



ACADEMIC  
PRESS

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

SCIENCE @ DIRECT®

Hormones and Behavior 43 (2003) 237–244

Hormones  
and Behavior

[www.elsevier.com/locate/yhbeh](http://www.elsevier.com/locate/yhbeh)

## The hormonal costs of subtle forms of infant maltreatment

Daphne Blunt Bugental,\* Gabriela A. Martorell,<sup>1</sup> and Veronica Barraza

*Department of Psychology, University of California, Santa Barbara, Santa Barbara, CA 93106, USA*

Received 1 March 2002; accepted 10 September 2002

### Abstract

We show here that subtle forms of maltreatment during infancy (below 1 year of age) have potential consequences for the functioning of the child's adrenocortical response system. Infants who received frequent corporal punishment (e.g., spanking) showed high hormonal reactivity to stress (a repeated separation from mother, combined with the presence of a stranger). In addition, infants who experienced frequent emotional withdrawal by their mothers (either as a result of maternal depression, or mother's strategic use of withdrawal as a control tactic) showed elevated baseline levels of cortisol. It was suggested that there are hormonal "costs" when mothers show response patterns (intentionally or unintentionally) that limit their utility as a means of buffering the child against stress. The hormonal responses shown by infants may alter the functioning of the hypothalamic–pituitary–adrenal (HPA) axis in ways that, if continued, may foster risk for immune disorders, sensitization to later stress, cognitive deficits, and social–emotional problems.

© 2003 Elsevier Science (USA). All rights reserved.

It has been convincingly established that maltreatment has negative consequences for the long-term cognitive and social–emotional welfare of children (Margolin and Gordis, 2000). Traditionally, such consequences have been interpreted as due to interference with the child's ability to learn adaptive response patterns. More recently, we have come to consider the possibility that such experiences may produce their effects partially as a function of changes in the functioning of the hypothalamic–pituitary–adrenal (HPA) axis and associated deficits in brain development (Bremner and Narayan, 1998; Glaser, 2000).

Little is known, however, about the hormonal effects of parental responses that occur frequently but are not traditionally viewed as abusive. The two examples we study here are (1) maternal use of spanking and (2) maternal emotional unavailability/unresponsiveness. In this report, we assessed variations in the child's production of a stress-related hormone (cortisol) in children as a function of these more subtle types of maltreatment in the first year of life.

### Animal models

Relevant animal models have focused on the effects of early stress on the functioning of the HPA axis, along with associated changes in the brain. Although some of this literature has been concerned with the effects of nonsocial stress (e.g., prenatal noise), much research has been concerned with the effects of maternal responses to the young. At the most extreme level, early research demonstrated the long-term social and emotional deficits found in rhesus monkeys as a result of maternal absence (e.g., Suomi et al., 1973). On a short-term basis, rat pups separated from their mothers show declines in their level of calling but show continued distress in terms of elevated cortisol levels (Levine et al., 1993). Another line of work with rats has shown the ways in which maternal behavior serves to buffer the young against the effects of stress—thus enhancing their capacity to cope with future stress. Beginning with the work of Levine (1957), and followed with the work of Meaney and his colleagues (e.g., Meaney et al., 1985; Francis et al., 1999), it has been shown that maternal behavior among rats (extensive licking and grooming) following stressful experience of pups (e.g., handling by a human) served to enhance their capacity to more easily habituate to future stress (i.e.,

\* Corresponding author. Fax: +1-805-893-4303.

E-mail address: [bugental@psych.ucsb.edu](mailto:bugental@psych.ucsb.edu) (D.B. Bugental).

<sup>1</sup> Gabriela Martorell is now at Portland State University.

show decreasing levels of adrenal cortisol release in response to repeated stress). The general finding within this research is that maternal factors are critical for the regulation of the young animal's developing HPA system and their adaptive response to stress (Levine, 2001).

In animal work (in rats, often as replicated with monkeys), experimental work demonstrated that the high level of glucocorticoids that follows induced early stress leads to maladaptive changes in the functioning of the HPA axis (McEwen et al., 1992; Sapolsky, 1996). Although elevated cortisol release is an adaptive response to stress in the short term, it can have negative consequences over the long term (Sapolsky, 1996). For example, elevated levels of glucocorticoids have been found to lead to loss of neurons in the hippocampus (Uno et al., 1990) and decreases in dendritic branching (e.g., Watanabe et al., 1992).

