Behavioral Inhibition and Stress Reactivity: The Moderating Role of Attachment Security

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Nachmias, Melissa; Gunnar, Megan; Mangelsdorf, Sarah; Parritz, Robin Hornik; and Buss, Kristin. Behavioral Inhibition and Stress Reactivity: The Moderating Role of Attachment Security. Child Development, 1996, 67, 508–522. The role of the mother-toddler attachment relationship in moderating the relations between behavioral inhibition and changes in salivary cortisol levels in response to novel events was examined in 77 18-month-olds. Behavioral inhibition was determined by observing toddler inhibition of approach to several novel events. Attachment security to mother was assessed using the Ainsworth Strange Situation. Changes in salivary cortisol were used to index activity of the stress-sensitive hypothalamic-pituitary-adrenocortical (HPA) system. In addition, toddler coping behaviors and the behaviors used by mothers to help toddlers manage novel events were examined. Elevations in cortisol were found only for inhibited toddlers in insecure attachment relationships. Mothers in these relationships appeared to interfere with their toddlers’ coping efforts. These results are discussed in the context of a coping model of the relations between temperament and stress reactivity.

The role of physiology in the development of temperament is receiving renewed attention (see Gunnar, 1990; Rothbart, 1989). Central to this interest is research and theory on the biological bases, correlates, and developmental sequelae of behavioral inhibition, defined as the tendency to restrain or restrict one’s approach to new people, events, and/or objects (Kagan & Snidman, 1991). Kagan and his colleagues have encouraged widespread interest in this construct through their longitudinal research on extremely inhibited and extremely uninhibited children (Kagan, Reznick, & Snidman, 1987). They argue that extremely inhibited children behave as they do because they have a lower threshold in the amygdala for the activation of stress-sensitive physiological systems in response to novel or strange events. Behaviorally inhibited children are thus described as more “stress reactive” (Kagan & Snidman, 1991).

Physiological stress reactivity involves activity of integrated neural and neuroendocrine systems. The neural systems are in part composed of the autonomic nervous system (both sympathetic and parasympathetic).

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The neuroendocrine component is in part composed of the hypothalamic-pituitary-adrenocortical (HPA) system, which secretes cortisol from the cortices of the adrenal glands. There is increasing evidence that behavioral inhibition is correlated with altered autonomic nervous system activity (Kagan & Snidman, 1991). However, there is mixed evidence regarding greater "stress reactivity" as indexed by activity of the HPA system. In their first cohort, Kagan, Reznick, and Snidman (1987) reported that at 5 years of age the extremely inhibited children had higher salivary cortisol levels than did their extremely uninhibited counterparts. However, this difference was not obtained at later ages, nor have they reported this difference for any other cohorts of children (Kagan, Reznick, Snidman, Gibbons, & Johnson, 1988). Furthermore, shyness or social inhibition in preschoolers is sometimes associated with less HPA reactivity than is boldness (Gunnar, 1994). In infants, increases in cortisol in response to separation have been found to correlate with the temperament dimension of distress-to-limitations and not fear-of-novelty (Gunnar, Larsson, Hertsgaard, Harris, & Brodersen, 1992). Given the centrality of the HPA system in research on stress and coping (e.g., Gunnar, 1986; Hennessy, Levine, 1979; Rose, 1980), a better understanding of the relations between behavioral inhibition and reactivity of the HPA system is warranted.

Not surprisingly, behavioral inhibition correlates with some measures of physiological reactivity and not with others (Gunnar, 1986). Dissociations are common in psychological studies. In part these dissociations stem from differential correlates of the cognitive-effort and emotional-distress components of reactions to stressful situations. Several research groups using factor analysis have demonstrated that psychobiological responses to threatening, stressful situations load on two relatively distinct factors (see Lundberg & Frankenhaus, 1980; Ursin, Baade, & Levine, 1978). The first, an effort factor, is significantly associated with vigilance, attention, and involvement; catecholamine activity and related cardiac measures load on this factor. The second, a distress factor, has high loadings for feelings of helplessness, loss of control, fear, and anxiety; cortisol loads highly on this factor.

Research on the HPA system has shown that the availability of coping resources and effective coping behavior play a major role in determining whether potentially threatening events stimulate elevations in cortisol over baseline values. Studies with adults and animals reveal that the ability to predict and control stimulation, along with the presence of supportive others, reduces the HPA response to a variety of stressors (see Stansbury & Gunnar, 1995, for review). Studies with human infants also reveal that the presence of a friendly, playful babysitter prevents increases in cortisol to half-hour maternal separations (Gunnar et al., 1992). In adults, Nicholson (1992) recently observed that problem-focused coping activity correlated with decreasing levels of cortisol during cognitively and emotionally challenging events, whereas emotion-focused coping correlated with increasing cortisol concentrations.

The role of coping in moderating relations between behavioral inhibition and physiological stress reactions has not been examined in research with children. Because young children do not cope with impending threat very well on their own (Compas, 1987), the availability and behavior of caregivers should play a decisive role with respect to children's stress reactions to novel, strange situations. This function of the caregiver may be especially important for the inhibited child, who may need more support than other children in new or strange situations. Quality of care as a potential moderator of children's physiological reactions to stressors has been relatively unexplored.

