Predicting Dyadic Synchrony in Early Childhood:
Maternal, Child, and Contextual Antecedents

by

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Abstract

Parent-child dyadic synchrony has been found to predict children's later adjustment outcomes. However, few studies have examined the factors that promote or interfere with the development of synchrony. Using data from the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (N = 1364), the present study examined the role of maternal (i.e., maternal depressive symptoms, responsiveness), child (i.e., temperament), and contextual (i.e., SES) antecedents of mother-child dyadic synchrony at 54 months. The present study aimed to examine the longitudinal association between the trajectory of maternal depressive symptoms and dyadic synchrony, the mediating role of maternal responsiveness in the linkage, and the moderating roles of SES and child temperament. The intercept, but not the slope, of maternal depressive symptoms predicted dyadic synchrony and this link was mediated by maternal responsiveness. Family SES and child temperament moderated the meditational model. Additional analyses sought to identify the specific paths that were moderated by SES and temperament. SES moderated the link between the depressive symptoms intercept and maternal responsiveness; the negative effect of depressive symptoms was stronger for mothers from average SES families than for mothers from low and high SES families. SES did not moderate the responsiveness – synchrony link. Child temperament moderated the link between the depressive symptoms intercept and maternal responsiveness. The negative effect of depressive

symptoms on responsiveness was stronger for mothers of children with average and difficult temperament than for mothers with easygoing children.

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1. INTRODUCTION

From the day a child is born, parents invest their time and effort in meeting the child's needs to be fed, changed, and entertained. Through the rhythm of parents' responding to the child's signals and the fulfillment of the child's needs, a bond between the primary caregivers and the child is formed. Through the repetitive day-to-day rituals and interactions, parents also gradually socialize their children. This intricate dance of interaction facilitates the development of subsequent reciprocal and mutually responsive behaviors between parents and the child, which the child may utilize to interact with people outside the family. No wonder studies have shown that the quality of the parent-child relationship plays a fundamental role in children's socio-emotional and behavioral development (e.g., Ainsworth, Blehar, Waters, & Wall, 1978; Maccoby, 1992; Russell, Pettit, & Mize, 1998; Sroufe, 1983).

The dynamics of influence within parent-child relationships historically were viewed as top-down, vertical, or parent-centered. In fact, the vast majority of parent-child relationship studies have focused on the constructs of parental behaviors toward the child, such as maternal sensitivity, responsiveness, and positive parenting. However, some researchers have argued that the dynamics of parent-child interactions are best characterized as a reciprocal process (e.g., Bell, 1968; Belsky, 1984; Kochanska, 1997; Maccoby, 1992). For example, Maccoby (1992) reconceptualized the socialization process as one in which the child is inducted into a system of reciprocity. Through the formation of a mutually binding, reciprocal, and responsive relationship, parent and child

feel more invested in the relationship and responsive to the other's needs (Kochanska, 1997). Attachment theorists also emphasize the reciprocal nature of the parent-child relationship in that secure attachment is facilitated by the mutual co-operation of parent and child and reciprocal responsiveness of each partner to the other's signals (e.g., Ainsworth, Bell, & Stayton, 1974; Sroufe, 1983).

Many different terms have been used as shorthand for dyadic interaction processes, including reciprocity (Belsky, Rovine, & Taylor, 1984), mutuality (Maccoby & Martin, 1983), and mutually responsive orientation (Kochanska, 1997). Harrist and Waugh (2002) integrated previous work on the dyadic nature of parent-child interaction and suggested the term dyadic synchrony as an organizing concept for this set of similar phenomena. Dyadic synchrony describes the reciprocal and mutually constructed nature of parent-child interaction that requires both parent's and child's responsiveness and their positive emotional availability toward each other. Thus, dyadic synchrony is different from parenting behaviors toward the child in that the term captures both individuals' behavior rather than the mother's alone or the child's alone.

