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Parenting Predicts Strange Situation Cortisol Reactivity Among Children Adopted Internationally

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Abstract

The functioning of the hypothalamic pituitary adrenal (HPA) axis can be altered by adverse early experiences. Recent studies indicate that children who were adopted internationally after experiencing early institutional rearing and unstable caregiving exhibit blunted HPA reactivity to stressful situations. The present study examined whether caregiving experiences post-adoption further modulate children's HPA responses to stress. Parental sensitivity during naturalistic parent-child play interactions was assessed for 66 children (*M* age= 17.3 months, *SD* = 4.6) within a year of being adopted internationally. Approximately 8 months later, children's salivary cortisol levels were measured immediately before as well as 15 and 30 minutes after a series of brief separations from the mother in an unfamiliar laboratory setting. Latent growth curve modeling indicated that experiencing more parental sensitivity predicted increased cortisol reactivity to the stressor. Although half the families received an intervention designed to improve parental sensitivity, the intervention did not significantly alter children's cortisol outcomes. These findings suggest that post-adoption parental sensitivity may help normalize the HPA response to stress among children adopted internationally.

Keywords

HPA axis; hypocortisolism; Strange Situation; parental sensitivity; international adoption

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Since 1999, families in the United States have adopted over 250,000 children from other countries, and many were adopted before the age of 3 (US DOS, 2015). Prior to adoption, many internationally adopted (IA) children experience a combination of institutional care, which is characterized by rotating shifts of a large number of caregivers, and foster care, which often involves frequent changes in caregivers (Dozier, Zeanah, Wallin, & Shauffer, 2012; Gunnar, Bruce, & Grotevant, 2000). Because of these early adversities, IA children are at increased risk for problematic adaptation in a number of domains, including physiological stress responses (for a review, see Juffer et al., 2011). Adoption leads to a dramatic improvement in caregiving environment, which has the potential to promote recovery in development following early social deprivation (Gunnar et al., 2000). The present study examined the role of IA children's post-adoption caregiving experiences in the recovery of their HPA axis regulation.

1.1 Early social regulation of the HPA axis

The HPA axis is one of the body's main stress response systems. Its primary hormonal end-product, the glucocorticoid cortisol, has wide ranging impacts on the body and brain, including regulation of the circadian rhythm and mobilization of the body's metabolic resources in response to real or imagined threat (Gunnar, Doom, & Esposito, 2015). In normative-risk populations, exposure to a stressor results in a moderate increase in circulating cortisol produced by the adrenal cortex (Gunnar & Quevedo, 2007). Negative feedback mechanisms serve to suppress the production of cortisol, which efficiently returns the system back to basal levels.

There are two main types of glucocorticoid receptors in the brain. Mineralocorticoid receptors (MRs) have a higher affinity for glucocorticoids, and cortisol typically is bound to a portion of these receptors in the absence of stress. Glucocorticoid receptors (GRs) have a lower affinity for glucocorticoids and mostly bind when there are high levels of circulating cortisol (for example, in response to stress). When the ratio of bound MR/GR receptors is high (i.e., there is cortisol bound to a high number of MR receptors and a low number of GR receptors), learning and memory are enhanced (Finsterwald & Alberini, 2014; see also Schilling et al., 2013). Thus, a moderate increase in cortisol to a stressor or stimulus, which facilitates MR binding with little GR binding, is likely conducive to healthy HPA stress response activation and termination.