### Early stress among humans

When extreme stress occurs early in the life of humans, the effects observed mirror those found among animals; that is, there are stress-induced changes in the hippocampus that follow dysregulation of the HPA axis. For example, children who experienced physical or sexual abuse—and subsequently experienced post-traumatic stress disorder—have been found to demonstrate reductions in the volume of the hippocampus and associated deficits in short-term memory. Such deficits are significantly related to the levels of abuse experienced (Bremner and Narayan, 1998). In addition, hippocampal atrophy following early trauma is associated with such psychiatric disorders as major depression (Stein et al., 1997). Trauma later in life has not been found to produce equivalent effects.

A history of maltreatment (a history that usually includes physical abuse) has often been found to be associated with reduced basal levels of cortisol and/or reduced adrenocortical reactivity (e.g., Cicchetti and Rogosch, 2001a; Hart et al., 1995). However, there is also evidence that the long-term effects of maltreatment may follow a different course for different children. In some instances, for example, maltreatment may lead to elevated levels of cortisol production—elevations that are in turn associated with internalizing disorders of childhood (Cicchetti and Rogosch, 2001b). At the most general level, early maltreatment is associated with disruptions in the functioning of the HPA axis—both in terms of basal activity and stress reactivity.

### Effects of maternal harshness or unavailability early in life of humans

In this paper, we consider the effects of two maternal response patterns that carry the potential for stress in infancy. The first involves maternal use of corporal punish-

ment during infancy. Use of corporal punishment is common among parents in the U.S. (Holden et al., 1999), in particular during early childhood (Straus and Stewart, 1999). By age 1, 15 to 37% of infants in the U.S. have been spanked or slapped (Holden et al., 2002; Straus and Stewart, 1999). Although spanking at older ages has been found to have negative consequences for children's later social behavior (e.g., Strassberg et al., 1994), little is known about its effects during infancy. Past research on the hormonal consequences of parenting tactics has focused on children's responses to physical maltreatment (as summarized by Cicchetti and Rogosch, 2001b), not on responses to nonabusive corporal punishment.

The second maternal response we study involves social-emotional unavailability. Unavailability may result from maternal depression, a response pattern in which the mother unintentionally withdraws attention from the child. Unavailability may also involve maternal withdrawal as an intentional control strategy (as reported by the mother). In both cases, mothers are emotionally unavailable to the child. Although the initial cause of the two patterns differs, the net effects may be similar. In both cases, the mother is unresponsive to the child's attention bids. Maternal unresponsiveness has been shown to interfere with the child's formation of secure attachment bonds (e.g., Crockenberg, 1981; Goldberg et al., 1994). In these circumstances, children are less likely to be buffered against the effects of stress. For example, children who are insecurely attached to their mothers have higher levels of cortisol production in response to stress (Gunnar et al., 1996; Spangler and Schieche, 1998).

Most of our knowledge about the effects of maternal emotional unavailability derives from observations of families that include a depressed mother. Field (1986, 1994) has argued that maternal depression often serves to prevent the infant from developing the ability to engage in effective emotion regulation. Even the mother's temporary appearance of apparent depression ("still face") serves to elicit matched responses, as well as physiological signs of distress (e.g., increased heart rate) on the part of the child (Weinberg and Tronick, 1996). When the mother is clinically depressed over a period of time, children may show physiological changes (e.g., changes in cortisol levels), accompanied by disruption of their social and emotion regulation capacities (Field, 1994). Although maternal depression occurs without intent (and has no necessary implications for child problems), it increases the likelihood of emotional neglect.

When maternal withdrawal is employed as a control strategy, it may be thought of as involving "psychological or emotional maltreatment" (Larrance and Twentyman, 1983). That is, it is consistent with the definition of emotional or psychological maltreatment as "any parental tactic that can have damaging emotional consequences for the child" (McGee and Wolfe, 1991; Nesbit, 1991). Although there has been extensive research on the effects of maternal unresponsiveness, little is known about the effects that follow when

such unresponsiveness is used as an intentional control tactic.

## Design of study

In this investigation, we addressed two central questions: (1) What are the effects of maternal use of corporal punishment and social–emotional unavailability on children’s baseline levels of cortisol production? (2) What are the effects of these two maternal patterns on children’s hormonal reactivity to stress? In measuring children’s response to stress, we selected the Strange Situation (Ainsworth et al., 1978)—a situation that involves repeated separations and re-unions with the mother, combined with the periodic presence of a stranger.