The present study was designed to examine aspects of a coping model of the relations between temperament and HPA activity as indexed by salivary cortisol (Gunnar, 1994). According to this model, inhibited children may perceive novel events as potentially threatening. The perception of potential threat, however, is not sufficient to produce increases in cortisol, although it might be sufficient to elicit vigilance, involvement and increased sympathetic activity (e.g., effort factor). In order to produce cortisol increases, the potential threat must be realized, or the child must expect that it will be realized. For this to happen, the child's coping resources must fail to protect her from threat. The security of the attachment relationship should influence whether the young child feels protected in the presence of the attachment figure, with securely attached infants feeling more protected from threat than avoidant and resistant infants (e.g., Ainsworth, Blehar, Waters, & Wall, 1978). Attachment security thus reflects one
aspect of children’s coping resources. The primary purpose of the present study was to test the following hypothesis: Behavioral inhibition in the face of novel, arousing events will be associated with elevations in cortisol only for children who are insecurely attached to their mothers. For children who are securely attached to their mothers, the presence of the attachment figure will prevent elevations in cortisol.

To adequately test this hypothesis, temperamental inhibit and attachment classification cannot be highly correlated. The relations between temperament and attachment have been debated for many years (e.g., Chess & Thomas, 1982; Kagan, 1984; Sroufe, 1985). Kagan (1984) has argued that avoidant, secure, and resistant attachment groups reflect temperamental responses to the Strange Situation assessment. Others suggest that inhibition and attachment are not overlapping constructs; they provide evidence of different temperamental types within the attachment classification groups (Belsky & Rovine, 1987; Thompson & Lamb, 1984). Calkins and Fox (1992) recently attempted to test Kagan’s hypothesis by examining both inhibition and attachment assessments in 14-month-olds. They found significant attachment group differences in inhibition. However, because they tested the infants on both inhibition and attachment during the same experimental session, it is possible that the children’s reactions to the inhibition testing affected their behavior in the Strange Situation. In the present study, behavioral inhibition and attachment security were assessed in two test sessions separated by at least 1 week to help insure independence of measurement.

We explored the role of the mother or attachment figure as a coping resource by contrasting periods of maternal noninvolvement (mother asked to sit quietly) with periods of maternal active involvement (mother asked to help). Behavioral inhibition was scored during maternal noninvolvement periods. This was done to approximate the major studies of inhibition (e.g., Calkins & Fox, 1992; Kagan et al., 1987). During maternal active involvement periods, several aspects of maternal and toddler behavior were of interest. First, we hypothesized that maternal behaviors that facilitated and supported the child’s control of the pace of interaction with the novel event would be correlated with low or decreasing levels of cortisol, whereas maternal behaviors that too intrusively attempted to focus the child on the novel event or that forced the child to approach the novel event would be associated with high or increasing levels of cortisol.

Second, with respect to attachment, we were interested in whether insecure attachment would be associated with (1) more attempts by mothers to get their children to attend to the novel stimuli in ways that might be considered intrusive (Isabella & Belsky, 1991), and/or (2) failure to respond to children’s needs for comforting and physical protection (Ainsworth et al., 1978). A finding that either or both maternal behaviors (i.e., forcing approach or low comfort giving) correlated with increasing levels of cortisol and insecure attachment would support a process explanation of the hypothesized role of attachment security in moderating relations between behavioral inhibition and HPA reactivity.

Finally, we were also interested in the types of behaviors used by the toddler to cope with novelty, and the relation between these behaviors and changes in cortisol levels. A number of recent studies of coping behaviors in young children document the rich and varied repertoire of both emotion- and problem-focused strategies available to toddlers (Band & Weisz, 1988; Hornik & Gunnar, 1987; Karraker & Lake, 1991; Kopp, 1989; Mangelsdorf, Shapiro, & Marzolf, 1995; Parritz, in press; Weinberg & Tronick, 1991). The study of coping behaviors overlaps with the study of emotion regulation (Kopp, 1989; Thompson, 1990), an aspect of development that has also been related to the security of the attachment relationship (Cassidy, 1994). Coping behaviors were scored during the mother-involvement periods because these periods of active caregiver behavior were considered more typical of normal coping contexts than the mother-noninvolvement periods.

To briefly summarize, the study’s major hypotheses were: (1) securely attached, inhibited children would not show elevations in cortisol to novel, arousing events, whereas insecurely attached, inhibited children would show such elevations; (2) maternal behavior that was unresponsive or that too vigorously encouraged/forced approach to the novel stimuli would be associated with cortisol elevations; and (3) vigorously encouraging and/or forcing the child to attend to the novel stimuli or failing to provide adequate comfort would be associated with insecure attachment relationships. The
study was also designed to allow examination of the relations between inhibition and attachment, and to explore the relations between child coping behaviors and HPA activity.