During early development, the HPA axis is especially plastic and is regulated by children's experiences with caregivers (Gunnar & Cheatham, 2003). Caregivers typically function to buffer children's cortisol reactivity, meaning that the presence of an emotionally supportive caregiver prevents excessive activation of the HPA axis in response to stressful situations; conversely, in the absence of caregiver support, children tend to exhibit elevated HPA activity in response to stressors (Hostinar, Sullivan, & Gunnar, 2014). When children experience chronic stress, such as the absence of typical early caregiving relationships, the HPA axis reorganizes and downregulates its cortisol production, resulting in blunted cortisol responses to stress (Doom, Cicchetti, & Rogosch, 2014; Fisher, Van Ryzin, & Gunnar, 2011; Fries, Hesse, Hellhammer, & Hellhammer, 2005; McLaughlin et al., 2015). Decreased reactivity of the HPA axis may be the result of altered MR/GR ratios, particularly through excessive expression of GR (Strüber, Strüber, & Roth, 2014). Although this is presumed to be an adaptive response to avoid dangerously high elevations of cortisol, exhibiting little to no HPA response to stressors may also have long-term consequences for behavioral adaptation and physical health, including increased risk for externalizing behaviors (Alink et al., 2008; Conradt et al., 2014; Koss et al., 2016; Ruttle et al., 2011), reduced executive function abilities (Blair, Granger, & Razza, 2005), problems with peer relations (Pitula, DePasquale, Mliner, & Gunnar, *in press*), and increased risk for PTSD (Fries et al., 2005).

Blunted cortisol reactivity is distinct from social buffering. Sensitive caregivers – caregivers that respond contingently and flexibly to their child's cues – tend to reduce children's HPA response to stress. Children who have not experienced chronic stress and are in the presence of a supportive caregiver display a moderate, though not excessive, HPA stress response (Gunnar & Quevedo, 2007). Among children from normative-risk backgrounds, more supportive parent-child relationships are associated with a dampened HPA response to stress (for a review, see Hunter, Minnis, & Wilson, 2011). This allows the body to activate the HPA axis and other systems in order to respond to the stimulus or stressor effectively, but not so much that it becomes overwhelming (Hostinar et al., 2014). This pattern of HPA functioning is not associated with changes in MR/GR expression or behavioral problems (Chrousos, 2009). Thus, there seems to be an inverted U-shaped curve association between HPA axis reactivity and developmental adaptation, such that both too much and too little cortisol production can have damaging effects on well-being (Gunnar et al., 2015; Gunnar & Vazquez, 2001)

1.2 HPA axis functioning for children adopted internationally

Researchers have examined the HPA responses of IA children as a way of better understanding whether early adversity results in dysregulation of children's neurobiological stress response system. An initial study of only 18 IA children suggested that these children showed increased cortisol reactivity relative to non-adopted children (Fries, Shirtcliff, & Pollack, 2008). However, more recent studies with larger samples indicate that IA children exhibited a more blunted pattern of cortisol reactivity than non-adopted children. Specifically, Koss and colleagues (2016) examined the cortisol responses to laboratory stress for over 100 IA children and reported that IA children exhibited an attenuated HPA response. Similarly, children raised in Romanian orphanages exhibited more blunted cortisol reactivity during early adolescence than children randomly assigned to receive a foster care intervention (McLaughlin et al., 2015). Similar patterns have also been found for children in foster care who have experienced maltreatment (Fisher, Kim, Bruce, & Pears, 2012). Thus, the preponderance of the evidence suggests that disturbances in early caregiving relationships typically experienced by internationally adopted children are associated with hypocortisolism.

To our knowledge, no studies have examined the significance of IA children's post-adoptive caregiving experiences for their cortisol stress responses. As a result, the consequences of IA children's experiences with their adoptive parents for their neurobiological development are still unknown. However, there is growing evidence indicating that sensitive caregiving promotes healthier behavioral outcomes among IA children (e.g., Garvin, Tarullo, Van

Ryzin, & Gunnar, 2012; Stams, Juffer, & van IJzendoorn, 2002). Thus, sensitive caregiving appears to facilitate the recovery of IA children's developmental outcomes following earlier experiences of deprivation.