## Method and materials

### Research participants

Forty-four mothers of toddlers were recruited from a sample of women who had been identified during pregnancy as at risk for future child maltreatment (on the basis of such risk factors as low education, lack of social support, high stress, and mothers’ own history of abuse as children). The mean years of maternal education was 9.82 years,  $SD = 8.84$ . The mean age of mothers was 26.61 years ( $SD = 6.65$ ). Eighty-nine percent of the families were Latino (50% of children born in Santa Barbara are Latino); the remaining families were either Anglo or of mixed ethnicity. Thirty percent of the families included only a mother. The child sample included 23 boys and 21 girls (mean age = 17.56 months,  $SD = 4.74$ ).

As our sample was drawn from a low SES environment, it included children who were at more than usual risk for stress in their everyday lives. As demonstrated by Lupien et al. (2001), this may be expected to lead to relatively high salivary cortisol levels (in comparison with levels shown by higher SES children). Lupien et al. demonstrated that this pattern was particularly likely to be true in the years preceding the child’s transition from family to school. As a compounding factor, mothers in the low SES sample were also found by Lupien et al. to show higher levels of depression than did mothers in the high SES sample.

### Measures

#### Conflict tactics scale (CTS)<sup>2</sup>

The CTS (Straus, 1979) asks parents to report on the tactics they use in response to conflict with their children.

The CTS was used to provide information on (1) frequency of legally nonabusive use of physical force, (2) frequency of physical abuse, and (3) reported frequency of strategic emotional withdrawal (physical withdrawal or not talking to the child as a means of managing conflict). The CTS items used to create the strategic emotional withdrawal scale were drawn from the existing “verbal abuse” scale of the CTS; all other items from the verbal abuse scale involve active verbal abuse (e.g., saying something spiteful).

The CTS asks for the frequency of occurrence of different ways of responding to family conflict. Reliability coefficients are 0.62 for the use of violent tactics and 0.77 for verbal abuse (Straus and Gelles, 1990). “Violent” CTS items were divided into those that have been defined as physically abusive (e.g., hitting with a fist or object, beating up, kicking, biting) or those that involve nonabusive use of force (e.g., spanking or slapping). As spanking and slapping were the predominant examples of nonabusive use of force, we refer to “spanking/slapping” in describing these tactics. Within this sample, 18% of mothers reported engaging in at least one act of physical abuse, 34% reported using non-abusive force, and 50% reported engaging in emotional withdrawal as a conflict tactic.

#### Beck depression inventory

The Beck Depression Inventory (BDI) is a well-researched instrument that provides a 21-item assessment of depressive symptoms. Coefficient alphas assessing internal consistency range from 0.73 to 0.92. Correlations between the BDI and clinical ratings of depression range from 0.55 to 0.73 (Beck, Steer, and Garbin, 1988).

#### Creation of composite scales

Physically coercive tactics (abusive or nonabusive), as assessed by the CTS, were combined to create a “harsh parenting” score. This term will be used in describing any use of physical force. Frequency of abusive and nonabusive use of physical force (as based upon maternal report) were moderately related ( $r = 0.47$ ,  $P < 0.001$ ).

Scores on the BDI and strategic withdrawal items of the CTS were combined to create a composite “emotional unavailability” score.<sup>3</sup> A reasonably strong relationship was found between BDI and strategic withdrawal scores ( $r = 0.53$ ,  $P < 0.01$ ). A moderate relationship was found between “harsh parenting” scores and “emotional unavailability” scores ( $r = 0.43$ ,  $P < 0.01$ ).

#### Adult cortisol production

Baseline levels of cortisol were obtained on all mothers. These measures were taken in order to determine the relationship between the cortisol levels of mothers and children.

<sup>2</sup> As Spanish was the primary language of most participants, all instruments were translated (and back-translated) into Spanish by a native Spanish speaker. In addition, instruments were also available on audiotape, for use by parents who had limited reading skills.

<sup>3</sup> When combining the two scales (BDI and “emotional withdrawal” items of the CTS) to create an “intensity” score, both scores were converted to z-scores. If one of the two scores was missing, a z-score of 0 was substituted for the missing value.

Saliva samples (minimum of 400  $\mu\text{l}$ ) were always taken midmorning to minimize circadian variation. Samples were obtained by asking the mother to spit into a small paper cup (after the experimenter had left the room) but in the presence of her child (used as a means of “normalizing” collection of saliva before efforts were made to obtain samples from the child). As a means of stimulating saliva flow, mothers were given sugarless gum to chew in advance of providing a sample. Saliva samples were pipetted into cryogenic vials. Assay procedures were the same as those used with children (described later).

