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Sarah Kim April 12, 2022

Examining the Associations between Maternal Childhood Maltreatment, Mother-Infant Attunement, and Constructive Parenting Behaviors in a Sample of Black American Mothers

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Abstract

Examining the Associations between Maternal Childhood Maltreatment, Mother-Infant Attunement, and Constructive Parenting Behaviors in a Sample of Black American Mothers

By Sarah Kim

Maternal childhood maltreatment may pose challenges for a mother's ability to bond with her child and employ warm and responsive parenting. Yet it remains unclear whether and how the ability of mother and her child to synchronize in their behaviors and physiology (known as "attunement") may relate to maternal exposure to early maltreatment and displayed parenting quality. In a sample of 105 Black American mother-infant dyads, we examined whether different types of maternal childhood maltreatment were differentially related to mother-infant behavioral and physiological attunement at infant age 6-months and whether the attunement was related to mother's constructive (warm and responsive) parenting behaviors. We collected retrospective reports of maternal childhood abuse during pregnancy and reports of experiences of being parented by their own mothers, as well as mother-infant behavioral mutuality and diurnal cortisol attunement measured at six months postpartum. Mother's exposure to childhood maltreatment did not predict her behavioral or physiological attunement with her offspring. However, greater severity of maternal childhood emotional abuse predicted lower mother-infant behavioral attunement when mothers reported receiving high care from their own mother. Moreover, behavioral attunement, but not physiological attunement, predicted constructive maternal parenting behaviors. Our results suggest that the experience of being maltreated in childhood does not determine how well a mother will connect with her infant, and that different types of maternal childhood maltreatment may result in differential associations with observed mother and infant behaviors early in the postpartum period.

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Introduction

Childhood adversity encompasses a wide range of disparate experiences such as abuse, neglect, extreme poverty, parental psychopathology, and family dysfunction. Exposure to these early life stressors may disrupt individuals' healthy development and further affect the subsequent generation through negative parenting behaviors (Kessler et al., 2010; Lomanowska et al., 2017). For instance, mothers who have experienced childhood maltreatment, which includes physical, emotional, and sexual abuse and neglect, have more difficulty bonding with their children and display lower levels of warm and responsive parenting behaviors (Muzik et al., 2013; Robinson et al., 2019). Less warm and responsive parenting is associated with poorer emotional outcomes in children (Bailey et al., 2009; Lomanowska et al., 2017; Pawlby et al., 2011); however, there is a lack of research examining the mechanisms by which maternal childhood maltreatment shapes later parenting behaviors. Some studies have shown that the ability of mother and her child to synchronize in their behaviors and physiology (known as "attunement") may play a role in the process (Fuchs et al., 2017; Hendrix et al., 2018; van Bakel & Riksen-Walraven, 2008), but relatively little is known about the association between maternal childhood maltreatment, mother-child attunement, and parenting behaviors. Therefore, the current study aims to examine how mothers' early maltreatment exposure associates with mother-child physiological and behavioral attunement and how attunement relates to maternal parenting behaviors. Children of mothers who were exposed to childhood maltreatment are more likely to experience childhood maltreatment themselves (Plant et al., 2013), highlighting the importance of identifying the pathways through which early childhood adversity negatively impacts the next generation.

A notable strength of the current study is its sample consisting exclusively of African American (AA) mother-infant dyads. Different cultural definitions and concepts on parenting behaviors suggest that the examination of parenting might benefit from studies within racial and ethnic groups, rather than across them. For example, parenting involving high control with warmth leads to positive child outcomes in AA samples in contrast to negative outcomes that have been noted in White samples (Tamis-LeMonda et al., 2008). Caregivers and teachers also report higher levels of externalizing behaviors in AA children compared to European American children (Miner & Clarke-Stewart, 2008), and AA and Black Americans also have the highest prevalence of childhood maltreatment with 1 out of 5 black children experiencing maltreatment (Wildeman et al., 2014). It should be noted that these high prevalence rates may be due to greater surveillance and therefore more reports to government services in neighborhoods associated with poverty and high numbers of ethnic minority individuals (Gibson-Davis, 2008). It is nonetheless important to study how childhood maltreatment in AA mothers relate to her current parenting behaviors to inform early parenting interventions targeting this population.

Associations between Maternal Childhood Maltreatment and Mother-Child Behavioral and Physiological Attunement

Maternal early childhood maltreatment negatively affects parenting through decreased constructive parenting – that is, warm and responsive parenting (Lomanowska et al., 2017; Bailey et al., 2009; Robinson et al., 2019). A constructive parenting style is associated with positive child health outcomes such as higher self-esteem and resilience, lower stress levels, prosocial behaviors, and higher socioeconomic status in adulthood (Chen & Kaplan, 2001; Cheng et al., 2016). Mothers with a history of childhood maltreatment, however, display lower levels of warmth and sensitivity in response to their children. For example, studies examining

mother-child interactions found that mothers with a history of childhood maltreatment employed more harsh discipline and intrusive parenting behaviors (Moehler et al., 2007; Muzik et al., 2013). They also engaged less frequently and less positively, and showed more restricted affect toward their children (Robinson et al., 2019). These harsh and less emotionally involved parenting behaviors suggest that mothers who experienced abuse and neglect from their caregivers early in their own life may have difficulty bonding with and providing quality care to their children. In fact, mothers who experienced early life maltreatment show greater bonding impairment with their infants as early as 6 months postpartum (Muzik et al., 2013).