Method

Subjects

The participants were 78 18-month-olds (+/- 2 weeks; 38 girls, 40 boys) and their mothers, recruited from university subject files. Although not selected on this basis, all children were Caucasian. Mothers’ mean age was 32.6 years (range, 24-42), with 15.8 years of education (range, 12-21). Fathers’ mean age was 34.0 years (range, 25-51), with 16.4 years of education (range, 12-21). Approximately half of the children were firstborns. Over half (58%) were not in any form of day-care; 28% were in some form of nonparental care for less than 20 hours per week; 14% were in more than 20 hours of nonparental care per week. One subject pair was excluded because the mother failed to follow instructions, leaving 77 subject pairs.

Procedures

Mothers were contacted by phone, procedures were described, and two sessions were scheduled approximately 1 week apart at the same time in the morning to control for the circadian rhythm in cortisol.

Parent report of behavioral inhibition.—Mothers were mailed the Toddler Behavior Assessment Questionnaire (TBAQ; Goldsmith, 1987). Of interest was the Social Fear Scale, which indexes inhibition in new social situations. Mothers (N = 72) completed the questionnaire at home and brought it to the first test session.

Session 1: Cope Session.—This session was designed to examine child behavioral inhibition and both child and mother attempts to manage the child’s inhibition in response to novel, arousing stimuli. The stimuli were, in order (1) a live, boisterous clown who invited the child to play; (2) a noisy mechanical clown robot that flashed lights and moved around; and (3) two talking hand puppets that performed in a puppet theater and who invited the child to play. The entire session was videotaped using a wall-mounted camera.

Upon arrival, the mothers were given a brief overview of the session, while a saliva sample for cortisol (see below) was collected from the child. Mothers also completed a brief questionnaire that included demographic information and questions about the child’s sleep the night before, meals the morning of testing, mood, and duration of the car trip to the university. The mother and child were then given 5 min of free play in the 4 x 4.5 m testing room. Age-appropriate, attractive toys were provided during free play and remained available to the child for play (or distraction) during the stimulus presentation periods.

Following free play, the stimulus events were presented. Each presentation period lasted 6 min, with 3-min breaks between stimuli. Each stimulus presentation period was divided into equal “Mother Noninvolvement” and “Mother Involvement” portions. Children began the sessions on their mothers’ laps. As soon as the stimulus was presented, the mother was told that she should allow the child to leave her lap, but not to force the child to get down. During the 3-min Mother Noninvolvement periods, the mother was told to sit quietly. She was told that she could respond to child-initiated comments with very brief statements (e.g., “It’s ok,” “It’s a clown”), but otherwise she should remain quiet. This period was used to assess behavioral inhibition in a manner similar to that of Kagan and his colleagues (e.g., Garcia-Coll, Kagan, & Reznick, 1984). During the 3-min, Mother Involvement periods, the mothers were told that they could do whatever they wanted to help their children feel comfortable before the next stimulus presentation. If the mother asked whether we wanted the child to approach the stimuli, we told her to follow her child’s lead.

The selection of stimuli was based on pilot data and previous work (Garcia-Coll et al., 1984; Hornik & Gunnar, 1987; Fairrutz, in press). The toddlers experienced three stimuli in a set order: Adult Female Clown, Mechanical Robot, and Puppet Show. Each stimulus was present for 6 min. The stimuli each had a standard location between 3 and 4 m from the mother’s chair. A standard script was followed for both the Clown and Puppet Show; the Robot moved on a platform, changing direction intermittently.

Session 2: Strange Situation.—Approximately a week later (M = 9.2 days, SD = 6.4 days), the children and their mothers participated in the Strange Situation (Ainsworth & Wittig, 1969). To differentiate the sessions, the Strange Situation was performed in a different testing room. Furthermore, the testing staff for the Strange Situation dif-
ferred from the Cope Session staff. Finally, the saliva sample for cortisol, obtained when the mother and child arrived for testing, was taken in a waiting room area separate from the 4 × 4.5 m Strange Situation testing room.

The staff for the Strange Situation were trained by L. A. Sroufe’s research staff. The standard Strange Situation procedures were followed. The experimenter who took the saliva sample and instructed the mother was a different woman from the one who played the role of the stranger in the assessment. As in the Cope Session, the Strange Situation was videotaped using a wall-mounted camera.

Measures

Videotapes for the Cope Session were scored by two teams of coders blind to attachment classifications. Separate teams scored child and mother behavior to allow independent assessment. Because of the complexity of the coding scheme, both coders of each team scored each tape. Disagreements were conferenced. The videotapes for the Strange Situation were scored by a third team of coders who were blind to the behavior of the children during the Cope Session. None of the coders knew the results of the cortisol assays.

Cope Session: Mother Noninvolvement period.—The videotapes for the three, 3-min Mother Noninvolvement periods were scored every 15 sec for behaviors expected to index child inhibition and child distress. The measure of inhibition was labeled ease of approach, scored from 1 = active avoidance, child turns away from stimulus, avoids looking, may distract with other toys, to 5 = active, interactive engagement of the stimulus with no evidence of wariness or hesitancy. This measure was scored only during mother noninvolvement.

To distinguish inhibition from distress and attachment behavior, three other child behaviors were scored as occurrence/nonoccurrence during each 15-sec interval of each Mother Noninvolvement period. These were fussing, contacting mother (initiation of physical contact with mother or more intense contact—snuggles closer, clings harder), and self-stimulation (stylized, rhythmic, or repetitive manipulation of clothing or body).

