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Improving infants' stress-induced cortisol regulation through attachment-based intervention: A randomized controlled trial

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ABSTRACT

Attachment-based parenting interventions have shown positive effects on early cortisol regulation, a key biomarker. Evaluations to date have focused on diurnal cortisol production in high-risk infants. It is important to understand whether attachment-based intervention may also improve stress-induced cortisol production in typically developing infants. This randomized controlled trial tested an enhanced model of U.S. Early Head Start (EHS) services that combined home-based EHS with a brief, attachment-based parenting intervention, Attachment and Biobehavioral Catch-up (ABC). The trial included 153 low-income mothers and their infants (M age 12.4 months [SD = 4.1]). Control participants received home-based EHS plus 10 weekly books. Intent-to-treat analyses using multilevel models revealed a significant indirect intervention effect on infants' rates of cortisol change in response to a series of mild stressors. The intervention increased maternal sensitivity, which in turn improved cortisol regulation, particularly infants' rates of cortisol recovery. The findings illustrate the efficacy of EHS plus ABC for supporting infants' stress-induced cortisol regulation and implicate sensitive maternal behavior as the underlying driver of the intervention effect. Findings are discussed in terms of the preventative value of attachment-based parenting interventions that improve both parenting and infants' physiological regulation.

1. Introduction

Understanding infants' cortisol production illuminates the physiological underpinnings of physical and mental health. Cortisol is a steroid hormone produced by the hypothalamic-pituitary-adrenal (HPA) axis, a major neuroendocrine system that regulates sleep/wake cycles and stress responsivity. Human cortisol production exhibits a diurnal pattern, peaking within 30 min of wake-up and declining steeply across the day. Typically developing infants exhibit this diurnal pattern by age 3 months (Gunnar and White, 2001; Price et al.,1983). Under conditions of perceived threat, the HPA axis's stimulation of cortisol production helps to mobilize resources such as glucose to galvanize self-defense. The HPA system also includes a negative feedback loop that down-regulates cortisol once the threat subsides. From birth, typically developing infants exhibit increased cortisol production in response to stressors (Gunnar et al., 2009; Jansen et al., 2010). This stress-responsivity appears highly sensitive to environmental factors (e.g., type of stressor, caregiving; Gunnar et al., 2009; Ursache et al., 2014). Circulating cortisol strongly influences multiple systems, and atypical cortisol production, including disrupted diurnal patterns and both over- and under-production in response to threat, has been associated with physical and mental health problems (Demitrack et al., 1991; Gunnar and Vazquez, 2001; Lopez-Duran et al., 2009; McBurnett et al., 2000). Cortisol production is thus an important biomarker of physical and mental health.

1.1. Social buffering of cortisol reactivity and recovery

Because the HPA axis is not fully organized at birth, infancy represents a sensitive period for its development (Cicchetti and Curtis, 2006; Loman and Gunnar, 2010). Key to the development of infants' diurnal and stress-related cortisol production is the caregiving environment (Bernard et al., 2010; Carlson and Earls, 1997; Gunnar and Vazquez, 2001; Kroupina et al., 2012). The social buffering framework specifies that, in typical caregiving environments (excluding institutional rearing or maltreating environments), the presence of a

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supportive social partner reduces behavioral and physiological reactions to threat (Gunnar, 2016; Hostinar et al., 2014). In cases where the social partner is present *following* the threat, his/her presence accelerates the return to baseline stress levels (i.e., accelerates *recovery)* (Gunnar, 2016).

A growing body of descriptive and experimental studies support the social buffering framework. These studies, while varied, increasingly suggest that sensitive and emotionally supportive parenting behavior can facilitate healthy diurnal and stress-responsive cortisol regulation, and that promoting such parental sensitivity in turn holds promise for galvanizing early cortisol regulation and the physical and mental health advantages associated with it. First, several descriptive studies of typically developing infants have linked mothers' sensitive and/or positively engaged parenting behaviors to their infants' healthy stress-induced cortisol regulation characterized by brief increases in circulating cortisol followed by decreases to baseline or near-baseline levels (Albers et al.,2008; Atkinson et al., 2013; Blair et al., 2008; Laurent et al., 2016; Martinez-Torteya et al., 2014). Second, several experimental studies of early attachment-based parenting programs designed to increase maternal sensitivity, *per se*, have demonstrated positive effects on infant cortisol regulation (see Berlin et al., 2016; Slopen et al., 2014, for reviews). Most of these inquiries focus on high-risk infants, and most have tested diurnal cortisol outcomes.