On the other hand, the structure of synchrony changes developmentally from infancy through early childhood (Harrist & Waugh, 2002). During infancy and the toddler years, it is mainly the parents who maintain and coordinate dyadic interaction. What some writers have referred to as parent-infant synchrony (e.g., Isabella & Belsky, 1991; Isabella, Belsky, & von Eye, 1989) might more accurately be referred to as parental responsiveness. Such responsiveness in infancy and toddlerhood is considered a prerequisite for the development of true parent-child synchrony. It is not until the preschool years that children come to exert equal or near-equal power in engaging or

withdrawing from interaction (Kochanska, 1997; Kochanska, Aksan, Prisco, & Adams, 2008; Vizziello, Ferrero, & Musicco, 2000). Thus, true synchrony that is a product of equal or roughly equal contributions by both the parent and the child may not become fully apparent until the preschool years (Harrist & Waugh, 2002).

Empirical research has revealed that synchronous parent-child interactions are predictive of children's later adjustment outcomes. For instance, children whose interactions with their primary caregivers are characterized by high levels of synchrony are more socially competent, securely attached, compliant, and show greater verbal ability (e.g., Isabella, Belsky, & von Eye, 1989; Lindsey, Cremeens, Colwell, & Caldera, 2009; Mize & Pettit, 1997; Rocissano, Slade, & Lynch, 1987). In fact, parent-child synchronous interaction during the preschool years is uniquely associated with positive outcomes for children even after controlling for individual parent and child behaviors (e.g., Lindsey, Mize, & Pettit, 1997).

Despite the evidence that parent-child dyadic synchrony is a powerful predictor of children's adjustment, very little is known about the factors that promote or interfere with the development of synchrony. Because synchrony is dyadic and co-constructed, the capacity to achieve synchrony may be a function of individual differences in both members of the dyad. Previous research does, in fact, link maternal factors such as maternal depressive symptoms (Feldman, 2003; Feldman & Eidelman, 2007) and responsiveness (Skuban, Shaw, Gardner, Supplee, & Nichols, 2006) and child factor such as negative emotionality (Feldman, 2003; Skuban et al., 2006) to dyadic synchrony in infancy and toddlerhood. However, few studies have investigated both parent and child factors simultaneously in relation to dyadic synchrony and even fewer have looked at

dyadic synchrony during preschool when it can be expected that both parent and child contribute about equally to the interaction. Moreover, previous studies have used correlational and cross-sectional designs, making it difficult to infer direction of influence. Development of approaches for analyzing change (e.g., Singer & Willett, 2003) and the availability of large longitudinal data sets (e.g., NICHD SECCYD) now make it possible to examine how early parent and child factors are associated with later dyadic synchrony.

In identifying potentially important early influences on parent-child dyadic synchrony during the preschool years, it is useful to consider conceptual models of parent-child relationships. In this regard, Belsky's (1984) model for the determinants of parenting is particularly helpful because it suggests parental, child, and contextual domains of influence on parental functioning and child development. Moreover, these domains, and factors within each domain, may act in cascading and interactive fashion to influence dyadic synchrony. For instance, maternal depressive symptoms may influence children and parent-child dyadic synchrony indirectly by initiating a cascade of negative effects on maternal behavior. It has been found that higher maternal depressive symptoms are associated with lower levels of parent-child synchrony (e.g., Field, Healy, Goldstein, & Guthertz, 1990; Lunday, 2002). Mothers displaying higher levels of responsiveness toward children have greater parent-child synchronous interaction and have children with higher responsive behaviors and compliance (e.g., Goin & Wahler, 2001; Kochanska et al., 2008; Skuban et al., 2006). The course of maternal depressive symptoms over time also affects maternal behaviors. Mothers whose depression symptoms are chronically high or worsen over time tend to be less responsive to their children than are mothers whose depression symptoms improve over time (e.g., Campbell, Matestic, von

Stauffenberg, Mohan, & Kirchner, 2007; Frankel & Harmon, 1996). However, the cascade model of the effects of maternal depressive symptoms on synchrony has yet to be tested empirically. Support for the cascade model would require demonstrating that maternal depressive symptoms is linked to mother-child dyadic synchrony through a mediating process, particularly maternal responsiveness (Cohn & Tronick, 1987; Milgrom, Westley, & Gemmill, 2004).