Maternal childhood maltreatment is also associated with higher levels of offspring internalizing and externalizing symptoms such as disruptive behavior disorders, conduct problems, and emotional difficulties (Robinson et al., 2019; Rijlaarsdam et al., 2014; Plant et al., 2012; Myhre et al., 2014); however, multiple questions remain about the mechanisms by which parenting mediates these negative consequences of maternal childhood maltreatment in their children and what potential protective factors affect this process. One important consideration is the increased risk for psychopathology related to childhood maltreatment. Population-based epidemiology studies indicate that childhood maltreatment was consistently associated with the first onset of 20 DSM-IV disorders across timepoints from adolescence into later adulthood (Green et al., 2010; Kessler et al., 2010; McLaughlin et al., 2012). This means that individuals who experienced childhood maltreatment are more likely to develop mental disorders throughout their lifetime. In fact, the experience of childhood maltreatment increases the likelihood of maternal depression, anxiety, and substance use during pregnancy (Kendler et al., 2000; Lang et al., 2006) and the symptoms are likely to continue into motherhood (Pawlby et al., 2011). Maternal psychopathology may have negative parenting consequences, such as difficulty paying

attention to child's needs or inability to form secure attachment with offspring. It is also notable that individuals with early maltreatment also report experiencing more adverse life events as adults, which suggests heightened perceived stress (Min et al., 2013) that may also exhaust the emotional resources that mothers need to allocate to their children.

One aspect of warm and responsive caregiving involves the mother's sensitive awareness of her child's needs in mutually regulated and flexible interaction (Shin et al., 2008). This reciprocal emotional and behavioral matching between mother and child is known as mother-child behavioral attunement (Fuchs et al., 2017). A large body of evidence indicates that maternal responsivity and sensitivity in infancy are associated with infants' positive mood and social behaviors (Kivijärvi et al., 2001), and predict lower levels of externalizing symptoms and emotion dysregulation later in development (Najman et al., 2000; Miner & Clarke-Stewart, 2008). Similarly, positive affect expressed by mothers and maternal synchrony with infant affect are related to children's self-control, adjustment, and social competence (Eisenberg et al., 2001; Feldman et al., 1999). In sum, higher levels of maternal sensitivity and mutual responsiveness lead to a meaningful and healthy emotional connection between a mother and her child.

A complementary construct is the reciprocal matching of biological markers between mother and child, known as physiological attunement. Some studies have focused on cortisol as the biomarker of physiological attunement as the hormone plays a key role in regulating the hypothalamic-pituitary-adrenal (HPA) axis and limbic system and found conflicting results with mothers who have a history of maltreatment. Empirical research suggests that maternal and child diurnal cortisol attunement correlates with the quality of behavioral attunement such as maternal sensitivity and child responsiveness (Fuchs et al., 2017). Mother-child attunement is also stable across infancy and toddlerhood and this stability is strengthened by greater maternal sensitivity

(Hibel et al., 2015), suggesting that mother-child attunement, regardless of the type, may be a representation of the sensitive and warm parenting behaviors. Although one study of women with high rates of psychopathology found that mother-infant dyads showed consistent mirroring of cortisol (Hendrix et al., 2018), another found that mothers with a history of early life maltreatment exhibited lower levels of diurnal cortisol synchrony with their children (Fuchs et al., 2017). The current study will explore this question in more detail, examining the relationship between maternal childhood maltreatment and both behavioral and physiological markers of mother-infant attunement.

Conceptual Model for the Association between Maternal Childhood Maltreatment and Mother-Infant Attunement

There are several potential mechanisms by which maternal childhood maltreatment may affect mother-child attunement (see Figure 1).

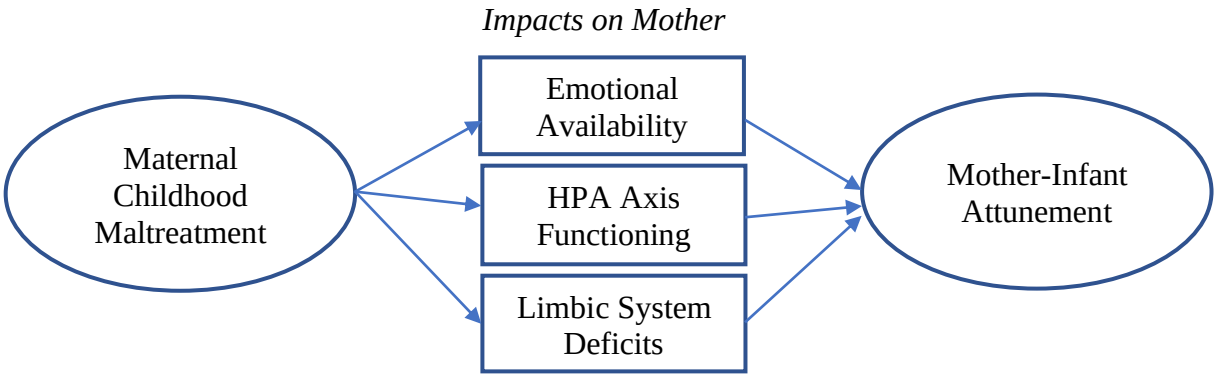


Figure 1. The conceptual model shows how the association between maternal childhood maltreatment and mother-infant attunement may be mediated by maternal emotional availabilty, HPA axis functioning, and limbic system deficits.

First, exposure to childhood maltreatment may disrupt a high quality mother-child connection by inhibiting mothers' affective expressivity, emotional regulation, and bonding with

her child (Grassi-Oliveira et al., 2008; Lyons-Ruth & Block, 1996; Muzik et al., 2013). Explained by the concept of emotional availability (EA; Biringen et al., 1998), the capacity to show sensitivity and respond mutually predict the successful connection between mother and her child and the lack of this capacity results in a disrupted connection. In fact, a longitudinal study with mother-infant pairs found that EA was significantly lower in mothers with a history of childhood abuse and their 12-month-old infants compared to controls (Fuchs et al., 2015).