Findings from three randomized controlled trials (RCT's) of the brief Attachment and Biobehavioral Catch-Up (ABC) program are especially provocative. The first trial included 96 foster infants/toddlers and their foster mothers, the second included 212 custodial biological mothers and their infants or toddlers receiving child protective services (CPS) because of concerns about caregiver neglect (Bernard et al., 2012; Dozier et al., 2006). Both trials demonstrated that the ABC intervention normalized diurnal patterns of cortisol production immediately following the intervention. The CPS trial also revealed sustained intervention effects on diurnal cortisol patterns approximately three years post-intervention (Bernard et al., 2015).

The ABC foster care trial also examined stress-induced cortisol in response to the laboratory Strange Situation Procedure (SSP) when children were approximately 20 months old (Dozier et al., 2008). The SSP includes two brief separations and reunions with the mother, thus directly eliciting recovery through social buffering. ABC infants exhibited significantly lower cortisol values than controls upon arrival to the lab. There were no RCT group differences, however, in infants' cortisol levels exhibited 15- and 30-minutes post-SSP. Similarly, although a recent report on 66 dyads from a third RCT with internationally adopted infants described positive associations between pre-ABC maternal sensitivity and infants' cortisol levels following the SSP, there were again no RCT group differences in these infants' cortisol reactivity or recovery (DePasquale et al., 2018). One question raised by these unexpectedly null findings is whether they reflect the high-risk nature of the participating infants whose cortisol production may have been chronically hyper- or hypo-active and, therefore, less responsive to mild stressors and to the effects of an attachment-based intervention on stress-induced cortisol regulation. To help address this question, the current study examined whether the ABC intervention might affect stress-induced cortisol regulation in typically developing infants.

1.2. The current study

The current RCT was one of six studies comprising the federal Buffering Toxic Stress Research Consortium, each of which tested an enhanced model of the U.S. Early Head Start (EHS) program for low-income families with infants and toddlers (Buffering Toxic Stress Consortium Principal Investigators et al., 2013). EHS services, which can be home-based, center-based, or mixed, include developmental screenings, parenting education, and child care. Program effects typically have been modest and frequently moderated, prompting suggestions for program improvements, especially in the areas of parenting and attachment (Love et al., 2005; 2013; Raikes et al., 2014). The current RCT tested home-based EHS supplemented by the ABC parenting intervention. Findings to date have shown positive impacts of the enhanced EHS plus ABC model on mothers' sensitive parenting behaviors (Berlin et al., 2018). The current inquiry tested intervention effects on infants' cortisol regulation. It adds importantly to the literature examining the impacts of parenting interventions on infant cortisol regulation by using a large RCT with typically developing infants and by evaluating stress-induced cortisol reactivity and recovery. In addition, previous studies have implied but have not explicitly tested parenting behavior as a statistical mediator of intervention effects on infant cortisol. The current RCT examined this mediated effect. The hypothesis tested was that the randomly assigned intervention infants would exhibit a more pronounced pattern of cortisol reactivity and especially *recovery* than controls (i.e., a temporary increase in cortisol followed by a decrease to baseline levels due to greater maternal buffering facilitated by the intervention). It was also hypothesized that this effect would be predominantly indirect, with the intervention improving parenting, and parenting in turn improving infant cortisol regulation.

2. Method

2.1. Participants

Eligible mother-infant dyads were referred from collaborating EHS programs. The principal eligibility criterion for EHS is family income at or below the federal poverty line. Inclusion criteria for the current RCT included mother English- or Spanish-speaking and age ≥ 18 years, and infant age 6 to 18 months and without a special needs diagnosis. Mothers who agreed to participate in the trial were randomly assigned to receive either EHS plus ABC (n = 104) or EHS plus "Book-of-the-Week" (n = 104), a light control protocol consisting of 10 English/Spanish developmentally appropriate books sent weekly to the mothers by mail. Fig. 1 presents participation details via the CONSORT flow diagram. Table 1 provides descriptive statistics for all baseline participant characteristics for the sample as a whole and by RCT group. There were no statistically significant group differences in any baseline characteristics. (See Berlin et al., 2018)