Cope Session: Mother Involvement period.—In addition to the above behaviors, 11 other behaviors were scored for the child as occurrence/nonoccurrence within each 15-sec interval of the Mother Involvement periods. These behaviors were derived from previous studies of infant/toddler coping behaviors (Hornik & Gunnar, 1987, 1988; Karraker & Lake, 1991; Mangelsdorf et al., 1995; Parritz, in press). They were: social referencing (child looks between mother and stimulus with a questioning expression); inquisitive vocalization (child vocalizes with a questioning tone); affective sharing (child looks to mother and displays positive affect and may show mother object); labeling (child names or appears to name an object/event); self-distraction (child redirects attention away from stimulus to apparent distractor object—not scored if child was actively engaged in positive play with a toy given by the stimulus); contacting object (child strokes, sucks, or cuddles a toy apparently for self-soothing); proximity seeking to mother (child increases or actively maintains proximity to mother within one arm’s length while not at the same time engaging in affective sharing); resisting (child verbally or physically rejects an invitation or object from the stimulus or mother); tension release (child exhibits nervous laughter, giggling, wiggling); diverting mother’s attention (when mother is talking about or encouraging approach to the stimulus, child attempts to engage mother in some other aspect of the room—e.g., the lights, another toy); and leave-taking/escape (child goes to door, gives mother her purse, or otherwise tries to leave). For all of the child behaviors, the coder agreement before conferencing, based on 15% of the sample, ranged from 89% to 99%. Cohen’s kappas ranged from .63 to .94 (M = .81).

Codes for maternal behaviors were developed based on videotapes of five pilot subjects. Maternal behaviors were scored as occurrence/nonoccurrence every 15 sec. Seventeen behaviors were included in the analyses. They were: demonstration (mother models how to interact with the stimulus); explanation (mother provides a play-by-play description of what stimulus is doing); labeling (mother labels stimulus or parts of stimulus); giving object to child for stimulus (mother hands child object to give to clown or puppets); quizzing (mother asks child questions about the stimulus); verbal encouragement (mother says things like “you can do it”); cheering (mother claps hands, praises the child for accomplishments); verbal comforting (mother speaks in
soothing tones to child); *stroking/patting* (mother provides physical comforting, hugging); *visual checking* (mother intently monitors child's behavior, sometimes shifting her position to be able to see child better); *pushing child to stimulus* (mother physically pushes, pulls, or repositions her child closer to the stimulus); *redirecting child's attention* (mother prompts the child to look at the stimulus when child is looking elsewhere); *controlling environment/stimulus* (mother moves things around the room, turns the robot off or on); *giving child instructions* (mother insists, with a demanding tone of voice, that her child approach or interact with the stimulus); *exaggerated positive affect* (mother expresses her delight in the stimulus with exaggerated facial and vocal expressions); and *asking affective question* (mother asks child how she feels). In addition to these behaviors, maternal proximity to child and stimulus were scored on 5-point scales from 1 = across the room to 5 = within arm's reach every 15 sec.

Unfortunately, in attempts to rescore the videotapes for maternal behavior, one tape containing data on eight mother-child pairs was accidentally erased, leaving data on 69 mothers available for analysis. Coder agreement before conferencing calculated on 15% of the sample ranged from 90% to 99%. Cohen's kappas ranged from .71 to .92 ($M = .79$).

**Attachment security.**—Videotapes of the Strange Situation were coded following procedures described in Ainsworth et al. (1978). Tapes were coded by S. Mangelsdorf. Children were classified into the traditional Secure (B), Insecure-Avoidant (A), and Insecure-Resistant (C) classifications and the eight subdivisions (A1, A2, B1, B2, B3, B4, C1, and C2). For the purposes of interrater reliability, 15% of the tapes were also coded by a graduate student. Intercoder agreement was 100% for the major classifications (Cohen's kappa $= .75$ for subclassifications). Four of 77 subjects could not be classified and might have fit the criteria for "D," disorganized. However, the coders had not been trained to make that classification. Of the remaining 73 children, 13 (18%) were classified as (A) Insecure-Avoidant, 12 (16%) were classified as (C) Insecure-Resistant, and 48 (66%) were classified as (B) Secure.

**Salivary cortisol.**—Samples of saliva (100–200 µl) were obtained by having the children dip the tip of a 6-inch-long cotton dental roll into sweetened Kool-Aid crystals. The children then licked and sucked the kool-aid from the cotton roll. Once the tip of the roll was soaked with saliva, it was cut off and placed in a needless syringe. The clear saliva was expressed into a vial for storage at $-20^\circ$ C. Four samples were obtained from each child, one immediately before and one approximately 45 min after the beginning of each test session. Insufficient saliva (<100 µl) resulted in missing samples at each time point. The numbers missing, of 73 possible, were 13, 6, 4, and 2 for Cope pre- and postsession and Strange Situation pre- and postsession, respectively. The decreasing number of missing or insufficient samples suggests that the subjects improved at this task with experience. There were no relations between any of the grouping factors (sex, behavioral inhibition, or attachment classification) and missing salivary cortisol data.