#### *Toddler behavior assessment questionnaire*

Mothers completed the Toddler Behavior Assessment Questionnaire (TBAQ; Goldsmith, 1996). The TBAQ includes scales that assess infant activity level, anger, pleasingness, and fearfulness. High scores on activity and anger and low scores on pleasingness are combined to create a child “difficulty” score. Children’s composite “difficulty” scores and “fearfulness” scores were included as child variables that might be related to the production of stress hormones.

#### *Child health history*

Children’s health history was measured primarily through the use of an interview that queried children’s frequency of illnesses during the first year of life (as described in Bugental et al., 2002). Good interjudge agreement was found between parents ( $r = 0.76$ ) in their independent ratings of infants’ health history. In addition, infant birth records were obtained to determine children’s level of prematurity.

#### *Children’s cortisol production*

A sterile 6-in. cotton dental roll was used for saliva collection. The tip of the cotton roll was lightly dusted with Kool-Aid crystals (cherry flavor), and was placed in the child’s mouth. The amount of Kool-Aid crystals did not exceed 1/16th of a teaspoon. The child was encouraged to chew on the roll until it was saturated with saliva and no visible crystals remained on the surface of the roll. If the child was reluctant to comply, the help of the mother was enlisted. The minimum volume of saliva was 200  $\mu\text{l}$  for conducting assays in duplicate. Although concern has been expressed about the use of Kool-Aid due to the possibility of artificial elevation in cortisol levels (Schwartz et al., 1998), this does not appear to pose a problem here in that (1) we used very small quantities of Kool-Aid and (2) the mean cortisol level was very low ( $M = 0.10 \mu\text{g}/\text{dl}$ ) and thus is unlikely to be inflated. Saturated cotton rolls were placed into a needleless syringe and saliva was expressed into a cryogenic vial.

Saliva samples were stored (in sealed vials) at  $-20^\circ\text{C}$ . On the day of assay, samples were thawed and centrifuged at 2400 RPM for 30 min to separate mucins. Cortisol was measured using a commercially available radioimmunoas-

say (RIA) kit (Diagnostic Products Corp., Los Angeles, CA), modified for detection of the hormone in saliva. Specifically, standards were diluted by a factor of 10 in order to measure the lower concentration of cortisol in saliva rather than blood. Furthermore, an additional standard ( $0.03 \mu\text{g}/\text{dl}$ ) was added in order to increase the sensitivity of the assay for cortisol levels at the lower end of the standard curve.

Saliva samples were assayed in duplicate (and averaged to create the scores used in analyses). All samples from the same research participants were run in the same assay. Assay sensitivity was  $0.03 \mu\text{g}/\text{dl}$ . Values from one research participant were eliminated as improbable ( $6.61 \mu\text{g}/\text{dl}$ ). Cortisol concentrations that were greater than 3 SDs above the mean were eliminated as outliers (there was one such case). The average intra- and interassay coefficients of variation were 9.7 and 7.5%.

#### *Procedure*

Initial measures (BDI, CTS, and Child Health History) were obtained from mothers when their child reached one year of age. Subsequently, mothers and children visited the lab some time during the child’s second year. The TBAQ was completed by mothers during this visit.

Initial saliva samples were taken from children and mothers 40 min following arrival (following an unstructured interaction with their children). These samples were then employed as a means of assessing children’s baseline (pre-separation) cortisol levels.<sup>4</sup> They were then taken to an adjoining room where children were exposed to the Strange Situation (Ainsworth et al., 1978), a well-known stressor. The Strange Situation involves a sequence of events that includes the introduction of a stranger, an initial departure of the mother while the stranger is present, and the subsequent departure of the mother with no one else present with the child. The sequence also involves an initial reunion following the mother’s first departure, and a second reunion following the mother’s second departure.

A second saliva sample was taken 20 min following the conclusion of the Strange Situation (a delay of 15–20 min is expected between stimulus events and cortisol changes in the saliva). Elevation in cortisol level was used as an indicator of hormonal reactivity to stress.

---

<sup>4</sup> It needs to be recognized that these initial differences may have reflected children’s reactions to their mothers during this initial interaction; past work has suggested that children’s cortisol levels may show small increases during their interaction with less sensitive mothers (Spangler et al., 1998). As children had been interacting with their mothers during a long car ride (approximately 1 h) preceding their arrival at the lab, this interaction represented a continuation of their normative experiences (children in the sample were cared for at home and had few separations from mothers).

