Adrenocortical Responses to the Strange Situation in Infants with Disorganized/ Disoriented Attachment Relationships

Louise Hertsgaard, Megan Gunnar, Martha Farrell Erickson, and Melissa Nachmias

Institute of Child Development, University of Minnesota

HERTSGAARD, LOUISE; GUNNAR, MEGAN; ERICKSON, MARTHA FARRELL; and NACHMIAS, MELISSA. *Adrenocortical Responses to the Strange Situation to Infants with Disorganized/Disoriented Attachment Relationships.* CHILD DEVELOPMENT, 1995, **66**, 1100–1106. Salivary cortisol levels were assessed in 19-month-old infants following the Ainsworth Strange Situation procedure. 38 infants participating in Project STEEP at the University of Minnesota served as subjects. Project STEEP is a longitudinal intervention program designed to promote healthy parent-child relationships and to prevent emotional problems among children born to mothers who are at high risk for parenting problems. Following the Strange Situation, saliva samples were collected and assayed for cortisol, a steroid hormone frequently examined in studies of stress. Behavior during the Strange Situation was coded by trained coders, and attachment classifications were determined for each infant. Cortisol concentrations did not differ between the 6 Avoidant/Resistant (A/C) and 17 Securely Attached (B) toddlers. Toddlers (n = 11) who were classified as having Disorganized/Disoriented (Type D) attachments exhibited higher cortisol concentrations than toddlers in the traditional (ABC) classifications. Results of this study were consistent with a model of stress reactivity that conceptualizes the organization of coping behaviors as a factor that mediates physiological stress responses.

There is currently great interest in the Type D or Disorganized/Disoriented attachment pattern first described by Main and her colleagues (Main & Solomon, 1986). Infants classified as having Type D attachment relationships do not fit into the traditional A, B, and C attachment categories. Their behavior during the Ainsworth Strange Situation procedure (Ainsworth, Blehar, Waters, & Wall, 1978) is characterized by simultaneous displays of contradictory emotions, an appearance of confusion and apprehension, incomplete or undirected movements, depressed affect, and/or behavioral stilling (Main & Solomon, 1986, 1990). Both securely attached (B) and insecurely attached (A,C) infants are seen as possessing organized or coherent strategies for coping with the stress caused by the separations and reunions in the Strange Situation, although the secure pattern is expected to reflect a less stress-reactive mother-child relationship (Sroufe & Waters, 1977). Infants who are Disorganized/Disoriented (D) are seen as lacking such a coherent stragegy (Main & Solomon, 1990). Compared to securely attached (B) and even insecurely attached (A/C) attachment patterns, the disorganized (D) pattern should reflect greater vulnerability to stressful stimulation.

One way of examining stress vulnerability is to measure activity of stress-sensitive physiological systems. In several recent studies, researchers have measured cortisol, the hormone produced by the hypothalamic-pituitary-adrenocortical (HPA) system. There is a long history of assessment of this neuroendocrine system in research on stress (see Mason, 1968). As noted by Spangler and

Support for this research came from a National Institute of Health and Human Services Training Grant (HD07151-13) to Louise Hertsgaard, a National Institute of Child Health and Human Development Grant (HD16494) and Research Career Award (MH00946) to Megan Gunnar, and a National Institute for Mental Health research grant to Byron Egeland and Martha Erickson (MH41879). We would like to thank all those who participated in gathering and coding the data as well as those who collected saliva samples for all the subjects. Thanks are especially due to Diane Bearman, Kathy Johnston, Joyce Moon, Maureen O'Brien, John Ogawa, and Anne Hunter Roe. Correspondence concerning this article should be directed to Louise Hertsgaard, Institute of Child Development, University of Minnesota, 51 East River Road, Minneapolis, MN 55455.

[*Child Development*, 1995, **66**, 1100–1106. 0009-3920/95/6604-0005$01.00]

Grossmann (1993), measures of HPA activity may be particularly useful in attachment research because this neuroendocrine system is believed to be stimulated when coping behaviors are inadequate and/or coping resources are unavailable (Gunnar, Marvinney, Isensee, & Fisch, 1988). Thus, if the Type D, Disorganized/Disoriented classification reflects the lack of a coherent behavioral strategy for coping with stressors in the Strange Situation, cortisol levels following the Strange Situation should be higher for the Type D classified children than for children classified as securely (B) attached. To the extent that the traditional insecure classifications (A/C) reflect organized coping patterns, postsession cortisol levels of insecurely attached children should be lower than those of Type D disorganized children, although possibly higher than those of securely attached children who should possess the most effectively organized coping behavior patterns.