1.4 The current study

The purpose of the current study was to examine the role of IA children's post-adoptive caregiving experiences for their HPA responses. Data for this study were drawn from a randomized controlled trial assessing the effectiveness of an attachment-based intervention for IA children's biobehavioral development. However, the current study focuses on the predictive significance of IA parents' sensitive caregiving, which was observed prior to receiving the intervention (see the Supplemental Materials for more information about the intervention). Approximately 8 months later children's cortisol responses to the Strange Situation Procedure (Ainsworth, Blehar, Waters, & Walls, 1978) were collected. The Strange Situation is one of the most common tasks for assessing cortisol reactivity among young children (for a review, see Gunnar, Talge, & Herrera, 2009). Based on the previous evidence that IA children are at risk for blunted cortisol reactivity to stress (e.g., Koss et al., 2016; McLaughlin et al., 2015), we hypothesized that experiencing higher post-adoption parental sensitivity would be associated with normalization of the stress response, and thus increased cortisol reactivity compared to those with less sensitive adoptive parents.

2. Methods

2.1 Participants

Participants included 66 children (33 female) who were adopted from orphanages or foster care systems in several countries, including China (38%), Russia (21%), Ethiopia (18%), South Korea (18%), Kazakhstan (3%), and Armenia (2%) into the Mid-Atlantic region of the United States. Participants were recruited through partnerships with local international adoption agencies, an international adoption clinic at a local children's hospital, and international adoption support groups. Families were asked to participate if they had recently adopted a child internationally. Children were excluded if they lacked mobility or if they had severe physical or mental disabilities. Children involved in the study came into the primary care of their adoptive parents between 4 and 28 months of age ($M = 13.9$, $SD = 4.8$). Based on adoptive parents' reports, 80% percent of the children had experienced institutional care prior to adoption. Those children who had experienced institutional care spent on average 82% of their pre-adoptive lives in institutions (range = 2 to 23 months, $M = 11.6$). Ninety-five percent of the adoptive parents who participated in the study were female, and 95% were White/non-Hispanic (2% were African-American, 2% were Asian-American, and one did not provide information). Ninety-two percent of the adoptive parents were married, and the remaining 8% were single. Eighty-two percent had at least a college degree, and the others had at least a high school degree or GED. Sixty-four percent of the families had an annual income of $100,000 or more; approximately 32% had an annual income of $60,000–$99,000, and approximately 5% had an annual income of $40,000–$59,000. There were two pairs of adoptive siblings in the sample. The results did not differ with the random exclusion of one sibling from each pair, so siblings were retained in the results presented below. This study was approved by the Institutional Review Board of the [deleted for blind review]. Informed consent was obtained from the child's primary caregiver prior to participation.

2.2 Procedure

The current study involved data collected at three time-points. First, parent-child interactions were videotaped during an initial home assessment when children were between 7 and 33 months old ($M = 17.3$, $SD = 4.8$). At that time, children had been in their adoptive families' care for between 1 and 12 months ($M = 3.4$, $SD = 2.0$). Second, shortly after this initial assessment families were randomly assigned by a coin toss to receive either an intervention intended to promote parenting behaviors associated with children's attachment quality and biological regulation (for a review, see Dozier, Peloso, Lewis, Laurenceau, & Levine, 2008) or an occupational therapy control intervention (see Supplemental Materials for more information). Third, after completion of the intervention, observations of parent-child interactions were collected during a second home assessment, and families participated in the Strange Situation during a laboratory visit. At the time of this laboratory visit, children ranged in age from 21 to 33 months old ($M = 25.8$, $SD = 2.1$) and had been in their adoptive families' care for between 5.2 and 21.5 months ($M = 11.9$, $SD = 4.1$).

2.3 Measures

2.3.1 Parental sensitivity—Parents and children were video recorded in their homes during semi-structured interaction tasks. The tasks were selected to be developmentally appropriate based on the children's ages at the time of the assessment. When children were under the age of 20 months, children were placed in a child seat and parents were provided with three toys: a rattle, a set of stacking cups, and a squeaking toy. When children were between 21 and 35 months, parents and children were provided with a set of building blocks. Regardless of the child age, parents were instructed to interact with their children as they normally would, and the interaction was filmed for approximately 10 minutes, including 7 minutes of free play and 2–3 minutes of clean-up.