In addition, childhood maltreatment may be associated with neurobiological deficits in mothers. For example, the HPA axis is triggered by stress to release glucocorticoids such as cortisol. This adaptation may provide short-term protection against the deemed threat; however, chronic exposure to stress, as it often is the case with childhood maltreatment, can lead to irreversible changes in brain structure and function (McEwen & Stellar, 1993; McLaughlin et al., 2014). Indeed, early life maltreatment disrupts the development of the HPA axis (Gunnar & Quevedo, 2007). The disruption in the HPA axis is associated with greater reactivity to stress-inducing stimuli and lessens the regularity of cortisol secretion, influencing how mothers respond to their children, both physiologically and behaviorally.

Childhood maltreatment is also associated with disrupted limbic system functioning (Teicher et al., 2003, 2006), with negative consequences for emotional expression and cognition (Teicher et al., 2000; Ashy et al., 2017; Grassi-Oliveira et al., 2008; Anderson et al., 2002; Dackis et al., 2012; Mercurio et al., 2020). Difficulty expressing and controlling emotions hinders the mother's ability to quickly react to her child's changing needs and respond in a warm and engaged manner and thus negatively impacts her attunement with her child.

Types of Maltreatment

It is also unclear whether and how different types of maternal childhood maltreatment might differentially affect mothers and their relationship with their children. Empirical findings suggest that the amount of abuse, but not of neglect, is associated with more responsivity in representing affective information and less responsivity in response control (Blair et al., 2019), which may explain the heightened reactivity to stressful situations and less affective response to children found in mothers with a history of childhood maltreatment. In other studies, exposure to sexual abuse shows the strongest association to risk of suicide attempts and problem alcohol use (Hoertel et al., 2015; Galaif et al., 2001), and a history of sexual abuse and physical neglect have been found to predict maternal depression, anxiety, and substance use more strongly during the pregnancy and postpartum period (Lang et al., 2006; Kendler et al., 2000). In contrast, other studies have demonstrated that exposure to emotional abuse and neglect are associated with increased maternal anxiety, depression, posttraumatic stress, physical symptoms, and lifetime trauma exposure (Spertus et al., 2003). One possible explanation posed for the differential impacts of different types of childhood maltreatment is that some may act as a source of deprivation (e.g. emotional neglect) and others may act as a threat (e.g. physical abuse) which have different effects on neurodevelopment (McLaughlin et al., 2014). However, it is important to note that adverse childhood experiences often co-occur and the effects of each type of maltreatment are difficult to tease apart in studies (Kessler et al., 2010). The current study will explore how different types of childhood maltreatment are associated with mother-child attunement, as this is an understudied area of the impacts of early childhood adversity.

Optimal Experiences of Being Parented as a Potential Protective Factor

One possible moderator in the association between maternal childhood maltreatment and mother-infant attunement is mothers' own experience of being parented. Parenting behaviors are

affected by the parenting that individuals themselves received early in life (Bailey et al., 2009; Chen & Kaplan, 2001; Simons et al., 1991). Research supports that both harsh and constructive parenting style can be transmitted intergenerationally (Bailey et al., 2009; Cheng et al., 2006; Simons et al., 1991). This continuity of parenting style may be attributable to children observing their parents and adopting role-specific behaviors later, when they are parents themselves (Chen & Kaplan, 2001; Conger et al., 2003). Of relevance to the current study, a constructive parenting style that is high in warmth and responsiveness is associated with higher self-esteem, lower stress levels, and resilience (Chen & Kaplan, 2001) as well as better adjustment, prosocial behaviors, and higher SES in the subsequent generation (Cheng et al., 2016). Constructive parenting received in childhood predicts mothers' later psychological health (i.e. higher self-esteem, lower stress levels, and resilience), internal working models for healthy social interactions, and participation in social activities which lead to more warm and responsive interaction with their children (Chen & Kaplan, 2001; Cheng et al., 2016; Conger et al., 2003). Therefore, constructive parenting received during childhood may act as a protective factor against intergenerational continuity of negative consequences of childhood maltreatment.

Associations between Mother-Child Behavioral/Physiological Attunement and Maternal Parenting Behaviors

It appears evident that the physiological and behavioral attunement between mother and her child are related. The reciprocity of the biomarkers represents an established regulatory dyadic system in which both mother and child react to each other and to external stimuli in a similar manner. The neurobiological connectivity indicates a working social functioning and is associated with mutual behaviors (Atzil et al., 2017), setting the ground for one of the most important early life relationships to be formed with intact bonding. Attunement and parenting,

therefore, are closely linked, as a constructive parenting style requires mothers to be reactive and warmly engaged in respect to what her child needs, and the contingent affect and mutual regulation also foster positive parenting behaviors in return (Feldman et al., 1999). Maternal experience of childhood maltreatment inhibits attunement and thus positive parenting by interrupting mother's ability to acutely respond to and bond with her offspring, although if the mother received positive parenting the disruptions elicited by maltreatment may be weakened.

The following model provides a proposed overall mechanism by which maternal childhood maltreatment is linked to parenting (Figure 2).

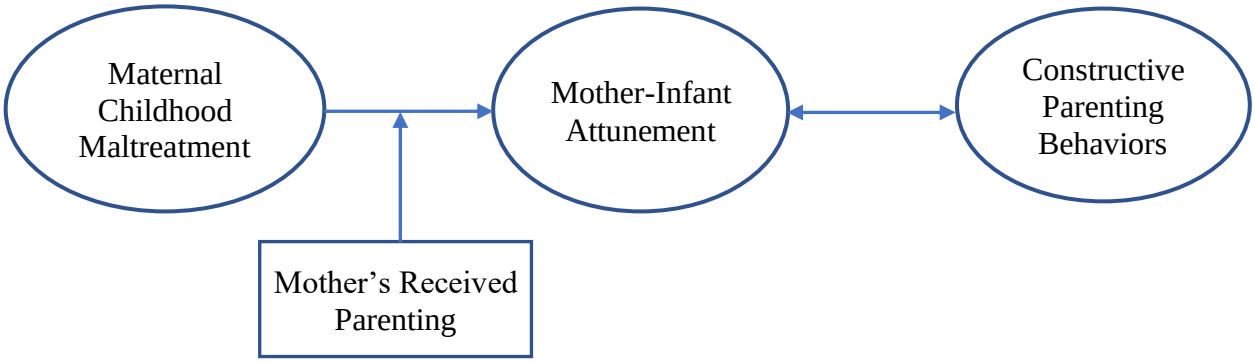


Figure 2. Hypothesized model by which mother's received parenting moderates the association between maternal exposure to childhood maltreatment and mother-infant physiological and behavioral attunement and how the attunement is associated with maternal constructive parenting behaviors.