Recent conceptual models such as Belsky's also emphasize the differential effects of parenting as a function of individual difference among children, particularly in regards to disposition factors such as temperament. Parents may find it more difficult to be responsive and sensitive to temperamentally difficult children, children who may quickly exhaust parents' resources. However, even if a parent is able to maintain responsive behavior with a difficult child, this may not necessarily yield synchrony if the child is unable to uphold his or her end of the "dance." Statistically, this situation would yield an interaction between child temperament and parenting in predicting parent-child dyadic synchrony. Responsive parenting may be less predictive of dyadic synchrony in dyads with difficult children.

Contextual factors also may moderate associations between parental behaviors and dyadic synchrony. Family socioeconomic status (SES) has proven to be a particularly powerful and pervasive contextual factor, having associations with virtually all domains of parent functioning, including maternal depressive symptoms. Not only do low income and low maternal education put mothers at risk for depressive symptoms (Horwitz, Briggs-Gowan, Storfer-Isser, & Carter, 2007; Mayberry, Horowitz, & Declercq, 2007), the effects of maternal depressive symptoms in the context of disadvantaged

socioeconomic background are more disruptive to parenting behaviors (Lovejoy, Graczyk, & O'Hare, 2000).

In sum, previous conceptual and empirical literature suggests that parental, child, and contextual domains are important in predicting mother-child dyadic synchrony. These three domains of effect may also interact in influencing mother-child interaction. Although some of the findings described above revealed possible joint parental and child factors, evidence is limited by the cross-sectional and correlational designs of previous research. Most important of all, no longitudinal studies have examined the joint actions of the three domains of influence – parent, child, and context – over a long enough time frame to disentangle the direction of effects.

This study used longitudinal data from the National Institutes of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD) to examine longitudinal associations among maternal depressive symptoms, maternal responsiveness, child temperament, family socioeconomic status, and dyadic synchrony in mother-child pairs. It was expected that the trajectory of maternal depressive symptoms from 6 to 24 months would predict dyadic synchrony at 54 months. However, this association was expected to be mediated by maternal responsiveness at 36 months. Child's temperament was expected to moderate the longitudinal mediation model. Maternal responsiveness was hypothesized to have less effect on mother-child dyadic synchrony when the child had a difficult temperament. Family SES was also expected to moderate the mediation model. Maternal depressive symptoms was anticipated to have stronger associations with maternal responsiveness for mothers from low SES families than for mothers from high SES families.

2. LITERATURE REVIEW

The purpose of this chapter is to review literature on parent-child dyadic synchrony and the factors that are hypothesized as the antecedents of dyadic synchrony. Hence, this section will provide a better understanding of the dyadic quality of the parent-child interaction. The definition and conceptualization of dyadic synchrony and the associations between dyadic synchrony and children's adjustment outcomes will be presented as an introduction. After discussing the importance of parent-child dyadic synchrony, the discussion will turn to the argument that there are few studies that examine the antecedents for the development of dyadic synchrony. Toward this end, the subsequent literature review will be focused on the maternal, child, and contextual factors that are hypothesized to contribute to the development of dyadic synchrony. Specifically, research documenting the relations of maternal depressive symptoms, maternal responsivity, child temperament, and family SES with dyadic synchrony will be presented. Special attention will also be given to literature on maternal responsivity as a mediator and child temperament and family SES as moderators of the link between depressive symptoms and dyadic synchrony. Factors such as partner status, social support, and parenting stress will also be addressed as potential control variables. In the final section, the necessity of using a longitudinal research design in order to examine the predictors of dyadic synchrony will be discussed.