Parents' behaviors during the interactions were coded on the basis of parents' sensitivity to the child's non-distress signals using a 5-point sensitivity scale (with decimal points allowed) that was adapted from the NICHD Observational Record of the Caregiving Environment (NICHD ECCRN, 1996). A score of 5 was assigned to parents who responded contingently and appropriately to their children's cues. A score of 1 was assigned to parents who followed their own agenda during the play interactions and/or ignored children's signals. All videos were double-coded, and the average score was used for analyses ($M = 2.9$, $SD = 0.8$). The intraclass correlation (two-way mixed, average measures) was .62.

Observations of parent-child interactions were collected prior to the intervention and shortly after completion of the intervention. We decided to focus on the pre-intervention parental sensitivity assessment to establish the temporal precedence of predicting cortisol reactivity from earlier parenting. However, all decisions regarding statistical significance remained the same when post-intervention parental sensitivity was used (see Supplemental Materials for more information).

2.3.2 Strange Situation—The Strange Situation Procedure involves eight increasingly stressful episodes that include two separations and two reunions with the parent. The first separation episode typically lasts up to three minutes (shortened if the child is very distressed), and the second separation episode can last up to six minutes (3 minutes with the stranger, and 3 in room alone). The separations are followed by three minute reunions with the parent. Children's behaviors during the procedure were video-recorded. The laboratory-based procedure was originally developed to assess the quality of children's attachment to their parent. Two trained coders coded children's attachment behaviors during the Strange Situation using the guidelines of Ainsworth et al. (1978). Specifically, coders assigned ratings for children's proximity seeking, contact maintenance, attachment avoidance, and contact resistance during the two reunion episodes. Based on these ratings, coders classified children as having a secure (75%), insecure-avoidant (11%), or insecure-resistant (14%) attachment to their parent. In addition, the coders evaluated children's attachment disorganization/disorientation using Main and Solomon's (1990) 9-point scale ($M = 3.39$, $SD = 2.05$), and children were classified as disorganized if they received a score of 5 or higher (31%; weighted $\kappa = .40$). We focused on categorically-measured attachment disorganization given the previous findings regarding the associations between disorganization and cortisol reactivity (e.g., Bernard & Dozier, 2010). Importantly, results did not substantively differ when dimensionally-measured disorganization or the categorical or dimensional indices of attachment security were used in the analyses.

2.3.3 Salivary cortisol—To assess salivary cortisol concentration, saliva samples were collected upon the child's arrival at the lab as well as 15 and 30 minutes following completion of the Strange Situation Procedure. The Strange Situation Procedure was completed primarily in the late morning (median start time = 10:16 AM, $SD = 112$ minutes). Children were not allowed to eat in between saliva samples so as not to affect cortisol levels or the quality of the saliva sample. The sample taken upon arrival represents each child's baseline cortisol level before experiencing the Strange Situation Procedure. Post-stressor samples were taken 15 and 30 minutes following completion of the Strange Situation because peak concentrations in response to various stressors are expected to occur within that interval (Kirschbaum & Helhammer, 1994). After completing the Strange Situation Procedure, children and their parents engaged in free-play in the examination room for 30 minutes to allow for post-Strange Situation salivary cortisol collection. For each sample, parents placed a dental cotton roll in the child's mouth until it was sufficiently wet with saliva. All samples were stored in a freezer at −20 °C in the laboratory prior to assaying. Samples were assayed in duplicate using the High Sensitivity Salivary Cortisol Enzyme Immunoassay Kit (Salimetrics, LLC, State College, PA). Samples with an intra-assay coefficient of variation greater than 10% were assayed a second time. All inter- and intra-assay coefficients of variation were below 10%. Two samples involved biologically implausible values (>2.0 μg/dL) and were therefore excluded from the analyses. Across the 66 participants, usable cortisol values were available for 191 saliva samples. Participants were required to have at least one usable saliva sample to be included in analyses: all three samples were usable for 92% of participants and at least two were usable for 97% of participants. To correct for positive skew, cortisol concentration values were $\log_{10}$ transformed prior to analyses.