2.2. The Attachment and Biobehavioral Catch-up Intervention

The manualized ABC program consists of 10 parent coaching sessions delivered to the primary caregiver and child together in their home (Dozier et al., 2005). The program targets three specific aspects of sensitive caregiving behavior key to early child development: (a) providing nurturance; (b) following the child's lead with delight; and (c) avoiding intrusive and frightening behaviors. Three randomized trials have demonstrated the ABC program's efficacy for foster parents, birth parents involved in child protective services, and parents of internationally adopted infants, with consistently positive impacts on sensitive parenting behaviors and multiple aspects of children's behavioral and physiological regulation (Berlin et al., 2016; Dozier and Bernard, 2017).

For the current RCT, two female, bilingual, certified parent coaches delivered ABC approximately weekly in mothers' homes in English or Spanish. Principal intervention activities included discussion of basic attachment principles, guided practice of new parenting behaviors, and review of video clips from previous sessions to help reinforce parenting targets. As illustrated in Fig. 1, 91 intervention dyads (87.5%) completed all 10 supplemental ABC sessions.

2.3. Procedures

The University of Maryland, Baltimore Institutional Review Board approved the study. Two sets of procedures, at baseline (pre-

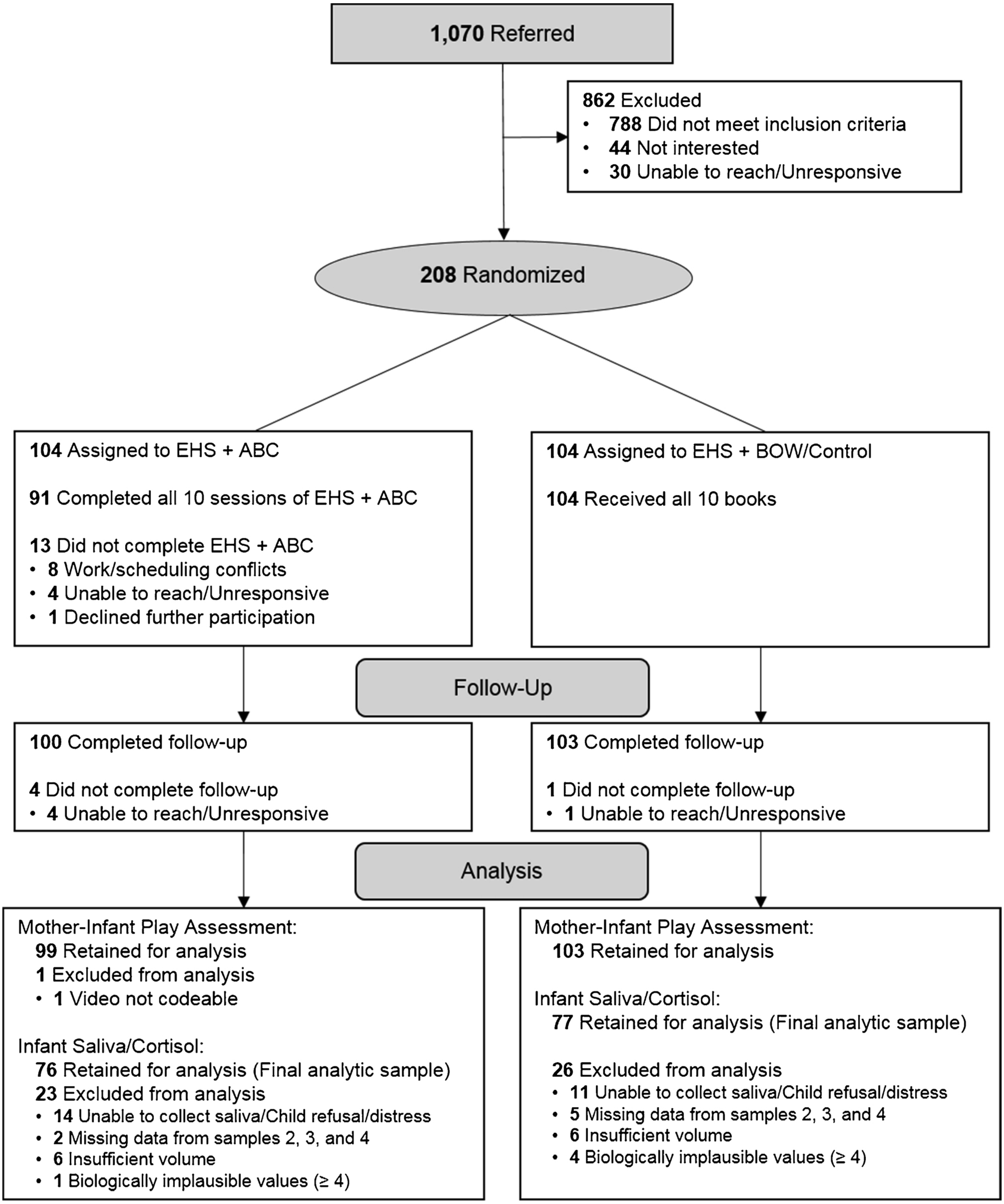

Fig. 1. Flowchart detailing enrollment, randomization, and participant retention. EHS indicates Early Head Start; ABC, Attachment and Biobehavioral Catch-up; BOW, Book-of-the-Week.

intervention) and follow-up (post-intervention), were conducted in the families' homes in English or Spanish (see Berlin et al., 2018). Baseline assessments consisted of a series of demographic and psychosocial questionnaires and a standardized 15-minute, video-recorded, semi-structured mother-infant play assessment. Follow-up procedures were conducted within approximately one month of intervention completion, at which point the mean age of the infants was 16 months (*SD* = 4.5). Given participants' unique and often challenging life circumstances (e.g., family and/or neighborhood poverty, parents' unpredictable work schedules, infants' unpredictable sleep schedules), research visits were conducted according to participants' availability (24% before 10am, 40% 10am-1 pm, 36% 1 pm or later).