Dyadic Synchrony

Dyadic synchrony is defined as the degree to which parent and child interactions

display mutual responsiveness, reciprocity, engagement, mutual focus, and shared affect (Belsky et al., 1991; Harrist, Pettit, Dodge, & Bates, 1994; Harrist & Waugh, 2002; Mize & Pettit, 1997). One main characteristic of synchrony is the dyadic nature of the interaction between parent and child. That is, dyadic synchrony is the continuous social coordination that requires dynamic adaptation from both partners in order to maintain a coherent and mutually rewarding interpersonal exchange (Fogel, 1993; Kirsh, Crnic, & Greenberg, 1995). Therefore, dyadic synchrony is believed to reflect the systemic wholeness of the dynamics and co-constructed nature of parent-child interaction (Fogel, 1993; Harrist & Waugh, 2002). In addition, dyadic synchrony also reflects the interactional style of the parent-child dyad rather than parent's or child's behavior alone (Criss, Shaw, & Ingoldsby, 2003; Harrist & Waugh, 2002). Specifically, although both parent and child characteristics may contribute to the development of dyadic synchrony, dyadic synchrony is more than the sum of parent and child attributes (Lindsey et al., 2008; Skubanet al., 2006). It displays the unique dynamics of the dyad beyond what two partners bring to the interaction. Hence, dyadic synchrony differs from global constructs such as parenting and constructs of individual behaviors such as responsiveness or warmth in that it provides a unique perspective on the nature of parent-child interaction (Lindsey et al., 2008). For instance, Lindsey, Mize, and Pettit (1997) found that parent-child synchrony is associated with children's social competence and peer acceptance, even after controlling for each individual's behavior. Feldman and Greenbaum (1997) also indicated that mother-infant synchrony predicts children's symbolic play at age 2 above and beyond global assessment of sensitivity or responsiveness, suggesting that synchrony is distinct from an individual's responsiveness. In addition, Skuban et al.

(2006) also reported that maternal nurturance (i.e., responsivity and acceptance) and child expressive language account for significant variance in dyadic synchrony, supporting the assertion that dyadic synchrony is more than a measure of parenting. More details of the above studies will be presented in the subsequent sections.

Harrist and Waugh (2002) suggest that the structure of dyadic synchrony changes in a predictable way from infancy through early childhood. They propose that infant-parent synchrony is achieved through mutual engagement that is temporally coordinated (i.e., matching of activity level such as attention and affect at a given point in time) and contingent (i.e., existing when one event has a temporal, probabilistic relationship to another event) in nature. As the infants can now only actively participate in the world through the give-and-take of social exchange with parents, the degree of parents' coordination with infant's state and signals now shape the parent-infant relational system (Feldman, 2007a; Feldman & Eidelman, 2007). The temporal coordination of nonverbal behavior during parent-infant interactions manifests through patterns such as co-occurrence of social gaze, matching of affective states, co-vocalization, coordination of body tone and movements, matching of arousal level, and coordination of parent's affectionate touch with infant's social gaze (Beebe & Gerstman, 1980; Feldman, 2007b; Feldman & Eidelman, 2004; Fogel, 1982; Tronick et al., 2005). By coordinating social behavior with the infant's state and cues, parents promote the infant's innate capacity to detect contingencies between discrete events in the environment, between different modalities in the infant's own behavior, and between the discrete behaviors of self and other (Feldman, 2007a; Tarabulsy, Tessier, & Kappas, 1996). Meanwhile, parents also model rhythmic interaction and teach the infant about social dialogue through moment-

by-moment coordination with the infant's affective state and biological rhythm (Feldman, 2007a). Synchrony thus can be viewed as the intricate dance between infant and parent, which builds on familiarity with the partner's behavioral repertoire and interaction rhythms (Feldman, 2007a). Since parents play a greater role in coordinating and maintaining interactions during this stage, parents' sensitivity and responsivity are particularly salient for the development of synchrony in infancy.

During toddlerhood, the structure of synchrony is similar to that of infancy. However, children take a more active role due to their increased mobility and cognitive ability and parent-child interaction exhibits a greater balance of participation compared to infancy. But still, the asymmetrical parent-child relationship exists in that interactions are largely guided by parents as they now need to tune in to not only the child's affective states but also to their cognitive level, communication ability, and increasing autonomy.