2.4 Data Analytic Plan

Latent growth curve analyses using the 'lavaan' package in R (Rosseel, 2012) were conducted to evaluate the predictors of children's baseline cortisol levels (intercept) and cortisol reactivity (linear slope) to the Strange Situation procedure. The covariance between the three cortisol samples was also modeled in each analysis. The focal predictor in these analyses was parents' sensitivity during the pre-intervention parent-child interactions. Whether children were exhibiting a disorganized attachment pattern was also included as a measure of children's behavior during the Strange Situation. Intervention condition was included as a predictor of both intercept and slope given previous evidence of associations with cortisol production during the Strange Situation (Dozier et al., 2008; see Supplemental Materials for more detailed results regarding the intervention).

Children's biological sex, number of siblings, age at the time of the Strange Situation Procedure, time of day of the procedure, region of adoption, percent of pre-adoptive life spent in institutional care, age at adoption, duration of time since adoption, family income, parent age at adoption, parent education, parent marital status, and whether the parents had previously adopted children were explored as potential covariates. These variables were not significantly associated with either cortisol intercept or slope across Strange Situation in this sample, with the exception that time since adoption significantly predicted baseline cortisol levels ($z = 2.26$, $p = .02$). This variable was included as a predictor of both intercept and slope.

3. Results

3.1 Preliminary Analyses

See Table 1 for zero-order correlations among the focal variables. Parental sensitivity, attachment disorganization, and intervention condition were not significantly associated with any individual cortisol measure. Parents who were randomly assigned to receive the attachment-based intervention demonstrated higher parental sensitivity prior to the intervention than parents who received the control intervention (see Supplemental Materials for more information). All three cortisol variables were highly correlated with one another.

3.2 Cortisol Reactivity to the Strange Situation

The baseline growth curve model with no predictors indicated that there was not a sample-level cortisol response to the Strange Situation Procedure ($z = -0.54$, $p = .59$). However, there was significant unexplained variation in intercepts ($z = 4.36$, $p < .001$) and trend-level variation in slopes ($z = 1.66$, $p = .10$). This suggests that, although there was no overall cortisol response, participants varied in their cortisol patterns.

3.3 Predicting Baseline Cortisol Levels

Results of the model predicting cortisol levels immediately before the Strange Situation are reported in Table 2. Neither parental sensitivity, attachment disorganization, nor intervention condition predicted basal cortisol.

3.4 Predicting Cortisol Reactivity to the Strange Situation

Results of the model predicting cortisol reactivity during the Strange Situation are reported in Table 2. Parental sensitivity predicted increased cortisol slope. As displayed in Figure 1 using a median split of high versus low parental sensitivity, IA children who experienced more sensitive care exhibited greater cortisol reactivity than children who experienced less sensitive care. Intervention condition and attachment disorganization were not significantly associated with cortisol reactivity. Moreover, results regarding the significance of parental sensitivity did not change when intervention status and/or attachment disorganization were omitted from the models, or when only looking at the subset of participants who completed the control intervention (see Supplemental Materials for more information).

4. Discussion

The present study examined the role of sensitive caregiving for regulating IA children's HPA responses to stress during early childhood. To our knowledge, the current study represents the first investigation of the implications of IA children's post-adoptive caregiving experiences for their HPA responses to stress. Within this sample, higher parental sensitivity was associated with increased cortisol reactivity during the Strange Situation. Given the evidence that IA children and children with histories of institutional caregiving are more likely to show blunted patterns of cortisol reactivity (Koss et al., 2016; McLaughlin et al., 2015), this finding may indicate that increased parental sensitivity facilitates recovery in IA children's HPA responses to stressors. This interpretation is further supported by evidence that sensitive post-adoptive parenting promotes more competent forms of behavioral adaptation among IA children (e.g., Garvin et al., 2012; Stams et al., 2002).

There is an inverted U-shaped curve in the association between cortisol and cognitive and behavioral outcomes in adults, such that moderate amounts of cortisol are associated with the best learning and memory performance. This non-linear association is due to the ratio of mineralocorticoid and glucocorticoid receptors that are bound to cortisol in the brain (a high MR/GR ratio; for a review, see Finsterwald & Alberini, 2014). In response to the type of chronic stress experienced by IA children prior to adoption, the HPA axis may reorganize via altered MR/GR expression in the brain in order to prevent consistently high levels of cortisol production (Gunnar & Vazquez, 2001; Strüber et al., 2014). This results in a pattern of HPA functioning characterized by little to no cortisol production in response to stressors. The findings from the current study indicate that post-adoption sensitive caregiving may facilitate recovery of the HPA axis and normalize the functioning of IA children's stress response systems.