Follow-up procedures included a second standardized 15-minute play assessment and two mildly stressful activities. The first, the mask

Table 1
Participant Baseline Characteristics by RCT Group.

	Total (*N* = 153)	EHS + ABC (*n* = 76)	EHS + BOW/Control (*n* = 77)
Receiving WIC, No. (%)	145 (94.8)	70 (92.1)	75 (97.4)
Maternal Hispanic/Latina ethnicity, No. (%)	135 (88.2)	68 (89.5)	67 (87.0)
Maternal age, mean (SD), y	31.3 (6.6)	31.0 (6.8)	31.6 (6.5)
Maternal education, No. (%)			
Did not complete HS/GED	65 (42.5)	36 (47.4)	29 (37.7)
Completed HS/GED	88 (57.5)	40 (52.6)	48 (62.3)
Maternal employment status, No. (%)			
Not employed	89 (58.2)	42 (55.3)	47 (61.0)
Employed	64 (41.8)	34 (44.7)	30 (39.0)
Marital status, No. (%)			
Single[a]	38 (24.8)	18 (23.7)	20 (26.0)
Married or has a partner	115 (75.2)	58 (76.3)	57 (74.0)
Infant age, mean (SD), mo	12.4 (4.1)	12.2 (4.2)	12.7 (4.0)
Infant sex, No. (%)			
Male	70 (45.8)	38 (50.0)	32 (41.6)
Female	83 (54.2)	38 (50.0)	45 (58.4)

Abbreviation: RCT, randomized controlled trial; EHS, Early Head Start; ABC, Attachment and Biobehavioral Catch-up; BOW, Book-of-the-Week; WIC, Women, Infants, and Children federal program; HS/GED, high school/general education diploma.

[a] Mothers who reported being divorced or separated were categorized as single.

task, was adapted from the laboratory-based Lab-TAB (Goldsmith and Rothbart, 1996). The infant sat in a booster seat on the floor. A female research assistant who was otherwise outside of the infant's view put on a mask and moved from side to side in front of the infant for 10 s while calling the infant's name. The mother was seated behind the infant and instructed not to interact. This activity was truncated if the infant was observed to cry hard for 15 consecutive seconds. Subsequently, there was a 2-minute period during which the mother could remove her infant from the booster and interact with him/her as she wished. Immediately following this period, the second stressful activity, a brief separation-reunion modeled on the SSP, occurred. The mother was asked to leave the home for 3 min while a female research assistant stayed with the infant, followed by a 3-minute reunion period. This activity was truncated if the infant was observed to cry hard for 15 consecutive seconds or if the mother wanted to return sooner.