Harrist and Waugh (2002) propose that when children approach early childhood, the balance of interaction is near equal, suggesting that both parent and child contribute to the quality of the dyadic interaction and the maintaining of synchrony. They argue that at this stage, children have the power to engage in and withdraw from interaction at will due to their improved communication competence and cognitive growth, compared to during infancy and toddlerhood when parents can more easily entice children into engaging in interaction. Therefore, dyadic synchrony between parent and child in early childhood reflects the notion of connectedness, which Harrist and Waugh (2002) defined as shared focus of attention and balanced participation (Harrist, Pettit, Dodge, & Bates, 1994).

Operationalization of Dyadic Synchrony. Though many studies have examined

parent-child dyadic interaction, there is no consensus on the optimal approach to assessing parent-child dyadic synchrony. Researchers have used both global ratings and microanalytic coding systems to measure dyadic synchrony. Global ratings typically assess overall dyadic synchrony based on certain dimensions during the entire parent-child interaction, whereas microanalytic measures assess a constellation of specific behavioral dimensions that reflect dyadic synchrony in small increments (e.g., coding every few seconds) and focus on specific behaviors and responses. For example, Criss, Shaw, and Ingoldsby (2003) used global ratings to examine dyadic synchrony between mothers and their school-age children. They defined synchrony as the degree to which the parent-child dyad displays responsiveness, reciprocity, harmony, interconnectedness, engagement, mutual focus, and shared affect during interactions. Their synchrony index represented the degree to which the members of the dyad reflect back on one another (e.g., reflective listening) and the balance between partners in leading and following the action sequence. They observed mother-child interaction during an eight-minute problem-solving task and rated synchrony based on a 9-point global scale with highly detailed anchor points. They reported an acceptable range of inter-rater reliability for the synchrony rating ($\rho = .73$, $p < .001$; within 1% agreement = 81%). Similarly, Skuban, Shaw, Gardner, Supplee, and Nichols (2006) adapted Criss et al.'s (2003) global rating scale to examine dyadic synchrony in preschool age children. They modified the global ratings to reflect non-verbal communication, child positivity, child negativity, as well as characteristics of parent-child interaction in toddlerhood when mothers play a greater role in initiating the interaction. Mother-child dyadic synchrony was rated on a 9-point global scale based on their interaction across three activities. The single code for synchrony

reflected the reciprocity, shared affect, and mutual focus of the dyad. Inter-rater reliability for the synchrony global rating was reported in the acceptable range of ($\rho = .79$, $p < .01$).

Harrist, Pettit, Dodge, and Bates (1994) also examined dyadic synchrony between preschoolers and their mothers. They defined synchrony as the extent to which the mother-child dyad engage in mutually focused, reciprocal, and responsive exchanges. Dyadic synchrony was operationalized as three dimensions that tap engagement, affective tone, and connectedness. Ratings of the three dimensions in their study were based on the detailed written transcript of social interactions involving the child and mother during home observation. The transcript was recorded by observers and mainly included the child's ongoing social activity that detailed the parent's and child's behavior and the immediate context of that behavior. The coder then rated the three dimensions using the transcript. Their first dimension, engagement, described the number or time span of back-and-forth exchanges or turns during social interaction. The second dimension, affective tone, rated whether the expressed emotion of each partner was negative or nonnegative. A dyadic affective tone was then coded as mutually negative, negative on one partner, and mutually nonnegative. The third dimension, connectedness, assessed the degree of shared focus of attention, balance of participation, reciprocity, and sense of closure on a 5-point scale (1 = highly disconnected, 3 = moderately connected, 5 = highly connected). The three dimensions were then used to classify each mother-child interactional episode as positively synchronous, nonsynchronous, or negatively synchronous. Their reliability analysis indicated that inter-rater agreement was .75 for engagement ($\kappa = .66$) and .84 for affective tone ($\kappa = .62$). Agreement-within-one-point was .94 for connectedness ($\kappa = .79$). This study is important in showing that dyadic synchrony can be coded even by

individuals who do not observe an interaction directly, but only read a detailed written narrative of the interaction. Dyadic synchrony can be operationalized by the description of individuals' behaviors in relation to each other and direct observation may not be necessary for the operationalization.