There have been only a few studies in which salivary cortisol concentrations have been assessed in relation to Strange Situation testing (Gunnar, Colton, & Stansbury, 1992; Gunnar, Mangelsdorf, Larson, & Hertsgaard, 1989; Spangler & Grossmann, 1993). Two of these studies have involved 12- and 13-month-old infants, while one has involved 18-month-old infants. All three studies over this age span yielded similar results. Because it takes 20 to 30 min for salivary concentrations of cortisol to peak in response to a stressor, one issue in this research has been when to take cortisol samples. Presumably, samples obtained 5 to 15 min after the end of the Strange Situation should reflect limbic-hypothalamic activity (i.e., the production of cortisol releasing hormone, CRH) *during* the Strange Situation. Samples of cortisol obtained 20 to 30 min after the end of the session, while continuing to reflect activity during the assessment (i.e., it takes time to clear cortisol from circulation), should also reflect limbic-hypothalamic activity following the final reunion. If reunion with the mother means termination of the stressfulness of the testing session, then cortisol concentrations should decrease gradually following the final reunion. Increasing levels of cortisol 20 to 30 min following the end of the Strange Situation would suggest continued or increased activity of the HPA axis. Increasing cortisol in response to reunion suggests that elements of the mother-infant relationship are stressful.

In all three of the studies in which cortisol was measured following Strange Situation testing, samples taken within the 5–15-min posttest window have failed to yield evidence of differences among infants with organized (Avoidant, Resistant, and Secure) attachment behavior patterns (Gunnar, Larson, Hertsgaard, Harris, & Brodersen, 1992; Gunnar et al., 1989; Spangler & Grossmann, 1993). These data are shown in Table 1. Although cortisol concentrations appear similar among the traditional classifications 5 to 15 min after the Strange Situation, Spangler and Grossmann (1993) have reported that by 30 min after testing, insecurely attached infants exhibit higher cortisol levels than do securely attached infants. Higher levels 30 min after the end of testing may reflect conflicts in the insecure dyads following the final Strange Situation reunion. Alternatively, or in addition, significantly lower cortisol levels among securely versus insecurely attached infants may be the result of pleasant reunion interactions lowering cortisol in securely attached dyads (see Gunnar, Gonzales, Goodlin, & Levine, 1981, for related findings in rhesus macaque infants).

The relation between Type D attachment and HPA reactivity has been examined in only one recent study (Spangler & Grossmann, 1993). In the same study described above, Spangler and Grossmann reported that at both 15 and 30 min following testing, infants in the disorganized classification had the highest mean cortisol levels, and, compared to the securely attached infants, the Type D infants exhibited greater increases in cortisol over baseline. While these results were consistent with the coping hypothesis suggesting that Type D classified children are highly vulnerable to stressful stimulation, they were based on a very small sample size. There were only seven Type D classified infants with cortisol data in the Spangler and Grossmann study.

The Spangler and Grossmann sample was drawn from a relatively low-risk population. Seventy-three percent of the sample were middle to upper middle class, and only 10% of the mothers were working outside of the home in part-time jobs by the child's first birthday. Type D attachments are expected to be most prevalent among infants who are at risk for poor parenting, or whose lives are characterized by a high degree of familial stress (Carlson, Cicchetti, Barnett, & Braunwald, 1989). In a higher-risk sample, one would expect to find a higher percentage of Type D attachments. Given the theoretical

TABLE 1

RELATIONS BETWEEN ATTACHMENT CLASSIFICATIONS AND SALIVARY CORTISOL CONCENTRATIONS OBTAINED 5 TO 15 MINUTES AFTER THE CONCLUSION OF THE STRANGE SITUATION IN SEVERAL STUDIES

Study	Securely Attached (B)	Insecurely Attached (A/C)
Gunnar et al., 1989	.61 μg/dl (SEM = .10) *N* = 30 Age = 13 months	.53 μg/dl (SEM = .13) *N* = 19 Age = 13 months
Gunnar et al., 1992[a]	.40 μg/dl (SEM = .06) *N* = 47 Age = 18 months	.45 μg/dl (SEM = .12) *N* = 24 Age = 18 months
Spangler & Grossmann, 1993	.46 μg/dl (SEM = .05) *N* = 18 Age = 12 months	.44 μg/dl (SEM = .08) *N* = 7 Age = 12 months

NOTE.—Gunnar et al. (1989) cortisol was obtained at 5 min, Gunnar et al. (1992) at 10 min, and Spangler and Grossmann (1993) at 15 min after the end of the Strange Situation.