The Current Study

The current study aims to further explore how maternal early life maltreatment relates to mother-child physiological and behavioral attunement in a non-clinical sample of African American (AA) mother-infant dyads. If mothers who experienced childhood trauma and adversity show differential attunement with offspring, this might be informative for parenting

intervention programs. In the proposed study, we will expand the understanding of mother-child attunement by exploring the following main aims: (1) to evaluate the associations between maternal childhood maltreatment and mother-infant physiological and behavioral attunement, (2) to evaluate whether maternal retrospective reports of their own parenting experiences moderate the associations between maternal childhood maltreatment and mother infant physiological and behavioral attunement, and (3) to evaluate whether the mother-infant physiological and behavioral attunement are associated with maternal constructive parenting behaviors. We hypothesize that (1) maternal childhood maltreatment will predict lower physiological and behavioral attunement between mother and her offspring and that different subtypes of maternal childhood maltreatment might have varying effects on attunement, (2) mothers with the experience of childhood maltreatment who report their own mothers being high in care will show higher physiological and behavioral attunement with their infants, and (3) mother-infant physiological and behavioral attunement will be associated with maternal constructive parenting behaviors.

Methods

Participants

The sample is derived from a pre-existing cohort of African American (AA) mother-infant dyads. Mothers were recruited for a longitudinal study during the second trimester of pregnancy (R01NR014800) and mothers and infants were subsequently followed across the first 18 months postpartum (R01MD009746). To create a socioeconomically diverse sample, mothers were recruited from a public hospital and a private hospital in the Atlanta area. Mothers provided written and verbal consent and were compensated monetarily for their participation. The study was approved by the Emory University Institutional Review Board.

Participant families were included in the current secondary analysis study, contingent on the availability of data concerning mothers' childhood trauma history and mother-child interaction quality at infant ages 6-months which provided a prospective, longitudinal sample of 105 women and their infants for this study. Mothers' ages ranged from 18 to 40 years (M = 25.2, SD = 5.2), and 42.9% of mothers were married or cohabitating. Of the infants, the majority were male (n = 59, 56.2%). See Table 1 for additional demographic information for the study participants.

Table 1. *Sample demographics*

Variable		Range
Maternal age, *M* (*SD*)	25.2 (5.2)	18-40
Married/Cohabitating, *N* (*%*)	45 (42.9) yes	--
Education, *N* (*%*)	45 (42.9) high school graduate	--
Income, *N* (*%*)	52 (49.5) below the poverty line	--
Parity, *M* (*SD*)	1.0 (1.0)	0-4
Parental Bonding Inventory, *M* (*SD*)		
Care score	25.7 (8.8)	0-36
Overprotection score	16.5 (7.2)	2-34
Childhood Trauma Questionnaire, *M* (*SD*)		
Total	43.9 (18.6)	25-116
Sexual abuse	7.9 (5.6)	5-25
Physical abuse	7.9 (4.3)	5-25
Emotional abuse	8.6 (5.1)	5-25
Physical neglect	8.1 (3.7)	5-23
Emotional neglect	11.3 (5.5)	5-25
Parenting Behaviors, *M* (*SD*)		
Parental Sensitivity	3.2 (0.8)	1-4
Parental Positive Regard	3.3 (0.7)	1-4
Mutuality, *M* (*SD*)	2.3 (1.0)	1-4
Infant		
Sex, *N* (*%*)	59 (56.2)	--
Gestational age at birth, *M* (*SD*)	38.7 (2.2)	25-41.4
Child negativity, *M* (*SD*)	1.9 (1.1)	1-4

Measures

Maternal Early Life Experiences

Mothers reported on their history of early-life trauma and the parenting they received in childhood on the following measures:

Childhood Trauma Questionnaire–Short Form (CTQ-SF; Bernstein et al., 2003). During the second trimester of pregnancy, mothers completed the validated and reliable (α=0.94) retrospective self-report questionnaire measuring childhood trauma and maltreatment. The 28-item scale measures childhood trauma and maltreatment on five subscales: sexual abuse (e.g. was touched sexually), physical abuse (e.g. hit hard enough to see doctor, punished with hard objects), emotional abuse (e.g. parents wished was never born, felt hated by family), physical neglect (e.g. not enough to eat, parents were drunk or high) and emotional neglect (e.g. made to feel unimportant, family did not feel close). Each subscale consists of five items in the questionnaire and the last three items correspond to Minimization/Denial validity scale to detect any underreporting of maltreatment. Each item was rated on a 1-5 Likert-type scale and items were then totaled, such that higher scores on each subscale indicated greater abuse or neglect. Overall maternal childhood trauma score was computed by summing all the scores from individual questions. The CTQ has been validated and demonstrates good reliability (Bernstein et al., 2003).

Parental Bonding Instrument (PBI; Parker, 1989). The PBI is a 25-item maternal self-report measure that asks about experiences of being parented up to 16 years of age. The scale focuses on the behaviors and attitudes of the respondent's mother towards the respondents and includes items such as "let me do those things I liked doing," "frequently smiled at me," and "was affectionate to me." Each item is rated on a 4-point scale ranging from very like to very unlike. Parenting on this measure is defined in two dimensions of care and overprotection. To be consistent in the definition of constructive parenting as warm and responsive parenting in the

current study, the scores for the care dimension (α=0.88) were used in primary analyses, with higher scores indicating higher received constructive parenting.