Given that this is one of the first studies of the contributions of the post-adoptive caregiving environment for IA children's HPA responses to stress, it will be important to replicate these findings in a larger sample of IA children. In addition, future studies should directly assess whether a moderate cortisol response as seen in IA children who experienced more sensitive care is associated with recovery in behavioral development. Further studies should assess whether the association between sensitive caregiving and cortisol reactivity seen in this study generalizes to children who have experienced other types of early adversity and are at risk for hypocortisolism (e.g., children who have experienced maltreatment). Another future direction will be to evaluate whether these findings are specific to the use of the Strange Situation Procedure or if they generalize to other stressors. Although the Strange Situation Procedure is the most commonly used paradigm for eliciting a stress response at this age (see Gunnar et al., 2009 for a review), there was not a significant sample-level cortisol response to the Strange Situation Procedure in this sample. This may have weakened the likelihood of observing associations with cortisol reactivity. However, the slightly older age of the children at the time of the procedure as well as the fact that these IA children may have been at risk for hypocortisolism possibly contributed to a smaller sample-level cortisol response in this study.

Similarly, given the evidence that IA children and children with histories of institutionalization show blunted HPA reactivity during later childhood (Hostinar, Johnson, & Gunnar, 2015; McLaughlin et al., 2015), it is important to investigate whether sensitive caregiving shapes IA children's cortisol responses during later developmental periods. Future studies should examine other aspects of IA children's post-adoptive environments, including the adoptive parents' previous parenting experiences, depressive symptoms, and levels of community support. Additionally, it will be important to explore the role of different dimensions of parenting on the normalization of HPA axis reactivity following early social deprivation. There are several other dimensions of parenting that may also play a role in the impact of parenting on HPA functioning; however, we chose to focus on parental sensitivity because there is a large body of evidence documenting its relevance for non-adopted children's cortisol outcomes (Hostinar, Sullivan, & Gunnar, 2014). Thus, parental sensitivity may have a particularly strong role in the adoptive parent's ability to facilitate recovery of the HPA stress response following international adoption.

In contrast to previous findings based on non-adopted children (Bernard & Dozier, 2010; Gunnar, Brodersen, Nachmias, Buss, & Rigatuso, 1996; Hertsgaard, Gunnar, Erickson, & Nachmias, 1995), IA children's attachment patterns were not significantly associated with their cortisol responses during the Strange Situation. This may be due to the fact that IA children's attachment patterns were changing as a result of the recent major transition in their caregiving environment. It will important to examine the associations between IA children's attachment patterns and cortisol responses after children have spent a longer duration of time with their adoptive families and their attachment patterns are more consolidated (Shapiro, Shapiro, & Paret, 2001).

Furthermore, enrollment in the attachment-based intervention was not associated with differences in cortisol reactivity to the Strange Situation. This null finding may seem paradoxical given that receiving the attachment-based intervention promoted increases in parental sensitivity (Yarger et al., *under review*), and parental sensitivity is positively associated with cortisol reactivity. Intervention effects may not have been detected due to limited statistical power given the relatively modest sample size. Additionally, those assigned to the attachment-based intervention in this sample were already more sensitive than their control group counterparts pre-intervention (however, Yarger et al., *under review* shows this is not the case in the larger sample from which this data was taken). Another possibility is the length of time needed for an effect to emerge at the neurobiological level. The Strange Situation Procedure was conducted soon after the completion of the 10-week intervention, which may not have allowed sufficient time for the changes in parental behavior to effect children's neurobiological responses to stress. Future studies should investigate this possibility by assessing potential intervention effects on cortisol reactivity over a longer period of time.