[a] Gunnar, Colton, and Stansbury (1992).

importance of a linkage between Type D and stress-reactivity, replication of the Spangler and Grossmann (1993) findings in a sample with more Type D classified infants was deemed important. The sample used in the present study were drawn from STEEP, a preventive-intervention program for first time mothers living in poverty who were considered to be at risk for parenting problems. Replication of the Spangler and Grossmann (1993) Type D results in such a sample would establish both the reliability and the generalizability of the finding.

Method

Subjects.—The subjects were infants who were participants in project STEEP (Steps Toward Effective, Enjoyable Parenting; Egeland & Erickson, 1990). The STEEP program was designed to promote healthy parent-infant interaction among children of mothers who are at risk for parenting problems. The program began with home visits prior to the birth of the child and continued with home visits and group sessions until the infants were 1 year old. The quality of the mother-infant attachment relationship was assessed using the Strange Situation procedure (Ainsworth et al., 1978) at 13 and 19 months. The idea of taking cortisol measures came late in the 19-month testing, and cortisol data were collected only on the last third of the STEEP sample. The infants included in the present study were the last 40 infants seen for the Strange Situation assessment at 19 months (mean age = 19.3 months; range = 18.5 to 20.2 months). Of the 40 infants tested, 20 were white, 16 were African-American, 1 was identified as "other," and 3 did not provide information about race or ethnic background.

The Strange Situation is a cumulative stress paradigm consisting of seven 3-min episodes, including two separations and two reunions. All Strange Situations were videotaped at one location and subsequently coded for A (Anxious/Avoidant), B (Secure), and C (Anxious/Resistant) attachment classifications according to procedures described in Ainsworth et al. (1978). Coding of the D classifications followed the procedures described in Main and Solomon (1990). Infants scoring 1 through 4 on the D scales were classified as non-Disorganized (non-D), while those scoring 5 through 9 were classified as Disorganized (D). Coders for the A, B, and C attachment categories had all been trained by L. Alan Sroufe. Coders for the D classification had all been trained by Mary Main. Intercoder agreement was greater than 80%.

Mothers and infants arrived for testing sessions scheduled between 10:00 A.M. and 4:00 P.M. Because of the high-risk nature of the sample and the fact that cortisol assessment was an ancillary purpose of the overall study, control of time of day was not possible. The time of assessment was recorded, however, along with information on the infant's health, mood, feedings, whether or not they were on medication, and so on that might influence cortisol assessment. In this study, no pretest cortisol measures were taken. We were concerned that any alter-

ation of the procedures prior to the Strange Situation assessment might inadvertently alter the child's behavior during testing and thus the validity of the quality of attachment classifications. As attachment classification was a primary outcome measure for project STEEP, we in no way wanted to jeopardize its accurate assessment. Although we were concerned about not taking pretest cortisol measures, several facts reduced our concern. First, Spangler and Grossmann (1993) reported no significant differences in pretest cortisol for Type D versus Type A, B, and C classified infants. Second, in neither of the other studies done by our research group (Gunnar, Colton, & Stansbury, 1992; Gunnar et al., 1989) have significant differences in salivary cortisol been found among attachment groups when time of day and time since morning awakening have been statistically controlled.

Procedures.—Saliva was sampled for cortisol determination 30 min after the beginning of first separation episode (i.e., approximately 10 to 15 min after the end of the session). This time point was chosen for two reasons. First, it allowed adequate time for the response to the Strange Situation to be reflected in salivary cortisol concentrations. Second, it was soon enough after the end of the Strange Situation so that events occurring after the conclusion of testing would not yet be reflected in circulating cortisol levels.

To collect the saliva, the infants were encouraged to suck/chew on a 6-inch sterile cotton roll pretreated with several grains of sweetened Kool-Aid crystals. Saliva samples were stored frozen at −20° C until analysis. Cortisol was assayed in duplicate using a modification of the Amersham International Amerlex Cortisol radioimmunoassay kit (see Gunnar, Larson, Hertsgaard, Harris, & Brodersen, 1992, for assay description).

Final data analysis subject sample.—One subject did not produce enough saliva for accurate measurement. In addition, one subject was eliminated from the analysis because of symptoms of neurological disorder, and three had Type D classifications that were in dispute. These subjects were eliminated from the analysis. Of the 35 remaining subjects, 11 were classified as having a Disorganized/Disoriented attachment pattern. The 24 infants with non-Disorganized patterns were given traditional classifications as follows: Avoidant (A) $n = 5$, Secure (B) $n = 17$, Resistant (C) $n = 1$. One infant with a non-Disorganized attachment pattern had a traditional classification that was in dispute.