## Results and discussion

### *Child and maternal characteristics as potential sources of influence on cortisol production*

Initial analyses were conducted to determine whether any significant relationships were present between maternal characteristics (age, education, marital status, baseline cortisol levels) or child characteristics (temperament, age, gender, health status, prematurity) and children's baseline levels of cortisol or their reactivity to stress (i.e., elevations in cortisol levels following separation from the mother in a novel setting). Children's baseline cortisol levels were covaried in determining the relationship between cortisol reactivity and other measures. As only one of these effects (infant's preterm status) reached significance, it was concluded that demographic effects and history do not pose viable competing explanations for effects observed as a function of parenting variables (maternal harshness or unavailability).

### *Mean levels of cortisol production*

A preliminary analysis was conducted to determine whether children's production of cortisol was influenced by the simple presence or absence (as opposed to intensity) of maternal harshness or unavailability. Differences were tested in mixed-design ANOVAs that included maternal response patterns (presence or absence of any reported instances of harsh parenting, presence or absence of maternal unavailability<sup>5</sup>) as a between-subjects factor and time (pre-post measures of cortisol) as a within-subjects factor. No significant effects or trends were found for maternal harshness. For maternal unavailability, the only effect that approached significance was a main effect for maternal unavailability,  $F(1, 35) = 3.15$ ,  $p = 0.08$ . Children of "unavailable" mothers produced higher levels of cortisol across time ( $M = 0.13 \mu\text{g/dl}$ ,  $SD = 0.11$ ) than did children of "available" mothers ( $M = 0.08 \mu\text{g/dl}$ ,  $SD = 0.06$ ).

### *Intensity of maternal responses and children's baseline cortisol levels*

A multiple regression analysis was conducted to determine the relationship between maternal variables as predictors of children's baseline level of cortisol production. Due to the skewed distribution of harsh parenting scores, scores were converted to log transformations of frequency scores. As can be seen in Table 1, only the mother's emotional withdrawal served as a significant predictor of children's basal cortisol levels.

Table 1

Maternal responses as predictors of children's baseline cortisol levels: a regression analysis

	<i>B</i>	<i>SE(B)</i>	Beta	<i>T</i>	Sig. <i>T</i>
Harsh parenting	1.05	3.69	0.04	0.29	ns
Emotional unavailability	5.75	1.51	0.53	3.81	<0.001

Follow-up analyses were conducted to determine the independent relationship between the two components of emotional unavailability and children's baseline level of cortisol production. Significant correlations were found between strategic emotional withdrawal, as measured by the CTS, and children's cortisol levels ( $r = 0.37$ ,  $P < 0.01$ ), as well as between mothers' BDI scores and children's cortisol levels ( $r = 0.57$ ,  $p < 0.001$ ). Power analyses (one-tailed tests) reveal that the observed effects for strategic withdrawal are "medium" (power = 0.51) and the observed effects for maternal depression are "large" (power = 0.94) for maternal depression. Therefore, it appears that significant effects occurred as a result of either intentional or unintentional emotional unavailability on the part of mothers. However, effects were stronger for maternal depression.

In short, higher baseline levels of cortisol were shown by children whose mothers showed a high level of emotional unavailability—either as an intentional tactic or as a side effect of her own depressed state. Elevated baseline levels of cortisol may be thought of as reflecting children's characteristic levels of HPA activity. Hypercortisolism at later ages has been found to be associated with internalizing problems (Cicchetti and Rogosch, 2001b). If mothers are emotionally unavailable to their children, they limit their utility as a buffer against the infant's demands of everyday life. In the short term, however, it may be that children's elevated production of cortisol represents an adaptive way of coping with unbuffered stress.

Although it is possible that early differences in children's temperament patterns or early health history may foster differences in maternal response, this would not seem likely in this case. That is, children's temperament patterns and health history were not found to be associated with their patterns of cortisol production. It is more probable that the observed pattern of hypercortisolism occurred in reaction to the mother's unavailability. It may be that such children are generally vigilant as a result of the emotional absence of their mothers.

### *Intensity of maternal responses and children's levels of cortisol reactivity*

A hierarchical regression analysis was conducted to determine the relationship between intensity of harsh parenting, intensity of maternal unavailability, and children's hormonal reactivity to stress (i.e., their levels of cortisol

<sup>5</sup> The "presence" or "absence" of unavailability was defined in terms of the presence or absence of any instances of a mother's use of withdrawal as a control tactic, or maternal depression levels that exceeded median values on the BDI.