Infants' saliva samples, collected by a female research assistant or the mother (per maternal preference), were collected using Salimetrics 8 mm x 125 mm inert polymer children's swabs, held in the infants' mouths for 60–90 s and then placed into a cryogenic vial.

Saliva samples were collected at four specific times selected to permit the analysis of cortisol reactivity and recovery. Mothers were requested in advance not to give infants anything to eat or drink from one hour prior to the start of the research visit until after the last saliva collection.

The first, "pre-activity" baseline sample was collected shortly after the researchers' arrival in the home. The remaining samples were collected 5, 20, and 40 min after peak arousal, defined á priori as the end of the separation (typically the time when infants were most distressed). Samples were stored on ice for transport and then in conventional freezers (−20 °C) before being shipped on dry ice for assay at the Institute for Interdisciplinary Salivary Bioscience (Irvine, CA). Cortisol assays were performed using a commercially available immunoassay specifically designed for saliva. Sample test volume was 25 μl (range of sensitivity .007–3.0 μg/dL). All samples were assayed in duplicate. The averages of the duplicates were used for analysis. The intra-assay and inter-assay coefficients of variation on average fell below 5% and 15%, respectively.

2.4. Measures

The mother-infant play assessments were coded at the University of North Carolina CDS Observes Center using a series of established scales (Mills-Koonce and Cox, 2013). A group of 5 coders, all blind to participants' RCT group assignment, were trained until inter-rater reliability was met and maintained on each scale, using a criterion intraclass correlation of > .70. A minimum of 20% of the assessments were double-coded for ongoing reliability checks. Coding discrepancies were resolved through conferencing. The current study focused on a composite index of overall *maternal sensitivity*, (reflecting sensitivity/responsiveness, intrusiveness [reversed], and positive regard) that is sensitive to ABC intervention effects (Berlin et al., 2018; Roben et al., 2017), and predicts infant socioemotional development (NICHD Early Childhood Research Network, 1997, 2001).

2.5. Statistical analysis

Tests of direct and indirect effects followed an intent-to-treat

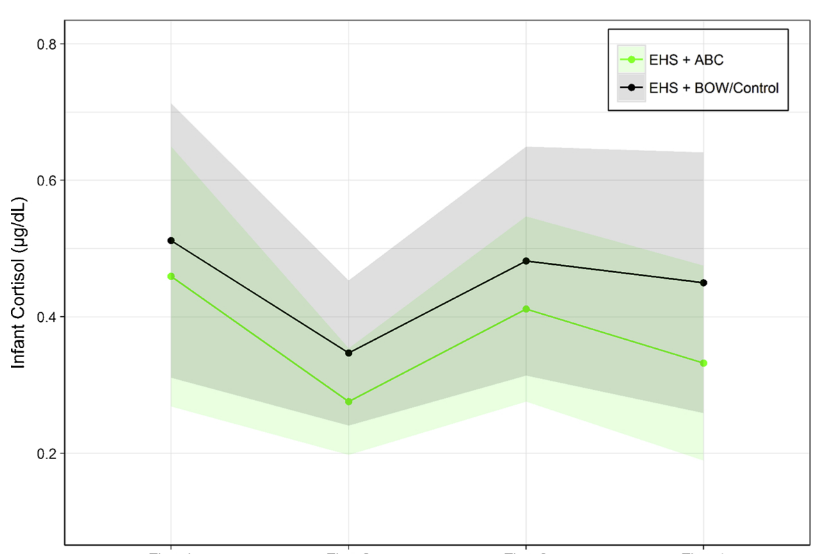

Fig. 2. Infant cortisol values with 95% confidence intervals by RCT group. EHS indicates Early Head Start; ABC, Attachment and Biobehavioral Catch-up; BOW, Book-of-the-Week.

approach. As illustrated in Fig. 2, cortisol values for both the intervention and control groups were highest at sampling time 1, shortly after the researchers' arrival in the home, and likely reflecting infants' anticipatory arousal. Consistent with previous studies (Ursache et al., 2014; van Bakel and Riksen-Walraven, 2008), and given the principal question of intervention effects on infants' stress-induced cortisol reactivity and recovery, multilevel models with random effects tested the simple direct (non-mediated) effect and the indirect (mediated) effect of the intervention on the quadratic curve in infants' cortisol production at times 2, 3, and 4. Time 1 cortisol values were covaried, as were infant age, time of day of assessment, and baseline maternal sensitivity scores. Secondarily, a multiple linear regression with the same covariates tested the intervention effect on infants' cortisol production at time 1 (pre-activity baseline). All principal analyses were performed in MPlus v.8 (Muthén and Muthén, 1998-2017).