Results and Discussion

Because time of day could not be controlled, preliminary analyses were performed to determine whether time might be influencing cortisol differences among attachment groups. The results of several analyses indicated that this was unlikely. First, cortisol concentrations were not significantly correlated with time of day, $r(df = 33) = 0.006$, N.S. Second, there was no relation between the time of day and when infants with different attachment classifications were tested, $F(3, 33) = 0.53$, N.S. Thus, any differences in cortisol between attachment groups could not be due to time of day. Because cortisol has been shown to increase following the noontime meal, we also examined the correlation between cortisol and time since feeding and failed to find a significant association, $r(df = 30) = -.05$. Because the correlations for both time of day and time since feeding were so low and nonsignificant, neither of the variables was used as a covariate in subsequent analyses.

The hypothesis that disorganized attachment behavior patterns would be associated with higher cortisol concentrations was first examined by comparing infants classified as Type D or disorganized with those classified as non-Type D (i.e., traditional A, B, and C classifications; see Table 2). The Type D classified infants had significantly higher cortisol than the non-Type D infants, $F(1, 34) = 4.08$, $p = .05$. Because most of the non-Type D infants were securely attached, we were concerned that the difference might really be a secure versus insecure difference. To examine this possibility, we performed t tests contrasting the Type D infants with infants in each of the traditional, ABC classifications. In fact, the difference between the Type A and Type D classifications achieved significance, $t(12.86) = 2.57$, $p < .05$ (using t test with separate variance estimates), whereas the Type D versus Type B difference, although in the same direction, was not statistically significant, $t(17.79) = 1.51$, N.S. There were too few C infants to analyze the C versus D difference. The score for the one subject classified as C, however, was very close to the mean cortisol value for the D classified infants.

Next, we examined the comparability of our findings with postsession measures obtained by Spangler and Grossmann (see Fig.

TABLE 2

ATTACHMENT CLASSIFICATIONS AND SALIVARY CORTISOL IN μg/dl MEANS AND STANDARD ERRORS

ATTACHMENT CLASSIFICATION		
Disorganized	Non-Disorganized[a]	
n = 11	n = 24	
.45	.34	
(.06)	(.03)	
NON-D TRADITIONAL CLASSIFICATION		
Avoidant	Secure	Resistant
"A"	"B"	"C"
n = 5	n = 17	n = 1
.28	.34	.46
(.02)	(.03)	

NOTE.—Values expressed as μg/dl. Numbers in parentheses are standard errors.

[a] One subject was classified as non-D, but his ABC classification was in dispute. This explains the discrepancy in the sample size between the non-D group and the sum of the ABC groups.

1). In general, postsession cortisol levels in the present study were lower than those in the Spangler and Grossmann study. Differences in cortisol values would be expected given that different assay procedures were used and that the Spangler and Grossmann subjects were tested in the morning (8 to 12 A.M.), while many of the subjects in the present study were tested in the afternoon (12 to 4 P.M.). Cortisol follows a circadian rhythm and decreases in circulation over the daytime hours. Given these differences, the similarity in the patterns of postsession means was striking. A t test comparing secure (B) to insecure (A/C) toddlers did not achieve significance, $t(21) = .46$, N.S. Spangler and Grossmann (1993)[1] did report a significant difference for secure versus insecure attachment groups, but their analysis was based on differences between pre- and postsession cortisol levels.

Finally, to analyze further the relations between posttest cortisol and Type D attachment, we computed correlations between cortisol and the D ratings (scored 1–9). Higher D ratings were correlated with higher cortisol, $r(df = 33) = 0.38$, $p = .01$. These data are plotted in Figure 2. It should be noted that, although there is the suggestion of a curvilinear pattern in these data, there were really too few subjects with D ratings of 8 and 9 to examine curvilinearity.