Because of the basal rhythm in HPA activity, the timing of sampling was carefully controlled. Testing for both sessions began on average at 9:30 A.M. (SD = 45 min; range, 8:00 to 10:40 A.M.). The average within-subject time difference between the start of each session was 15 min (SD = 18 min). The time between pre- and postsamples was also similar at the two sessions, with means of 44 and 46 min for the two sessions, and standard deviations of 8 min.

To control for interassay variations, all samples from the same child were analyzed in the same assay run. Each assay batch was balanced for sex of child. The assays were performed to quality control standards using a variant of the Amersham Amerlex Cortisol kit. This is a radioimmune assay with inter- and intraassay coefficients of variation less than 6%. Saliva was sampled in duplicate, with the correlation among duplicates ranging from 0.93 to 0.99 across the batches of assays. Stable and reliable estimates of cortisol were obtained using these procedures. The two presession samples were correlated $r(54) = .44, p < .01$, as were the two postsession samples, $r(63) = .48, p < .01$, indicating that reliable estimates of the individual differences were obtained.

**Preliminary analyses.**—Four sets of preliminary analyses were conducted. First, sex differences were examined for all of the variables using $t$ tests. None of the tests achieved the .05 level of significance. Second, because experience may modify inhibition, parent reports of their children's experiences with clowns, robots, and puppets
were examined and were found not to vary by either inhibition or attachment classification. Third, variables that might influence HPA activity, such as sleep patterns, time since morning awakening, feeding, duration of car trip, and mood during car trip, were examined. Only time since morning awakening was associated with salivary cortisol, and then only with presession concentrations: Cope Session, \( r(57) = -0.31, p < 0.05 \), and Strange Situation, \( r(67) = -0.57, p < 0.01 \) (ns vary, as some parents did not complete the background questionnaire). Correlations with postsession cortisol were low and nonsignificant (\( r < -0.10 \), N.S.). To control for the circadian effect, presession measures were analyzed separately from postsession measures, and time since awakening was used as a covariate with the presession data.

Fourth, child and mother behaviors during the Mother Involvement period of the Cope Session were factor analyzed using principal components analyses in order to reduce the data. Three factor solutions were sought, and varimax rotation was used. The results, shown in Tables 1 and 2, yielded readily interpretable factors for both child and mother. For the children (Table 1), the first factor appeared to be a comfort-seeking factor (eigenvalue of 2.96; 21.2% of the variance); the second a coping-competence factor (eigenvalue of 2.2; 15.7% of the variance); and the third being a distraction factor (eigenvalue of 1.8; 8.8% of the variance). Both the comfort-seeking and distraction factors may be interpreted as emotion-focused coping, while the coping-competence factor may be interpreted as problem-focused coping (Karraker & Lake, 1991).

For the mothers (see Table 2), the first factor may be viewed as an encourage approach factor (eigenvalue of 3.3; 18.5% of the variance); the second as a comfort-giving factor (eigenvalue of 2.2; 12.3% of the variance); and the third as a demand approach factor (eigenvalue 2.04; 11.4% of the variance). As discussed, both encourage approach and demand approach were expected to be associated with elevations in cortisol as these behaviors, performed too vigorously, would force the inhibited child to interact with the arousing stimuli. Comfort giving, however, was expected to buffer the HPA response to these arousing, novel events. The factor scores for both the child and

TABLE 1

<table>
<thead>
<tr>
<th>Variables Loading on Child Summary Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor I, Comfort Seeking</td>
</tr>
<tr>
<td>.83 Proximity Mother</td>
</tr>
<tr>
<td>.85 Contact Mother</td>
</tr>
<tr>
<td>.70 Self-Stimulate</td>
</tr>
<tr>
<td>.60 Resistance</td>
</tr>
<tr>
<td>.48 Fuss at Mother</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Note.—Variables listed with scales based on \( \geq 0.40 \) loading. Percent of variance: Factor I = 21.2, Factor II = 15.7, Factor III = 8.8.

TABLE 2

<table>
<thead>
<tr>
<th>Variables Loading on Mother Summary Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor I, Encourage Approach</td>
</tr>
<tr>
<td>.51 Proximity to Child</td>
</tr>
<tr>
<td>.71 Proximity to Stimulus</td>
</tr>
<tr>
<td>.66 Demonstration</td>
</tr>
<tr>
<td>.66 Verbal Encouragement</td>
</tr>
<tr>
<td>.59 Explanation</td>
</tr>
<tr>
<td>.42 Quizzing</td>
</tr>
<tr>
<td>.40 Cheering</td>
</tr>
<tr>
<td>.47 Give Object to Child for Stimulus</td>
</tr>
</tbody>
</table>

Note.—Variables loading \( \geq 0.40 \) are listed. Percent variance: Factor I = 18.5, Factor II = 12.3, Factor III = 11.4.
mother behaviors were used in all subsequent analyses.

Results

Behavioral Inhibition and Attachment

The first set of analyses examined ease of approach as a potential measure of behavioral inhibition. Ease of approach was correlated across the three situations: clown, robot, and puppet show (rs [71] ranged from .25 to .33, ps < .05). To increase stability, the three measures were averaged. This average was reverse scored to yield an inhibition of approach measure that was correlated with the parents' reports of social fear on the TBAQ, r(70) = .33, p < .01.