3. Results

Preliminary analyses included those participants for whom pre- and post-intervention parenting data and at least one infant saliva sample of sufficient volume for assay from sampling time 2, 3, or 4 were available ($N = 158$). Data were further reduced through cleaning of initial cortisol data by dropping biologically implausible cortisol values ($n = 5$), resulting in a principal analytic sample of 153 (RCT group n's = 76 and 77; see Fig. 1). Log-transformation and winsorizing were used to normalize the distribution of cortisol values due to a positive skew (see Table 2 and Fig. 2).

Fig. 3 summarizes the principal path coefficients for the model. (Tables A1 and A2 provide full model results.) There was a marginally significant simple direct effect of the intervention on the quadratic curve in infants' cortisol production (Fig. 3, path c). Analyses also indicated a statistically significant indirect effect of the intervention on infants' cortisol production, mediated by a positive intervention effect on maternal sensitivity (Fig. 3, paths a and b); the standardized mediated path (ab) = -0.07, 95% CI (-0.13 to -0.01), $p =$ .02. The magnitude of the indirect effect, calculated by multiplying the mediated path (ab) by the within-level standard deviation, indicated a small-medium effect of slightly more than one third of a standard deviation: d = -0.36 (95% CI, -0.68 to -0.05) (Cohen, 1988). The ratio of the mediated effect to the total effect (Fig. 3, path c') was 0.44, indicating that 44% of the total effect was transmitted through maternal sensitivity. There was no intervention effect on infants' cortisol production at time 1 (B = -0.04, 95% CI [-0.36 to 0.28]).

Table 2
Infants' Cortisol Values by Time and RCT Group.

	Mean (SD) [95% CI]	
	EHS + ABC[a] (n = 76)	EHS + BOW/Control[a] (n = 77)
Raw infant cortisol values, mean (SD), µg/dL		
Time 1	0.46 (0.78) [0.27-0.65]	0.51 (0.80) [0.31-0.71]
Time 2	0.28 (0.32) [0.20-0.35]	0.35 (0.44) [0.24-0.45]
Time 3	0.41 (0.57) [0.28-0.55]	0.48 (0.69) [0.31-0.65]
Time 4	0.33 (0.57) [0.19-0.47]	0.45 (0.73) [0.26-0.64]
Winsorized (± 3 SD) infant cortisol values, mean (SD), µg/dL		
Time 1	0.42 (0.63) [0.27-0.57]	0.48 (0.71) [0.31-0.66]
Time 2	0.26 (0.25) [0.20-0.32]	0.31 (0.31) [0.24-0.39]
Time 3	0.40 (0.55) [0.27-0.53]	0.47 (0.65) [0.31-0.63]
Time 4	0.30 (0.41) [0.20-0.40]	0.41 (0.56) [0.26-0.55]

Abbreviation: RCT, randomized controlled trial; EHS, Early Head Start; ABC, Attachment and Biobehavioral Catch-up; BOW, Book-of-the-Week.

[a] No. of infant assays were: 67 for EHS + ABC and 64 for EHS + BOW/Control at time 1; 67 for EHS + ABC and 69 for EHS + BOW/Control at time 2; 71 for EHS + ABC and 67 for EHS + BOW/Control at time 3; and 64 for EHS + ABC and 59 for EHS + BOW/Control at time 4.

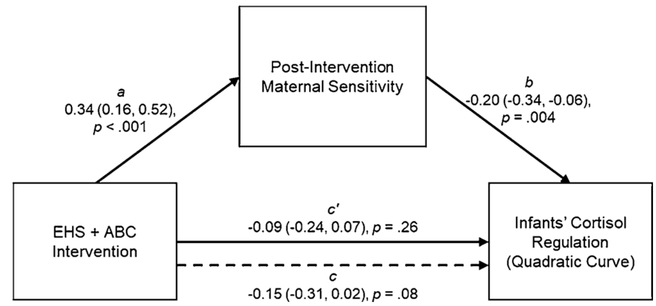

Fig. 3. Unstandardized path coefficients with 95% confidence intervals in parentheses (ICC = 0.84, Design Effect = 128.68). EHS indicates Early Head Start; ABC, Attachment and Biobehavioral Catch-up.