The results of the present study provide strong support for the hypothesis that D or disorganized attachment behavior reflects a vulnerability to stressful stimulation, perhaps because of the lack of an organized set of attachment-related coping responses. The correlational nature of the study, however, does not allow us to rule out the possibility that this association reflects the impact of stress-reactivity on attachment behavior rather than the reverse direction of effect. Presumably, the question of direction of effect could be examined by conducting the Strange Situation following some other

[1] Spangler and Grossmann (1993) reported a trend ($p < .10$) for Avoidant/Resistant (A/C) infants to show greater cortisol elevations than Secure (B) infants averaging over data from the post-15- and post-30-min time points. However, their analysis was based on difference scores. Although pretest cortisol concentrations did not differ significantly, the mean for the secure infants was higher than that of the insecure infants (B = 0.46 vs. A/C = 0.36 μg/dl). By 15 min after the Strange Situation, the mean cortisol concentrations of the A/C infants had increased from 0.36 to 0.44 μg/dl, while the levels for the B infants remained close to their pretest values (i.e., 0.463 to 0.456 μg/dl). Given the (1) small sample size, (2) instability of delta scores, and (3) $p < .10$ level of effect, it is not clear whether these data reflect a reliable HPA stress response for the Avoidant and Resistant infants.

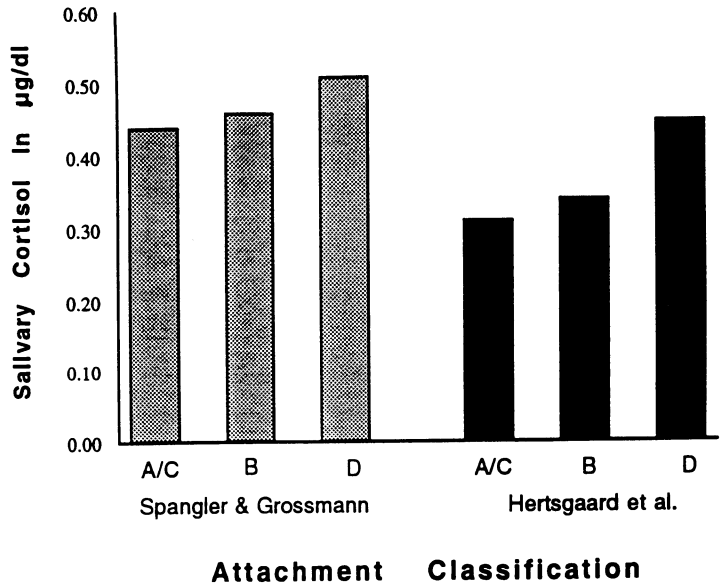

FIG. 1.—Strange situation salivary cortisol in µg/dl by attachment classification. Data on the left are from Spangler and Grossmann (1993), posttest 15 min, whereas data on the right are from the present study, posttest 10 min. *N*'s for the Spangler and Grossmann attachment groups were 6A/1C, 18B, and 7D; *N*'s for the present study were 5A/1C, 17B, and 11D.

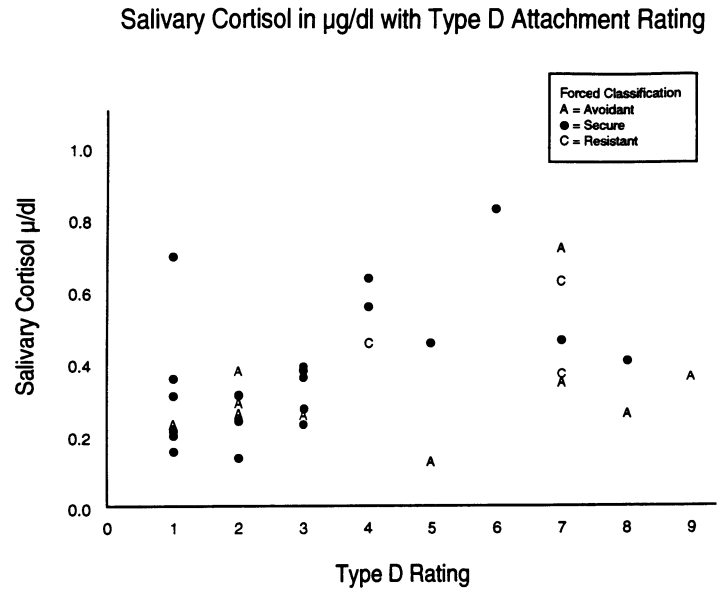

FIG. 2.—Salivary cortisol in µg/dl as a function of Type D attachment classification ratings. Infants scoring 5–9 were classified as Disorganized (D). The symbols represent the attachment classifications the infants would have been "forced" into had the D classification not been used.

stressful event to determine whether more infants would exhibit disorganized/disoriented Type-D behavior.