The data were then examined to determine whether inhibition and attachment could be analyzed as independent factors. A one-way analysis of variance (ANOVA) indicated no significant difference in inhibition of approach between avoidant, resistant, and secure attachment groups (see Table 3). To further explore the relations between the inhibition of approach measure and attachment classification, three other measures obtained during the Mother Noninvolvement periods were also analyzed. These measures were chosen because they should also reflect fearfulness and might be related to attachment classification. They were: contact mother, self-stimulation, and fussing. Only fussing differed significantly by attachment group, with toddlers in the resistant (C) group fussing more (Newman-Keuls, p < .05) than toddlers in the other groups. Correlations were computed between these three behaviors and inhibition of approach. Fussing, which was associated with attachment classification, was not significantly correlated with inhibition of approach, r(71) = .14, N.S. Contact mother and self-stimulation, which did not differ by attachment classification, were correlated with inhibition of approach (rs [71] = .38 and .39, respectively, ps < .01).

Salivary Cortisol, Inhibition, and Attachment Security

The next set of analyses addressed the central hypothesis: Children scoring higher on behavioral inhibition would have higher postsession cortisol if they were also in insecure attachment relationships. To examine this hypothesis, we needed to rule out the possibility of group differences in presession cortisol levels. Because time since awakening was negatively correlated with presession cortisol, it was covaried in the presession analysis. A median split of inhibition of approach scores was used to create lower- and higher-inhibition groups. To increase power and because differences in cortisol were not predicted for avoidant and resistant groups, these two groups were combined. A 2 (attachment security: secure vs. insecure) × 2 (inhibition: lower vs. higher) × 2 (session: Cope vs. Strange Situation) multivariate analysis of covariance (MANCOVA) with repeated measures on the last factor, and time since awakening for each session as a covariate, was conducted. For the presession data, the regression effect of time since awakening was significant, F(1, 52) = 15.66, p < .001; however, no other main or interaction effects were significant. The means, adjusted for the covariate, are displayed in Figure 1.

### TABLE 3

**Means, Standard Errors, and Univariate F Statistics for Behavioral Inhibition and Other Measures of Fearfulness/Distress by Attachment Classification**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Avoidant (N = 13)</th>
<th>Resistant (N = 12)</th>
<th>Secure (N = 48)</th>
<th>F STATISTIC (df's = 2, 69)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral inhibition</td>
<td>3.41 (1.13)</td>
<td>3.42 (1.12)</td>
<td>3.51 (1.06)</td>
<td>.39</td>
</tr>
<tr>
<td>Intervals of contacting mother (%)</td>
<td>4 (2)</td>
<td>10 (4)</td>
<td>9 (2)</td>
<td>1.35</td>
</tr>
<tr>
<td>Intervals of self-stimulation (%)</td>
<td>46 (8)</td>
<td>46 (7)</td>
<td>46 (4)</td>
<td>.00</td>
</tr>
<tr>
<td>Intervals of fussing (%)</td>
<td>5 (2)</td>
<td>9 (3)</td>
<td>3 (2)</td>
<td>3.54*</td>
</tr>
</tbody>
</table>

* Data obtained during Mother Noninvolvement periods.

* Numbers in parentheses are standard errors.

* p < .05.
The postsession cortisol data were analyzed using the same analysis plan without the covariate. There was a significant effect of inhibition, $F(1, 62) = 14.29, p < .001$, qualified by an inhibition $\times$ attachment security interaction, $F(1, 62) = 4.07, p < .05$. There were no other main or interaction effects. Newman-Keuls tests indicated that insecure, higher-inhibition children had higher postsession cortisol levels than secure, higher-inhibition children.

To be certain that these analyses did not mask important differences between the two insecure attachment groups, the analyses were repeated, contrasting the avoidant and resistant groups. This analysis did not yield any significant effects. Because much of the work on behavioral inhibition has focused on extreme groups (e.g., Kagan et al., 1988), we examined whether the same pattern of results would be obtained for postsession cortisol if only the most inhibited (top 20%) and least inhibited (bottom 20%) of subjects were examined. The interaction of inhibition and attachment failed to achieve significance, $F(1, 21) = 1.9$, N.S.; however, the difference in means was in the same direction, being greater for insecurely attached infants (high- vs. low-inhibition groups differed by an average of 0.25 $\mu$g/dl) than for securely attached infants (high- vs. low-inhibition groups differed by an average of 0.06 $\mu$g/dl).
Child and Parent Behavior Factors

Next we examined the child and mother behaviors from the Cope Session. Children who were more inhibited in approach during the initial moments of testing sought more comfort from mother in the Mother Involvement portions of testing, $r(71) = .43$, $p < .01$. They also had mothers who encouraged them to approach the novel stimuli more, $r(67) = .27$, $p < .05$, and who comforted them more, $r(67) = .44$, $p < .01$. Using partial correlations controlling for inhibition of approach, we then examined the correlations between child and mother behavior factors. Only two significant associations emerged. Child comfort seeking was positively correlated with maternal comfort giving, $r(66) = .27, p < .001$, and competent child coping was negatively correlated with maternal demands for approach, $r(66) = -.35, p < .05$.