Behavioral Attunement

The Three-Bag Assessment involves mother-infant dyads being videotaped during a five-minute play interaction at infant age 6-months, after which maternal and child interaction behaviors were coded offline. Behavioral attunement was operationalized as "mutuality" and rated on a 1-4 Likert-type scale with a higher score indicating greater attunement. Coders coded mutuality as synchrony and connection in energy and affective levels and mutual pleasure in mother-child interaction. Coders were trained with sample interaction videos until the coding reached 0.80 interrater reliability.

Physiological Attunement

Mothers used oral swabs to collect three samples of saliva each from her and infant throughout the course of one day (at awakening, and at 30-minutes and 12-hours after awakening). Mothers were sent text reminders at each of the saliva collection times and were asked to record what time they collected the sample. Saliva samples were stored at room temperature until staff returned them to the lab, at which point they were frozen at -80 °F. Samples were batch assayed at Salimetrics using a high-sensitivity enzyme immunoassay. This assay has a lower sensitivity limit of 0.007 lg/dL, a standard curve ranging from 0.012–3.0 lg/dL, an average intraassay coefficient of variation of 4.60%, and an average interassay coefficient of variation of 6.00%. Notably, these standards exceed the National Institutes of Health guidelines for enhancing reproducibility through rigor and transparency.

Constructive Parenting

Constructive parenting is operationalized as maternal positive regard and sensitivity as observed in a 5-minute free play session in the home or lab when the infants were six months of age. Positive regard was operationalized as mothers' observed warmth towards their infants (e.g., facial expressions, vocal tone, physical touch). Sensitivity was operationalized as mothers' responsiveness to their infants, and their ability to create a child-centered interaction. Both factors were rated on a 1-4 Likert-type scale with higher score indicating greater positive regard and sensitivity, respectively. The scores show good reliability at 6-months (α=0.90 for positive regard; α=0.96 for sensitivity).

Maternal age, education, and parity were collected during the prenatal phase of the study and were statistically controlled in all analyses.

Procedure

Mothers were recruited in the second trimester of pregnancy in the context of a hospital or clinic prenatal care appointment. They completed a variety of questionnaires including self-reports of childhood trauma. Following the birth of their child, mothers were given a choice to participate in a follow up study in the home or laboratory setting, including visits at infant age 6-months. During each visit, mothers completed a set of printed self-report measures and mother-infant dyads were instructed to have a five-minute free play interaction as they would on a normal day. The questionnaire responses were entered onto a secure and confidential online REDCap database after the visit. The mother-child interactions were videotaped and later coded by trained research assistants. After each visit mothers were given a saliva collection kit and instructions to collect their own and their infant's saliva at three timepoints across the same day. Once the saliva sampling was completed, research staff picked up the samples from the home

and transferred them to a -80 degrees lab freezer for storage. They were later batch assayed for cortisol off-site at Salimetrics.

Analytic Plan

Descriptives including skewness and kurtosis were examined for all variables. Because of their theoretical relevance to mother-child attunement and parenting, the following covariates were entered in all analyses: maternal age, maternal education, and parity.

Multilevel modeling was conducted using Hierarchical Linear Modeling 8 (HLM-8) software to examine the association between mother and child cortisol levels throughout the day and to study predictors of this time-varying association. The infant and mother cortisol levels over 3.0 were removed as outliers and the cortisol data was then log-transformed to correct for skewness and enhance distribution normality. Partial correlation and Hayes PROCESS models were used to test hypotheses where behavioral attunement was the outcome.

Results

Aim 1

Association between maternal childhood maltreatment and mother-infant physiological attunement

HLM was used to examine maternal and infant diurnal cortisol across all three time points. Infant cortisol (grand mean centered) and collection time point (uncentered) were entered as Level 1 predictors of maternal cortisol in the following model:

maternal cortisol = π_{0i} + π_{1i} (time point) + π_{2i} (infant cortisol) + error. (1)

Attunement between mothers and their infants was assessed using significance testing of Level 1 time-varying infant and mother cortisol levels (see Equation 1). Infant cortisol levels significantly predicted maternal cortisol, beyond any shared association between them that was

due to timing of the saliva sample collection. There was not a significant amount of variance remaining in maternal cortisol after accounting for the impact of infant cortisol and sample timing, $\sigma^2 = 0.21$, χ^2 ($df = 47$) = 52.71, $p = 0.26$. This lack of variance suggests that infant cortisol levels consistently predicted maternal cortisol levels across dyads, and that no moderators were present for this association.

Next, maternal cortisol (grand mean centered) and collection time point (uncentered) were entered as Level 1 predictors of infant cortisol in the following model:

infant cortisol = π_{0i} + π_{1i} (time point) + π_{2i} (maternal cortisol) + error. (3)

Attunement between mothers and their infants was assessed using significance testing of Level 1 time-varying mother and infant cortisol measures (see Equation 3). Mothers' cortisol levels significantly predicted infant cortisol, beyond any shared association between them due to timing of the saliva sample collection. There was a significant amount of variance remaining in infant cortisol after accounting for the impact of maternal cortisol and sample timing, $\sigma^2 = 0.33$, χ^2 ($df = 57$) = 91.57, $p < 0.01$, suggesting that moderators of this association could be tested at Level 2. Total CTQ score and each of the subtype (sexual abuse, physical abuse, emotional abuse, physical neglect, emotional neglect) score were individually entered as Level 2 predictors of the slope of the relationship between mother and infant cortisol in the following model (along with covariates):

π_{2i} = β_{20} + β_{21} (CTQ score) + β_{22} (maternal age) + β_{23} (education) + β_{24} (parity). (4)

Assessment time point was set to reflect the fixed effects for this analysis and all HLM analyses involving infant cortisol as the outcome variable as there was no variance in diurnal cortisol change across sample participants. None of the CTQ scores predicted mother-infant attunement (see Table 2). Maternal age was positively associated with physiological attunement

in the predictor models for CTQ total score and all subtypes, and education was negatively associated in the models where CTQ sexual and physical abuse was the predictor.