Table 2  
Maternal responses as predictors of children's production of cortisol in response to stress: a hierarchical regression analysis

	<i>B</i>	SE( <i>B</i> )	Beta	<i>T</i>	Sig. <i>T</i>
Step 1					
Child's baseline cortisol	0.76	0.11	0.75	6.70	<0.001
Step 2					
Harsh parenting	8.70	3.40	0.30	2.56	<0.001
Emotional unavailability	-0.23	1.59	-0.02	-0.14	ns

production following repeated separation from their mother, combined with the presence of a stranger). In order to control for individual variability between children, the effects of baseline levels of cortisol production were covaried. This analysis strategy allows an assessment of the relationship between parenting responses and children's hormonal response to stress in a manner that cannot be accounted for by initial differences between children. This approach is typically viewed as more defensible than a change score approach (differences between pre- and post-measures) when there is a substantially positive relationship between pre- and postmeasures (the correlation found here was 0.72). That is, this approach allows an appropriate control for initial values and is typically more sensitive than the change score approach (Russell, 1990).

Children's baseline level of cortisol was entered at Step 1, and the two maternal variables were entered at Step 2. Postinduction cortisol levels constituted the dependent variable. As can be seen in Table 2, only the mother's use of harsh parenting tactics served as a significant predictor of children's increases in cortisol levels. In a secondary analysis, child prematurity (the only child variable found to be significantly related to cortisol reactivity) was introduced as a covariate; the observed effect of harsh parenting was unchanged.

A follow-up analysis was conducted to determine the differential hormonal reactions shown to maternal spanking/slapping versus physical abuse. When baseline levels of cortisol were statistically controlled, frequency of spanking/slapping served as a significant predictor of postseparation cortisol levels (partial  $r = 0.53$ ,  $P = 0.001$ ); no equivalent effect was found for frequency of physical abuse (partial  $r = 0.20$ , ns). A power analysis (one-tailed test) for the spanking/slapping data reveals a "strong" effect (power = 0.87). The weaker effects found for abuse may have reflected range restriction on this variable.

These findings suggest that very early use of corporal punishment fosters heightened stress when the child is confronted with a novel and potentially frightening event—in this case, the presence of a stranger following the departure of the parent. Children's hormonal reactivity in this setting may be seen as reflecting their vulnerability to unexpected, challenging, or novel life events. When mothers make use of physically punitive tactics at an age when children are as yet unable to regulate their behavior effectively, children

appear to become more susceptible to the effects of stressful events. To the extent that elevated levels of reactivity continue, reductions in the child's ability to cope with future stress may be anticipated.

As a competing explanation of these findings, it may be that some infants initially show HPA hyperreactivity—thus posing a more difficult stimulus to parents. As a result, they may be more likely to be targeted for harsh control tactics. Although this explanation cannot be ruled out, it is seen as less tenable due to the fact that no relationship was found here between mothers' perceptions of the child's temperament and children's HPA reactivity.

### Limitations

Our findings are limited in a number of ways. The sample is limited in size and biased in composition. At the same time, the biased nature of the composition (maternal childhood history of maltreatment, and high levels of environmental stress) may actually have provided a particularly useful window, in that adrenocortical reactivity of the young was observed in a population that was particularly likely to have experienced early stress. Such stress would be expected as a combined function of the family's environment (poverty, combined with low education and lack of facility in the dominant language) and the elevated prevalence of child maltreatment within this group. Nonetheless, replication is needed with other populations.

As an additional limitation, the average levels and changes in cortisol levels were low; thus, there was little true manifestation of hyperadrenocortical reactivity. Children only showed clear reactivity to stress when they had experienced very high levels of maternal harshness. This range restriction provides a second reason why replication of findings is needed.

### Summary and implications

Infants' hormonal responses were shown here to be reactive to subtle forms of parental maltreatment. Mothers who were emotionally unavailable (either due to depression or their use of withdrawal as a control tactic) were more likely to have children who demonstrated higher baseline levels of cortisol. Mothers who reported using physically harsh discipline were more likely to have children who were hyperreactive to stress.

When very young children experience hypercortisolism and/or hyperreactivity to stress, there are maladaptive changes in physiological systems designed to manage stress, for example, the HPA axis. Granger et al. (1994) have demonstrated the presence of individual differences in the HPA reactivity of very young children to social challenge. Our findings suggest one possible source of such variation. When exposed to repeated stress early in life, children may come to experience "allostatic load" (McEwen and Seeman, 2000). That is, they may experience maladapt-

tive wear and tear on their physiological response systems that are activated in response to stress. As a result, children are less able to habituate to new events, or to regulate their own emotional reactions in adaptive ways. In the best circumstances, parents allow children to confront such events in ways that facilitate recovery and “growth”; that is, young children become increasingly able to cope with an expanding world when they are socially supported by their parents in their response and recovery from stress-inducing events within that world.