Using a design similar to that used for the cortisol data, with the three child and three mother behavior factors as dependent variables, a 2 (attachment security: secure vs. insecure) $\times$ 2 (inhibition: lower vs. higher) MANOVA yielded significant effects of attachment security, Hotelling's $F(6, 56) = 5.0, p < .001$, and inhibition, Hotelling's $F(6, 56) = 5.4, p < .001$. Follow-up univariate tests (see Table 4) indicated that securely attached toddlers scored higher on competent coping than did insecurely attached toddlers, and they had mothers who encouraged approach less. More inhibited toddlers sought comfort more than did less inhibited toddlers. Mothers of more inhibited toddlers encouraged them to approach the stimuli more and comforted them more than did mothers of less inhibited toddlers. The attachment $\times$ inhibition interaction effect did not achieve significance, Hotelling's $F(6, 56) = 1.4, p = .23$. An additional analysis comparing only avoidant and resistant toddlers failed to yield significant difference between these two insecure attachment groups.

Prediction of Cortisol Reactivity

Having explored how the child and mother behaviors were related to one another and to attachment and inhibition classifications, we then examined our ability to predict cortisol levels using these child and mother measures. Because cortisol levels were correlated across sessions as reported earlier, we created average presession and average postsession measures for use in the following analyses.

A hierarchical regression equation was constructed, entering inhibition of approach followed by the three child factors (I, II, III) and then the three mother factors (I, II, and III). In the analysis of presession cortisol, time since awakening (averaged over the two test sessions) was entered in a block with inhibition of approach to control for its influence. The $R^2$ change was examined for significance at each step in these equations (see Table 5).

For presession cortisol, only the first block, consisting of time since awakening

<table>
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<td>CHILD AND MOTHER FACTOR SCORES BY ATTACHMENT AND INHIBITION GROUPS</td>
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<td>FACTORS</td>
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<td></td>
</tr>
<tr>
<td>Child:</td>
</tr>
<tr>
<td>Comfort seeking</td>
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<td>(12)*</td>
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<tr>
<td>Coping competence</td>
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<td>(.17)</td>
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<td>Distraction</td>
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<tr>
<td>Mother:</td>
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<td>Encourage approach</td>
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<td>(.23)</td>
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<td>Comfort giving</td>
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* Numbers in parentheses are standard errors of the mean.

*p < .05.

**p < .01.
and inhibition of approach, contributed significantly to the equation. For postsession cortisol, inhibition of approach contributed strongly to the equation. Once the variance associated with this measure was explained, competent child coping was still significantly and negatively related to postsession cortisol levels. Furthermore, once the variance related to all child measures was explained, maternal behavior still made significant contributions to predicting child HPA activity. Mothers who encouraged approach more and gave more comfort had toddlers with higher postsession cortisol.

Discussion

The results supported the prediction that attachment security would moderate the effect of inhibited temperament on the activity of the HPA system. These data also suggested processes whereby maternal behavior in insecure attachment relationships may be stimulating increased levels of cortisol. Finally, they provided evidence that inhibition of approach is unrelated to attachment security. This latter finding will be discussed first because it was a necessary condition for analysis of the core prediction.

Kagan (1984) has argued that the behaviors of infants in avoidant, resistant, and secure attachment groups reflect temperamental responses to the Strange Situation. He has suggested that resistant attachment reflects high inhibition, whereas avoidant attachment reflects low inhibition. Work by Calkins and Fox (1992) appeared to confirm Kagan’s hypothesis; results of the present study provided evidence that temperament and attachment security are distinct constructs (Sroufe, 1985). There are at least two reasons why our results may have differed from those of Calkins and Fox. First, as noted earlier, in the Calkins and Fox study, the infants were tested for behavioral inhibition immediately prior to testing in the Strange Situation. In the present study, these test sessions were separated by at least 1 week. In Calkins and Fox, inhibition testing may have stimulated more resistant behavior in infants who would not otherwise have appeared to be resistantly attached ("C").

There is also a second explanation that may generalize beyond the differences in the study protocols. Measures of temperamental inhibition have often included fussing and crying, thus blending irritability with inhibited temperament (e.g., Calkins & Fox, 1992; Kagan et al., 1988). In their meta-analysis, Goldsmith and Alansky (1987) demonstrated that irritability was a dimension of child behavior that differentiated infants in resistant from those in secure relationships. Irritability was also the dimension of behavior that Belsky and Rovine (1987) and Thompson and Lamb (1984) found to differentiate avoidant and B1/B2 secure groups from resistant and B3/B4 secure groups. The logic for including fussing and crying in the operational definition of behavioral inhibition is that these behaviors may
reflect more intense inhibition. However, as demonstrated in the present analysis, fussing and inhibition may be uncorrelated dimensions of behavior, at least under conditions in which wariness (and not outright fear) is elicited. Nonetheless, because toddlers in insecure resistant attachment relationships fuss more than other toddlers, including fussing in operational definitions of inhibited temperament tends to blend this temperament dimension with insecure resistant attachment.