The hypothesis that maternal childhood maltreatment would predict lower mother-infant physiological attunement was not supported.

Table 2. *Hierarchical linear models of physiological attunement*

Fixed Effect	t	p
Infant cortisol		
CTQ total	0.71	0.48
CTQ sexual abuse	-0.64	0.53
CTQ physical abuse	0.63	0.53
CTQ emotional abuse	0.98	0.33
CTQ physical neglect	1.53	0.13
CTQ emotional neglect	-0.84	0.41

Note: Analyses examined each Level 2 factor as a predictor of the slope of mother and infant cortisol.

Association between maternal childhood maltreatment and mother-infant and behavioral attunement

Partial correlations were examined with covariates statistically controlled. None of the CTQ scores were associated with mutuality at infant age 6-months (see Table 3). The hypothesis that maternal childhood maltreatment would predict lower mother-infant behavioral attunement was not supported.

Table 3. *Partial correlations of behavioral attunement*

CTQ Score	r	p
Total	-0.06	0.59
Sexual abuse	-0.01	0.89
Physical abuse	-0.05	0.65
Emotional abuse	-0.06	0.54
Physical neglect	-0.12	0.23
Emotional neglect	-0.11	0.92

Note: Mutuality score was used to represent mother-infant behavioral attunement.

Aim 2

Mothers' own experience of received parenting as the moderator of the association between maternal childhood maltreatment and mother-infant physiological attunement

There was not a significant amount of variance remaining in maternal cortisol after accounting for the impact of infant cortisol and sample timing as shown in Aim 1 analysis. Therefore, the moderator model was not tested for maternal cortisol.

HLM was used to examine whether the mother's experience of being parented interacted with her experience of trauma to predict physiological attunement. Equation 3 was used for Level 1, and the PBI care dimension score and CTQ scores, and their interaction terms were entered as Level 2 predictors of the relationship between mother and infant cortisol (see Equation 5). The PBI care dimension score did not moderate any associations between CTQ scores and mother-infant physiological attunement (see Table 4). Maternal age was positively associated with physiological attunement in models with emotional abuse, physical neglect, and emotional neglect subtype as the predictor.

The hypothesis that mothers' experience of receiving parenting high in care would moderate the association between maternal childhood maltreatment and mother-infant physiological attunement was not supported.

Table 4. *Hierarchical linear models of physiological attunement with mothers' received parenting as a moderator*

Fixed Effect	t	p
Infant cortisol		
CTQ total	0.25	0.80
CTQ sexual abuse	0.34	0.74
CTQ physical abuse	-0.18	0.08
CTQ emotional abuse	0.12	0.91
CTQ physical neglect	1.31	0.20
CTQ emotional neglect	-0.56	0.58

Note: Analyses examined each Level 2 factor as a predictor of the slope of mother and infant cortisol.

Mothers' own experience of received parenting as the moderator of the association between maternal childhood maltreatment and mother-infant behavioral attunement

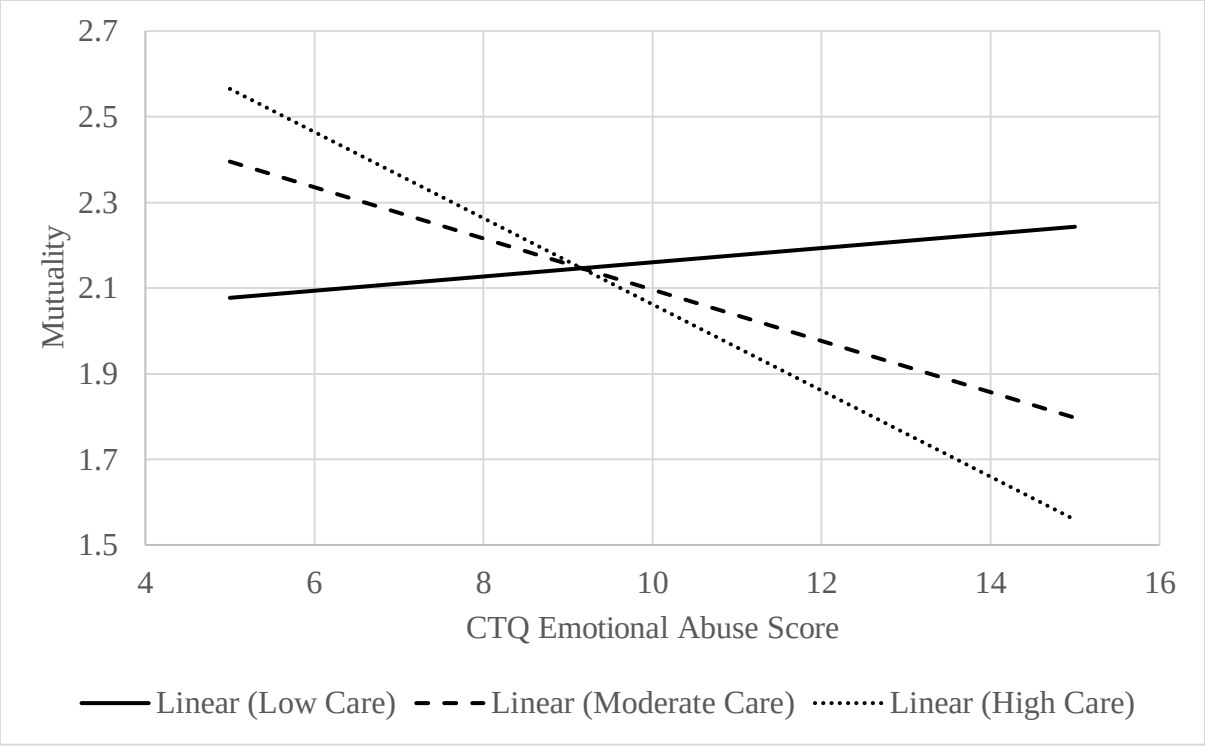
Using Hayes PROCESS models in SPSS, CTQ scores were individually entered in separate models as the independent variable with mutuality score as the dependent variable and PBI care dimension score as the moderator variable. The PBI care score significantly interacted with the CTQ emotional abuse score to predict mutuality, accounting for 6.45% of the variance in the mutuality score (see Table 5 and Graph 1). The hypothesis that mothers' experience of receiving parenting high in care would moderate the association between maternal childhood maltreatment and mother-infant behavioral attunement was partially supported.