4. Discussion

The current RCT was the first to test the effects of an attachment-based parenting intervention on typically developing infants' stress-induced cortisol production. The findings of both a direct and indirect intervention effect on infants' cortisol regulation not only illustrate a causal role of early parenting in infants' cortisol production but also add to the literature on the promise of parenting interventions for facilitating early cortisol regulation. The current findings supported the hypothesized effects of the EHS plus ABC intervention on infant cortisol regulation. These effects, on the quadratic curve in infants' cortisol production, indicate different rates of cortisol change in response to the stressors in the intervention versus control group. The indirect effect indicated that intervention's impact on mothers' sensitive parenting was a mechanism underlying the RCT group differences. As predicted, the intervention improved parenting behavior which in turn improved infant cortisol regulation.

Close inspection of the cortisol values for each RCT group highlights intervention effects on cortisol *recovery*. Specifically, although the control infants produced more cortisol than the intervention infants at all time points, the two groups followed roughly parallel tracks until time 3, at which point their trajectories diverged. The mean change in cortisol from time 3 to time 4 in the intervention group was 0.08 µ/dL, whereas in the control group it was 2.6 times lower, 0.03 µ/dL. Put another way, the intervention group's mean cortisol level dropped by approximately 20% between times 3 and 4 whereas the control group's mean cortisol level dropped by approximately 6% during this same interval.

The intervention effect on infant cortisol recovery, *per se,* is consistent with the focus of the ABC program on promoting sensitive parenting behavior (i.e., strong social buffering). The intervention mothers' return from the separation appeared to prompt a decline in their infants' cortisol levels, whereas the control infants' elevated cortisol levels were sustained. These results parallel those from previous non-experimental studies (e.g., Albers et al., 2008; Laurent et al., 2016). They are also consistent with previously demonstrated effects of the ABC intervention on infant attachment security (Bernard et al., 2012), a defining feature of which is the infant's confidence in the caregiver's nurturance during times of distress (Cassidy, 2016). A relatively quick down-regulation of circulating cortisol, moreover, protects both physical and mental health by returning the body to glucose homeostasis. That the intervention effects on cortisol recovery were more pronounced than those for cortisol reactivity suggests that the combination of the novel masks followed by the absence of the mother (buffering agent) elicited a similarly strong cortisol reaction in intervention and control infants. In addition, the lack of intervention effects on time 1 (pre-activity baseline) cortisol suggests that all infants had a similarly strong reaction to the researchers arriving in their homes and beginning saliva sampling.

The current set of findings of (a) intervention effects on maternal sensitivity and infants' stress-induced cortisol regulation and (b) no intervention effect on time 1 (pre-activity baseline) cortisol is partially consistent with those of DePasquale et al. (2018) (i.e., associations between maternal sensitivity and infants' stress-induced cortisol reactivity but no ABC intervention effect on infants' cortisol reactivity or recovery) and inconsistent with those of Dozier et al. (2008) (i.e., an ABC intervention effect on infants' baseline but not stress-induced cortisol). These inconsistencies across studies may reflect differing samples of infants. The current study included typically developing infants with considerably more consistent early caregiving environments than those experienced by foster infants or internationally adopted infants. Indeed, disruptions in early caregiving have been associated with blunted patterns of cortisol regulation (e.g., Fisher et al., 2011; Gunnar and Vazquez, 2001). The inconsistencies across studies may also reflect differing assessment contexts (e.g., home- versus lab-based stressors). As numerous researchers have discussed, the assessment of stress-responsive cortisol appears highly sensitive to multiple factors and must be conducted - and interpreted - accordingly.

The current trial had both strengths and limitations. Strengths included the RCT design with an active control condition that implicated the supplemental ABC program as pivotal in the enhanced EHS plus ABC model. The study also benefitted from high rates of retention, minimal missing data, and from the use of precise, well-validated research measures. Robustness of the findings was bolstered by the conservative, intent-to-treat approach and the use of statistical models that included multiple covariates.