The core issue in the present study was the role of attachment security in moderating stress responses of the HPA system in more inhibited children. Security of attachment was viewed as summarizing a history of responsive, sensitive caregiving that provided the securely attached infant with the resources to reduce activation of the HPA system, even though the child’s temperament might bias him or her to experience novel events as “potentially” threatening. Elevations in cortisol were expected to require both the anticipation of potential threat, represented by the children’s inhibition of approach, and the lack of sufficient coping resources, represented by the presence of an attachment figure with whom the child had an insecure relationship. It should be noted that the attachment relationship does not encompass the sum total of the toddlers’ coping resources; nonetheless, it is a salient component (see Compas, 1987).

The results yielded strong support for this model. Elevations in cortisol were noted only in the group of insecurely attached, more highly inhibited toddlers. There have now been several independent replications of this finding. Spangler and Schiecke (1994) reported that elevations in cortisol to the Strange Situation were significant only for infants scoring above the median on social fear who were also in insecure attachment relationships. Scholmerich (1994) reported the same finding using a laboratory assessment of behavioral inhibition.

Although more inhibited, insecurely attached toddlers did have higher postsession cortisol than did the other children, mean postsession levels were between 0.60 and 0.70 μg/dl. These levels reflected about a 50%–70% increase over presession concentrations. The import of these higher levels must be interpreted within the context of what is known about responsiveness of the HPA system, as measured using salivary cortisol, during the second year of life. There is now growing evidence that cortisol undergoes significant decreases in reactivity over the first 2 years. Although the neonatal adrenocortical system can be stimulated to produce increased cortisol levels to perturbations as seemingly mild as a physical exam (Gunnar, 1989), several studies have now shown that responsivity to stressors (e.g., inoculations) decreases markedly between 2 and 6 months, and this low reactivity continues into the second year of life (Gunnar, Brodersen, Krueger, & Rigatuso, in press; Lewis & Ramsey, 1995). Separation also becomes less effective at eliciting increases in cortisol over this time. Whereas at 9 months, small increases in cortisol can be obtained following 30 min of maternal separation (Larson, Gunnar, & Hertzgaard, 1991), by 13 months, 30 min of separation no longer effectively stimulate cortisol increases (Gunnar & Nelson, 1994). Thus, between 6 and approximately 18 months of age, the infant's HPA system as measured by cortisol appears to be relatively nonresponsive to many of the events that previously functioned as mild to moderate stressors. Viewed in this light, the postsession levels of cortisol for the more inhibited, insecurely attached toddlers are revealed as atypical for children of this age.

The results also inform our understanding of the processes by which mother-child interaction in insecure relationships fails to prevent elevations in cortisol for more inhibited toddlers. According to the coping model outlined earlier, linkages between inhibition and elevations in cortisol should be modified by the coping resources available to the child. Those resources include the child’s behavior and the behavior of caregivers. Behavioral inhibition itself is a coping behavior. By inhibiting approach, the child regulates contact with potentially threatening events. Inhibiting approach should reduce the likelihood of increased levels of cortisol among fearful children. However, in order for this to occur, the threatening stimuli cannot force themselves upon the child, and the caregivers cannot place excessive demands on the child to engage the novel events. Mothers in the present study varied greatly in how much they attempted to get their toddlers to engage the events. As predicted, too insistent an emphasis on approach was associated with insecure attachment and higher postsession levels of cortisol. It is unlikely that encouraging approach, per se, was stressful for the children. Rather, an overemphasis on approach may
have been intrusive, disrupting the toddler’s efforts to regulate proximity and contact with the arousing stimuli.

Unexpectedly, comfort giving was also associated with higher posttest levels of cortisol. Providing comfort was expected to reduce the toddlers’ cortisol response to novelty. However, the positive association with postsession cortisol was noted after the variance associated with the children’s comfort seeking was accounted for in the regression analysis. The association, therefore, may reflect the impact of intrusive comfort giving (beyond the amount sought by the child) on children’s cortisol activity.

Despite the general consistency of these results with the predictions, several caveats are warranted. First, because these are correlational data, the direction of effects could be interpreted differently. As children were not randomly assigned to attachment or inhibition groups, we cannot rule out the possibility that reactivity of the HPA system predisposed children to a combination of inhibited behavior and insecure attachment. Similarly, it is possible that children who engaged in less competent coping elicited intrusive maternal attempts to comfort them and encourage interest in the stimuli. Second, we do not know what would happen if more extremely inhibited children had been the focus of this study. Indeed, it would be useful to have data on the role of the mother in moderating physiological responses to stressful stimulation in extremely inhibited children.

To summarize, the results of the present study provided evidence that more inhibited 18-month-olds growing up in insecure attachment relationships may be at greater risk for experiencing elevated cortisol levels in situations that elicit inhibition. Although these elevations were small, they were atypical for children of this age. Elevations in cortisol for these children appeared to derive from overzealous and/or intrusive attempts by mothers to have their children remain calm and interact with novel stimuli. This kind of intrusive maternal behavior may be activating the HPA system because it interferes with the inhibited child’s coping strategy of avoiding novel stimulation and/or only gradually approaching such events. Overall, these results suggest that the physiological impact of inhibited temperament cannot adequately be understood without an appreciation of the coping resources and coping behaviors available to the child.

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522 Child Development


