivity as measured in this study.

By intervening at a sensitive time in a mother's emotional life, right after she has given birth, and encouraging her to carry her infant in a soft baby carrier, it may be possible to influence the pattern of her parenting and to promote a healthier mother-infant relationship. The process by which the physical contact leads to healthier relationships requires elucidation by further research. This might include exploration of the possible effects on mothers' working models of attachment and exploration of the possible channels through which carrying affects the infant directly. Confirmation of these findings with other SES populations and with larger samples will be necessary before we can conclude that increased physical contact between mother and infant is a major factor in creating secure attachment.

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## 1626 Child Development

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