This study has a number of strengths. Namely, the inclusion of an observational measure of post-adoption parenting to examine associations with cortisol reactivity is a unique strength of the current study. There was also a wide range of sensitive caregiving in this sample. Typically, studies measuring parenting in internationally adopted populations include primarily parents with relatively high parenting quality (e.g., Garvin et al., 2012; Lawler, Koss, & Gunnar, 2017), which reduces their ability to make conclusions that generalize to parents who display average or lower parenting quality. This sample allows us to more accurately evaluate the impact of post-adoption parenting across a wider range of observed parental sensitivity than the variation limited to only the most sensitive parents.

Altogether, the current study supports the notion that the functioning of children's HPA axes are especially plastic during early development and are regulated by their experiences with caregivers. In addition, these findings offer initial evidence that post-adoption parental sensitivity may help promote IA children's stress-regulatory development following severe early life adversity. These results help advance our understanding of how the consequences of adverse early caregiving experiences for children's stress-regulatory development can be offset by later experiences. Specifically, post-adoption parental sensitivity may be a vital resource through which IA children achieve positive developmental outcomes despite experiencing considerable early life adversity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Predictors of internationally adopted children's cortisol reactivity are examined.
- Increased cortisol reactivity is associated with more sensitive caregiving.
- The extent of pre-adoptive deprivation did not predict reduced cortisol reactivity.
- Results suggest that post-adoptive caregiving may recalibrate HPA axis functioning.