The mother’s emotional unavailability or use of corporal punishment when children are very young carries a risk of later “costs.” In future research, it will be important to determine if the disruptions in normative functioning of the HPA axis—as observed here—go on to mediate these same negative care-giving outcomes at later ages. In other research (Bugental et al., 2002), we have shown that the kinds of adverse parenting responses shown here decline when “at risk” parents are the beneficiaries of home visitation early in the child’s life. The long-term gains would be expected to include the child’s recovery of more normative functioning of the HPA axis.

## Acknowledgments

We express our appreciation to David Beaulieu, who assisted in conducting the hormonal assays reported here. Portions of this research were conducted as part of the doctoral dissertation completed by Gabriela Martorell. This research was supported by NIMH Grant 5 R01 MH19095 and NSF Grant BNS 9021221.

## References

- Ainsworth, M., Blehar, M., Waters, E., Wall, S., 1978. *Patterns of Attachment: a psychological study of the strange situation*. Erlbaum, Hillsdale, NJ.
- Beck, A.T., Steer, R.A., Garbin, M.G., 1988. Psychometric properties of the Beck Depression Inventory. *Clin. Psychol. Rev.* 8, 77–100.
- Bremner, J., Narayan, M., 1998. The effects of stress on memory and the hippocampus throughout the life cycle: implications for childhood development and aging. *Dev. Psychopath.* 10, 871–885.
- Bugental, D.B., Ellerson, P.C., Lin, E.K., Rainey, B., Kokotovic A., O’Hara N., 2002. A cognitive approach to child abuse prevention. *J. Fam. Psychol.* 16, 243–258.
- Cicchetti, D., Rogosch, F.A., 2001a. Diverse patterns of neuroendocrine activity in maltreated children. *Dev. Psychopath.* 13, 677–693.
- Cicchetti, D., Rogosch, F.A., 2001b. The impact of child maltreatment and psychopathology on neuroendocrine functioning. *Dev. Psychopath.* 13, 783–804.
- Crockenberg, S.B., 1981. Infant irritability, mother responsiveness, and social support influences on the security of infant–mother attachment. *Child Dev.* 52, 857–865.
- Field, T., 1994. The effects of mother’s physical and emotional unavailability on emotion regulation. *Monogr. Soc. Res. Child Dev.* 59 (2–3), 208–227, 250–283.
- Field, T., 1986. Models for reactive and chronic depression in infancy. *New Dir. Child Dev.* 34, 47–60.
- Francis, D., Diorio, J., Liu, D., Meaney, M.J., 1999. Nongenomic transmission across generations of maternal behavior and responses of the rat. *Science* 286, 1155–1158.
- Glaser, D., 2000. Child abuse and neglect and the brain—A review. *Child Psychol. Psychiatry Allied Disciplines* 41, 97–116.
- Goldberg, S., MacKay-Soroka, S., Rochester, M., 1994. Affect, attachment, and maternal responsiveness. *Infant Behav. Dev.* 17, 335–339.
- Goldsmith, H.H., 1996. Studying temperament via construction of the Toddler Behavior Assessment Questionnaire. *Child Dev.* 67, 218–235.
- Granger, D.A., Stansbury, K., Henker, B., 1994. Preschoolers’ behavioral and neuroendocrine responses to social challenge. *Merrill-Palmer Q.* 40, 20–41.
- Gunnar, M.R., Brodersen, L., Nachmias, M., Buss, K., Rigatuso, J., 1996. Stress reactivity and attachment security. *Dev. Psychobiol.* 29, 192–204.
- Hart, J., Gunnar, M., Cicchetti, D., 1995. Altered neuroendocrine activity in maltreated children related to depression. *Dev. Psychopath.* 8, 201–214.
- Holden, G.W., Buck, M.J., and Stickels, A.M. (2002). A four-year longitudinal study of the onset of disciplinary practices. Manuscript in preparation. University of Texas, Austin.
- Holden, G.W., Miller, P.C., Harris, S.D., 1999. The instrumental side of corporal punishment: parents’ reported practices and outcome expectancies. *J. Marriage Fam.* 61, 908–919.
- Larance, D.T., Twentyman, C.T., 1983. Maternal attributions and child abuse. *J. Abnorm. Psychol.* 92, 449–457.
- Levine, S., 1957. Infantile experience and resistance to physiological stress. *Science* 126, 405.
- Levine, S., 2001. Primary social relationships influence the development of the hypothalamic–pituitary–adrenal axis in the rat. *Physiol. Behav.* 13, 255–260.
- Levine, S., Wiener, S.G., Coe, C.L., 1993. Temporal and social factors influencing behavioral and hormonal responses to separation in mother and infant squirrel monkeys. *Psychoneuroendocrinology* 18, 297–306.
- Lupien, S.J., King, S., Meaney, M.J., McEwen, B.S., 2001. Can poverty get under your skin? Basal cortisol levels and cognitive function in children from low and high socioeconomic levels. *Dev. Psychopath.* 13, 653–676.
- Margolin, G., Gordis, E.B., 2000. The effects of family and community violence on children. *Annu. Rev. Psychol.* 51, 445–479.
- McEwen, B.S., Angulo, J., Cameron, H., Chao, H.M., Daniels, D., Gannon, M.N., Gould, E., Mendelson, S., Sakai, R., Spencer, R., Woolley, C., 1992. Paradoxical effects of adrenal steroids on the brain: protection versus degeneration. *Biol. Psychiatry* 31, 177–199.
- McEwen, B.S., Seeman, T., 2000. Allostasis and allostatic load: implications for neuropsychopharmacology. *Neuropsychopharmacology* 22, 108–124.
- McGee, R.A., Wolfe, D.A., 1991. Psychological maltreatment: toward an operational definition. *Dev. Psychopath.* 3, 3–18.
- Meaney, M.J., Aitken, D.H., Bodnoff, S.R., Iny, L.J., Tatarewicz, J.E., 1985. Early postnatal handling alters glucocorticoid receptor concentrations in selected brain regions. *Behav. Neurosci.* 99, 765–770.
- Nesbit, W., 1991. Emotional abuse. Vulnerability and developmental delay. *Dev. Disabilities* 19, 66–80.
- Russell, D.W., 1990. The analysis of psychophysiological data: multivariate approaches, in: Cacioppo, J.C., Tassinary, L.G. (Eds.), *Principles of Psychophysiology*. Cambridge Univ. Press, New York, pp. 802–842.
- Sapolsky, R.M., 1996. Why stress is bad for your brain. *Science* 273, 749–750.
- Schwartz, E.P., Granger, D.A., Susman, E.J., Gunnar, R., Laird, B., 1998. Assessing salivary cortisol in studies of child development. *Child Dev.* 69, 1503–1513.
- Spangler, G., Schieche, M., 1998. Emotional and adrenocortical responses of infants to the strange situation: the differential function of emotional expression. *Int. J. Behav. Dev.* 22, 681–704.