Table 5. *PROCESS matrices of behavioral attunement with mothers' received parenting as a moderator*

Interaction with PBI care	t	p	lower CI	upper CI
CTQ total	-1.62	0.11	-0.0038	0.0004
CTQ sexual abuse	-1.08	0.28	-0.01	.0034
CTQ physical abuse	-0.08	0.94	-0.01	0.01
CTQ emotional abuse	-2.01	0.0497	-0.01	-0.00001
CTQ physical neglect	-1.59	0.12	-0.02	.0021
CTQ emotional neglect	-0.44	0.66	-0.0073	0.0046

Note: Analyses examined interaction between CTQ score and PBI care dimension to predict mutuality score to represent mother-infant behavioral attunement.

Graph 1. *Moderating effect of mothers' received parenting in the association between emotional abuse and behavioral attunement*



Note: Higher PBI care dimension score indicates more warm parenting mothers received in childhood. Low Care, Moderate Care, and High Care group correspond to mutuality score of 16.8, 28.0, and 34.0, respectively. The relationship between emotional abuse and behavioral attunement was only significant for the High Care group.

Aim 3

Association between mother-infant physiological and behavioral attunement

There was not a significant amount of variance remaining in maternal cortisol after accounting for the impact of infant cortisol and sample timing as shown in Aim 1 analysis. Therefore, the association was not tested for maternal cortisol.

HLM was used to examine the relationship between mother-infant physiological and behavioral attunement with time varying measures of maternal cortisol predicting infant cortisol at Level 1 and the mutuality score entered as Level 2 predictor of the relationship between infant and maternal cortisol as per the following model:

$$\pi_{2i} = \beta_{20} + \beta_{21}\,(\text{mutuality score}) + \beta_{22}\,(\text{maternal age}) + \beta_{23}\,(\text{education}) + \beta_{24}\,(\text{parity}). \quad (6)$$

Mutuality was not associated with mother-infant cortisol attunement (see Table 6). Age was positively associated with physiological attunement whereas parity was negatively associated in the model. The hypothesis that mother-infant physiological and behavioral attunement are related was not supported.

Table 6. *Hierarchical linear models of the association between physiological and behavioral attunement*

Fixed Effect	t	p
Infant cortisol		
Mutuality	-1.05	0.30

Note: Analyses examined each Level 2 factor as a predictor of the slope of mother and infant cortisol.

Association between mother-infant physiological attunement and constructive parenting behaviors

There was not a significant amount of variance remaining in maternal cortisol after accounting for the impact of infant cortisol and sample timing as shown in Aim 1 analysis. Therefore, the association was not tested for maternal cortisol.

HLM was used to examine the relationship between mother-infant physiological attunement and mother's constructive parenting behaviors with time varying measures of maternal cortisol predicting infant cortisol at Level 1 and parental sensitivity and positive regard entered individually as Level 2 predictor of the relationship between infant and maternal cortisol as per the following model:

$$\pi_{2i} = \beta_{20} + \beta_{21}\,(\text{constructive parenting behavior}) + \beta_{22}\,(\text{maternal age}) + \beta_{23}\,(\text{education}) + \beta_{24}\,(\text{parity}). \quad (7)$$

Neither parental sensitivity nor positive regard was associated with mother-infant physiological attunement (see Table 7). Age, education, and parity were positively associated with physiological attunement in both models.

Table 7. *Hierarchical linear models of the association between physiological attunement and constructive parenting behaviors*

Fixed Effect	t	p
Infant cortisol		
Parental sensitivity	1.20	0.23
Parental positive regard	-0.51	0.61

Note: Analyses examined each Level 2 factor as a predictor of the slope of mother and infant cortisol.

Association between mother-infant behavioral attunement and constructive parenting behaviors

Partial correlations were examined with maternal age, parity, and education as covariates. Both maternal sensitivity and positive regard were associated with mutuality ($r = 0.48$, $r = 0.52$, $p < 0.01$, respectively). The hypothesis that mother-child behavioral attunement would predict more constructive parenting behavior was supported.

Post-Hoc Analyses

The PBI care dimension score interacted with CTQ emotional abuse score to predict child negativity (coded by behavioral observation). For mothers who received high care from their mothers, higher emotional abuse was associated with higher child negativity (coded by behavioral observation) whereas for mothers who received low care from their mothers, higher emotional abuse was associated with lower child negativity. This interaction was not found with PBI overprotection dimension score as a moderator. The PBI care dimension was also negatively associated with CTQ total and all subtype scores. The PBI overprotection dimension score was positively associated with CTQ total and all subtype scores except for emotional neglect, but it

did not have any moderating effect for the association between CTQ score and mother-infant attunement.

Discussion

This study is the first to examine how a woman's childhood experience of maltreatment and parenting upbringing shapes mother-infant physiological and behavioral attunement, and how attunement relates to her constructive parenting behaviors towards her infant. We examined these questions in a sample of Black American mother-infant dyads, a group that is disproportionately exposed to adverse experiences in the United States. We did not find support for the first hypothesis that maternal childhood maltreatment would predict lower mother-infant physiological and behavioral attunement. The second hypothesis that mothers' experience of receiving parenting high in care would moderate the association between maternal childhood maltreatment and mother-infant attunement was only supported for behavioral attunement. Lastly, the hypothesis that physiological and behavioral attunement would be associated and that physiological attunement would be associated with more constructive parenting behaviors was not supported. However, the hypothesis that behavioral attunement would be associated with more constructive parenting behaviors was supported.