Regardless of the direction of effect, the vulnerability of this group of infants to stress may have significant effects on their emotional and social development. With regard to the HPA axis, it has been argued that chronic or frequent stress activation of this neuroendocrine system may play a role in the etiology of affective disorders, particularly depression (Gold, Goodwin, & Chrousos, 1988, 1988a, b). Cortisol is known to enter the brain and to have significant effects on neurons in the hypothalamus and hippocampus. Indeed, high levels of cortisol are known to stimulate hippocampal cell death (McEwen, Gould, & Sakai, 1992). Although the Strange Situation has been viewed as a stressful experience for infants, in fact, the stressors would seem relatively mild. In this assessment the children are confronted with only a few minutes (up to 9 min) of maternal separation and a strange adult female who comforts them if they become distressed. If Type D classified infants exhibit elevated cortisol to these seemingly mild stressors, one wonders what they experience during the course of their daily lives. The results of the present study, combined with those of Spangler and Grossmann (1993), suggest that relating attachment classification to HPA activity during children's daily activities would be an important area of inquiry.

References

Ainsworth, M. D. S., Blehar, M. C., Waters, E., & Wall, S. (1978). *Patterns of attachment: A psychological study of the Strange Situation.* Hillsdale, NJ: Erlbaum.

Carlson, V., Cicchetti, D., Barnett, D., & Braunwald, K. (1989). Disorganized/disoriented attachment relationships in maltreated infants. *Developmental Psychology,* **25,** 525–531.

Egeland, B., & Erickson, M. F. (1990). Rising above the past: Strategies for helping new mothers break the cycle of abuse and neglect. *Zero to Three,* **11**(2), 29–35.

Gold, P. W., Goodwin, F. K., & Chrousos, G. P. (1988a). Clinical and biochemical manifestations of depression (Part 1). *New England Journal of Medicine,* **319**(7), 348–353.

Gold, P. W., Goodwin, F. K., & Chrousos, G. P. (1988b). Clinical and biochemical manifestations of depression (Part 2). *New England Journal of Medicine,* **319**(7), 413–420.

Gunnar, M. R., Colton, M., & Stansbury, K. (1992, May). *Studies of emotional behavior, temperament, and adrenocortical activity in human infants.* Paper presented at the 8th International Conference on Infant Studies, Miami, Florida.

Gunnar, M. R., Gonzales, C., Goodlin, B., & Levine, S. (1981). Behavioral and pituitary-adrenal responses during a prolonged separation period in infant Rhesus macaques. *Psychoneuroendocrinology,* **6**(1), 65–75.

Gunnar, M. R., Larson, M. C., Hertsgaard, L., Harris, M. L., & Brodersen, L. (1992). The stressfulness of separation among nine-month-old infants: Effects of social context variables and infant temperament. *Child Development,* **63,** 290–303.

Gunnar, M. R., Mangelsdorf, S., Larson, M. C., & Hertsgaard, L. (1989). Attachment, temperament, and adrenocortical activity in infancy: A study of psychoendocrine regulation. *Developmental Psychology,* **25,** 355–363.

Gunnar, M. R., Marvinney, D., Isensee, J., & Fisch, R. O. (1988). Coping with uncertainty: New models of the relations between hormonal, behavioral, and cognitive processes. In D. Palermo (Ed.), *Coping with uncertainty: Biological, behavioral, and developmental perspectives* (pp. 101–130). Hillsdale, NJ: Erlbaum.

Main, M., & Solomon, J. (1986). Discovery of a disorganized/disoriented attachment pattern. In T. B. Brazelton & M. W. Yogman (Eds.), *Affective development in infancy* (pp. 95–124). Norwood, NJ: Ablex.

Main, M., & Solomon, J. (1990). Procedures for identifying infants as disorganized/disoriented during the Ainsworth Strange Situation. In M. Greenberg, D. Cicchetti, & M. Cummings (Eds.), *Attachment during the preschool years* (pp. 121–160). Chicago: University of Chicago Press.

Mason, J. W. (1968). A review of psychoendocrine research on the pituitary-adrenal cortical system. *Psychosomatic Medicine,* **30,** 576–608.

McEwen, B. S., Gould, E. A., & Sakai, R. R. (1992). The vulnerability of the hippocampus to protective and destructive effects of glucocorticoids in relation to stress. *British Journal of Psychiatry,* **160,** 18–24.

Spangler, G., & Grossmann, K. E. (1993). Biobehavioral organization in securely and insecurely attached infants. *Child Development,* **64,** 1439–1450.

Sroufe, L. A., & Waters, E. (1977). Attachment as an organizational construct. *Child Development,* **48,** 1184–1199.