- Stein, M.B., Koverola, C., Hanna, C., Torchia, M.G., McClarty, B., 1997. Hippocampal volume in women victimized by childhood sexual abuse. *Psychol. Med* 27, 951–959.
- Strassberg, Z., Dodge, K.A., Pettit, G.S., Bates, J.E., 1994. Spanking in the home and children's subsequent aggression toward kindergarten peers. *Dev. Psychopath.* 6, 445–461.
- Straus, M.A., 1979. Measuring intrafamily conflict and violence: the Conflict Tactics Scale. *J. Marriage Fam.* 41, 75–88.
- Straus, M.A., Gelles, R.J., 1990. Physical violence in American families: risk factors and adaptation to violence in 8,145 families. Transaction, New Brunswick, NJ.
- Straus, M.A., Stewart, J.H., 1999. Corporal punishment by American parents: national data on prevalence, chronicity, severity, and duration, in relation to child and family characteristics. *Clin. Child Fam. Psychol. Rev.* 2, 55–70.
- Suomi, S.J., Collins, M.L., Harlow, H.F., 1973. Effects of permanent separation from mother on infant monkeys. *Dev. Psychol.* 9, 376–384.
- Uno, H., Tarara, E., Else, J.G., Suleman, M., Sapolsky, R.M., 1989. Hippocampal damage associated with prolonged and fatal stress in primates. *J. Neurosci.* 9, 1205–1711.
- Watanabe, Y., Gould, E., McEwen, B.S., 1992. Stress induces atrophy of apical dendrites of hippocampal CA3 pyramidal neurons. *Brain Res.* 588, 341–345.
- Weinberg, K.M., Tronick, E.E., 1996. Infant affective reactions to the resumption of maternal interaction after the Still-Face. *Child Dev.* 67, 905–914.