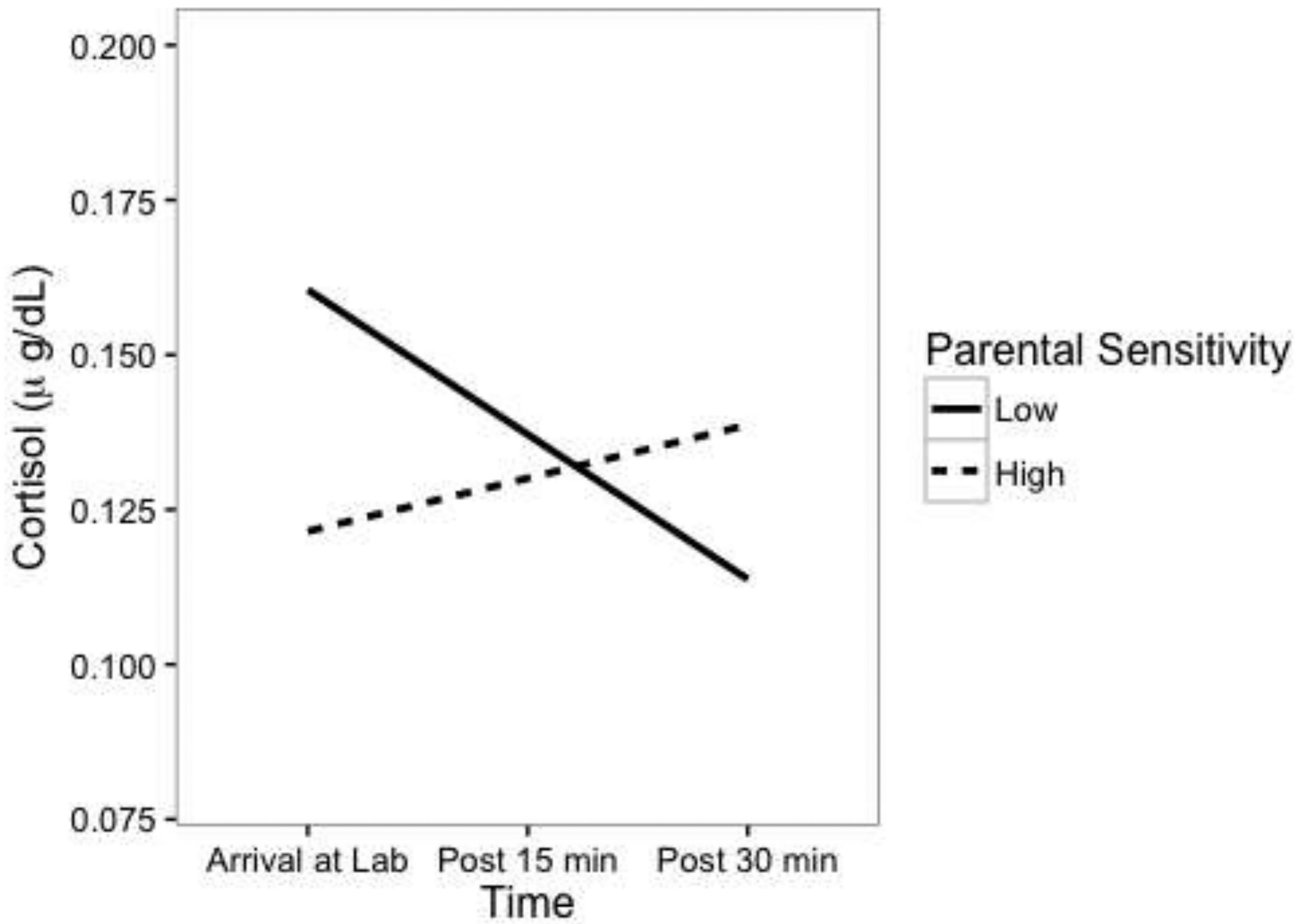

Figure 1.

Predicted values of internationally adopted children's cortisol response to the Strange Situation as a function of high (≥ 3) and low (< 3) post-adoptive parental sensitivity (*n*s = 36 and 30, respectively), calculated using a median split. Raw cortisol values are presented for visualization purposes.

Table 1

Zero-order correlations and descriptive statistics for main study variables and covariates

	1	2	3	4	5	6	7	8	9
1. Intervention status	—								
2. Attachment disorganization	−.13	—							
3. Pre-intervention parental sensitivity	.25*	−.16	—						
4. Percent time in institutional care	.12	.24*	−.12	—					
5. Age at adoption	.09	.06	.14	.04	—				
6. Time since adoption	−.17	.00	−.09	−.07	−.90***	—			
7. Pre-Strange Situation cortisol	−.21	−.05	−.24	−.13	−.14	.14	—		
8. 15 min-post Strange Situation cortisol	−.13	−.00	.00	−.03	−.10	.05	.70***	—	
9. 30-min post Strange Situation cortisol	−.08	.05	.05	−.05	−.05	.01	.61***	.77***	—
Mean (*SD*)	—	—	2.87	.66	13.91	11.90	−1.02	−1.02	−1.05
			(.83)	(.38)	(4.80)	(4.05)	(.32)	(.35)	(.32)

Note. N = 66.

* $p < .05$,

*** $p < .001$.

For intervention condition, attachment-based intervention = 1 ($n = 34$), control intervention = 0 ($n = 32$); for attachment disorganization, organized attachment = 0 ($n = 44$), disorganized attachment = 1 ($n = 20$). All values shown are Pearson correlations of continuous variables, except those with intervention status and attachment disorganization which are Spearman's rank correlations. Descriptive statistics for cortisol are $\log_{10}$ transformed values due to positive skew.

Table 2

Parental sensitivity, attachment disorganization, and intervention condition as predictors of baseline cortisol levels and cortisol reactivity during the Strange Situation

	Intercept			Slope		
	β	*z*-value	R^2	*β*	*z*-value	R^2
Constant	−2.56	−3.12***	.13	−2.30	−1.89	.40
Parental sensitivity	−.18	−1.29		.49	2.32*	
Attachment disorganization	−.18	−1.31		.33	1.60	
Time since adoption	.10	0.70		−.21	−1.02	
Intervention condition	−.22	−1.53		.14	0.67	
Residual variance	.87	4.20***		.60	1.11	
Intercept-slope covariance	−.02	−0.06		—	—	

Note. $N = 66$.

* $p < .05$,

*** $p < .001$.

For intervention condition, attachment-based intervention = 1, control intervention = 0; for attachment disorganization, organized attachment = 0, disorganized attachment = 1. *β* values represent standardized regression coefficients.