Our finding that mothers' experience of being parented specifically interacted with emotional abuse severity (and not other types of abuse) to predict mother-infant behavioral attunement, suggests that different subtypes of childhood maltreatment may have differential effects on attunement. Interestingly, women who report receiving more severe emotional abuse showed lower behavioral attunement with their infant only when they received parenting that was high in care from their mother. For women who reported that their mothers were less high in care, there was no association between childhood emotional abuse and their behavioral

attunement with their child. There are several possible explanations for this seemingly counterintuitive result. In the case that these women were raised in an environment where they were being emotionally abused while also receiving high care from their mothers, the conflictual upbringing may serve as a source of great confusion and stress. The confusion coming from inconsistent treatment received in childhood may inhibit these women's emotional availability necessary to create a meaningful connection with her own child (Fuchs et al., 2015). Previous studies have also noted that exposure to emotional abuse is associated with heightened reactivity to stress and changes in neurodevelopment (Blair et al., 2019; McLaughlin et al., 2014); the reduced emotional control and expression may further contribute to women's inability to attune to her child's needs.

Another explanation is the potential importance of the infant in shaping the mother-infant relationship. For instance, our results show that greater severity of emotional abuse predicted higher negative affect of infant for women who reported receiving high care parenting from their mother. It may be that mothers with this conflicted history of receiving emotional abuse in the contest of high care had children who were higher on negativity, which in turn led to difficulty in connecting with them. The idea that infant has a significant role in the attunement process is consistent with the literature. Hendrix et al. (2018) found that while both maternal and infant cortisol consistently predicted each other's across timepoints, other factors could impact the baby's physiological changes whereas mother's physiological response was solely dependent on her child's physiological changes; this result was replicated in this study. It may be that maternal childhood maltreatment negatively impacts offspring reactivity, as suggested by previous studies (Plant et al., 2012; Myhre et al., 2014). A negatively reactive child may make it difficult for mothers to implement warm and sensitive parenting behaviors as well as to synchronize with

their children. Compared to a stress paradigm where it may be adaptive for mothers and their children to stay attuned in face of a threat (Hendrix et al., 2018), it may not be useful to do so in a day-to-day diurnal cycle.

Overall, maternal age and education level appear to impact mother-infant attunement and mother's constructive parenting. Older aged mothers were more likely to have greater physiological attunement. It may be that as mothers grow older in age and have more knowledge on what constitutes good parenting, they become more socially and emotionally skilled to better attune to their baby's needs. Interestingly, education level showed conflicting findings. It was negatively associated with physiological attunement in hierarchical linear models where sexual and physical abuse was each a predictor. This may be due to more educated women's longer work hours or shorter maternity leave worsening the diurnal physiological cycle disruptions that are related to these specific types of abuse. On the other hand, more education predicted higher physiological attunement in models that accounted for constructive parenting behaviors which suggests that more education is generally positively related to physiological attunement. Education was also the only covariate for mother-infant behavioral attunement in which mothers who were more educated showed greater behavioral attunement. It may be that mothers effortfully change their conscious behaviors to match the level of her infant behaviorally in which case more education helps mothers know what constitutes constructive parenting and make appropriate behavioral adjustments.

There were some limitations to the current study. The sample size was small and different analyses involved smaller sub samples that completed all measures, resulting in low power for our findings. Due to missing values, income was not used as a covariate and education alone was representing participant's socioeconomic status (SES). Also, the current study focused on

mother-infant dyads at infant age 6-months. During this time, the mother-infant relationship and the parenting behaviors may not be representative of that of later toddlerhood and childhood because of the limited abilities of the infants to communicate with their mother. In addition, our study relied on retrospective reports of maternal trauma history and maternal reports of received parenting. This poses a particular concern for the reliability of PBI which measured mother's experience of being parented by her mother; participants may not clearly remember their mother's parenting from decades ago and may even not have an accurate understanding of how warm their mother was. Considering our significant results involving emotional abuse severity, it is even possible that their idea about their mother's parenting may be biased if the perpetrator of emotional abuse was their mother. Lastly, measures for behavioral attunement and parenting qualities came from the same mother-child interaction which may have artificially increased the strength of association between behavioral attunement and constructive parenting.

Nonetheless, the current study had many strengths. It was the first to examine the association between maternal childhood maltreatment and both mother-infant physiological and behavioral attunement outside the context of a stress paradigm, and how these women's experiences of being parented play a role in this association. Different subtypes of childhood maltreatment were analyzed. It was also novel to explore how two types of attunements relate to displayed constructive behaviors. The null results suggest that the experience of being maltreated in childhood does not predict how well a mother will connect with her infant, and that the current social system and environment are more important in shaping the interaction and synchrony with her baby. The idea that the concurrent factors are more relevant than the intergenerational effect of childhood maltreatment is consistent with the recent finding that lifetime discrimination, but not maternal childhood adversity, was associated with increased maternal distress in pregnancy

and later impacts on the newborn (Hendrix et al., 2022). These findings provide an important insight about the importance of considering the social structural differences such as SES and structural racism in interpreting outcomes that vary across different racial and ethnic populations.

Future studies should use a prospective measure of received parenting and separate interactions to measure behavioral attunement versus constructive parenting behaviors. There should also be a focus on how participant's concurrent factors such as secondary caregiver support, current relationship satisfaction, strength of social network, work status shape mother-infant attunement. Moreover, future studies should gather information about the perpetrators of maternal childhood maltreatment to understand how perpetrator identity might influence the long-term impacts of a mother's experience of early life abuse on her physiological and behavioral attunement with her infant, and her constructive parenting behaviors.

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