One limitation pertains to the variation in the time of day of infant saliva sampling. Although time of day was covaried, it would have been ideal to standardize the time of saliva collection. Another limitation of the current study is the lack of data pertaining to infants' behavioral reactivity and regulation. Analysis of intervention effects on infants' stress-induced behaviors and on the correspondence between infants' behavioral and cortisol regulation stand to add to the developing understanding of social buffering. These analyses (contingent upon ongoing video coding) will be the subject of future reports.

5. Conclusion

The social buffering framework specifies that supportive social partners regulate behavioral and physiological responses to threat which in turn influence humans' physical and mental health trajectories (Gunnar, 2016). The current findings support and extend the social buffering framework by pinpointing increased sensitive maternal behavior as the mechanism through which an attachment-based parenting intervention improved infants' cortisol regulation, an important biomarker. From a public health perspective, these findings, while requiring replication, suggest the preventative value of attachment-based parenting interventions.

Conflicts of interest

None.

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Appendix A

Table A1
Multilevel Modeling Coefficients of Direct Intervention Effects on Infants' Cortisol Regulation.

Intervention Effect[a]	*B* (95% CI)	*P* value
Dependent variable: intercept		
Intervention	0.01 (-0.20 to 0.22)	.94
Infant age	−0.03 (-0.06 to -0.01)	.02
Time of day	0.01 (-0.04 to 0.05)	.72
Time 1 cortisol	0.70 (0.59 to 0.80)	< .001
Dependent variable: linear slope		
Intervention	0.29 (-0.04 to 0.62)	.08
Infant age	−0.04 (-0.08 to 0.00)	.05
Time of day	0.03 (-0.03 to 0.09)	.27
Time 1 cortisol	0.16 (0.01 to 0.32)	.04
Dependent variable: quadratic slope		
Intervention	−0.15 (-0.31 to 0.02)	.08
Infant age	0.01 (-0.01 to 0.04)	.20
Time of day	−0.01 (-0.04 to 0.02)	.49
Time 1 cortisol	−0.11 (-0.20 to -0.02)	.02

[a] Estimates are reported as unstandardized coefficients (*B's*).

Table A2
Multilevel Modeling Coefficients of Indirect Intervention Effects on Infants' Cortisol Regulation.

Intervention Effect[a]	*B* (95% CI)	*P* value
Dependent variable: post-intervention maternal sensitivity		
Intervention	0.34 (0.16-0.52)	< .001
Infant age	0.02 (0.00-0.04)	.07
Pre-intervention maternal sensitivity	0.62 (0.51 to 0.73)	< .001
Dependent variable: intercept		
Post-intervention maternal sensitivity	−0.04 (-0.21 to 0.14)	.69
Intervention	0.02 (-0.19 to 0.24)	.84
Infant age	−0.03 (-0.06 to 0.00)	.03
Time of day	0.01 (-0.04 to 0.05)	.70
Time 1 cortisol	0.69 (0.59 to 0.80)	< .001
Pre-intervention maternal sensitivity	0.01 (-0.16 to 0.19)	.90
Dependent variable: linear slope		
Post-intervention maternal sensitivity	0.42 (0.12 to 0.71)	.01
Intervention	0.16 (-0.15 to 0.48)	.31
Infant age	−0.05 (-0.09 to -0.01)	.02
Time of day	0.03 (-0.03 to 0.09)	.29
Time 1 cortisol	0.18 (0.03 to 0.34)	.02
Pre-intervention maternal sensitivity	−0.27 (-0.52 to -0.02)	.04
Dependent variable: quadratic slope		
Post-intervention maternal sensitivity	−0.20 (-0.34 to -0.06)	.004
Intervention	−0.09 (-0.24 to 0.07)	.26
Infant age	0.02 (0.00 to 0.04)	.12
Time of day	−0.01 (-0.04 to 0.02)	.49
Time 1 cortisol	−0.12 (-0.20 to -0.03)	.01
Pre-intervention maternal sensitivity	0.15 (0.03 to 0.28)	.02
Indirect effect: intervention on cortisol via post-intervention maternal sensitivity		
Dependent variable		
- Intercept	−0.01 (-0.07 to 0.05)	.68
- Linear slope	0.14 (0.02 to 0.26)	.02
- Quadratic slope	−0.07 (-0.13 to -0.01)	.02

[a] Estimates are reported as unstandardized coefficients (*B's*).

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