Mize and Pettit (1997) reported two studies in which they developed a 5-point global rating scale that reflected interactional synchrony between preschoolers and mothers. The global rating measured the shared focus of attention, responsiveness to partner's cues, and the maintenance of the same topic between mother-child dyad across a 10-min dyadic play session. The inter-rater reliability for the global rating was reported as .75 in their first study. In their second study, they rated the interactional synchrony and mutual gratification (i.e., obtain mutual pleasure during interaction such as smile or laugh) at 30-s intervals. The inter-rater reliability was reported as .91 for interactional synchrony and as .90 for mutual gratification. Interactional synchrony was found to be significantly correlated with mutual gratification ($r = .79$, $p < .005$).

At the other end of the spectrum, Isabella, Belsky, and von Eye (1989) investigated mother-infant interaction and they defined interactional synchrony as reciprocal, mutually rewarding interaction and an interactive experience reflecting appropriate fit of mother and infant behavior. A 45-min home observation of mother-infant interaction was conducted at 1, 3, and 9 months to examine synchrony. They utilized a microanalytic method and coded maternal, child, and dyadic behaviors in 15-second intervals. The maternal interactive-behavior scale consisted of 12 categories (e.g., attend to infant, response to vocalization and soothe, stimulate/arouse), whereas the infant scale contained 11 categories (e.g., sleep/drowsy, look at mother, vocalize). Then all co-

occurrences of infant and mother behaviors were generated for each 15-s interval. Each combination of maternal and child behavior was classified on an a priori basis as reflecting synchronous, asynchronous, or neutral interaction. For instance, the co-occurrence of behavior was coded as asynchrony when the infant was sleeping and the mother stimulated or aroused the infant, whereas it was coded as synchronous when the infant was fussing or crying and the mother responded with soothing.

Feldman (2007b) also examined synchrony in infancy and she defined synchrony as the matching of micro-level affective behavior between parents and infant within lags of 1.5 to 2 seconds. Mother and father were observed playing separately with the infant for 5 min during home visit. Infant-mother and infant-father interactions were analyzed separately in 1-s frames using the Monadic Phase Manual (Tronick, Als, & Brazelton, 1980). Using this scheme, each partner's stream of affective behavior is separately and continuously coded into 5 affective codes ("phases") for parents and 6 affective codes for the infant. Codes are based on facial expressions, vocalizations, direction of gaze, body orientation, and the level of observed positive or negative arousal. Since their coding was on a continuum from negative to positive interaction, they used time-series analysis for the codes of behaviors. They also created four composites from the phases (codes) for each individual: negative/withdrawn, neutral, positive arousal, and social orientation. Reliability (kappa) was reported as .84 for mothers' time series, .86 for infants' time series with mother, .84 for fathers' time series, and .85 for infants' time series with father. In the next step, they examined the co-occurrence of affective match between parent and child using conditional probability, which is the proportion of time out of the entire interaction when parent and child matched on level of arousal. In addition, they used

time-series analysis to examine the affective state preceding and following episodes of positive arousal. Lastly, they examined synchrony by using a time-domain time-series analysis (Cohn & Tronick, 1988; Gottman, 1981). The autocorrelated component in each time series, which referred to the associations between consecutive behaviors that are internal and not related to the behavior of the partner, was first partialed out. Synchrony coherence then indicated the strength of the correlations between the two time series of parent and infant found at any lag. The author found that infants showed more neutral arousal and social orientation with mother and more negative and positive arousal with father. Although infants showed less frequent positive arousal with mothers, their duration of positive peak lasted longer. Positive peaks during mother-infant interactions were often preceded by shared gaze between the two, whereas no particular phase occurred significantly more often before or after the positive peaks during father-infant interactions. Nevertheless, the author did not find main effects of child gender or parent gender for the degree of synchrony. Specifically, although father-infant interactions appeared more random, mother-infant and father-infant interactions had similar levels of synchrony coherence.

There is another body of research that incorporates both global and microanalytic coding systems. In addition to rating interactional synchrony on a 5-point scale at 30-second intervals during 10-min mother-child and father-child play interactions, Lindsey, Mize, and Pettit (1997) also used an event-level coding scheme to record the occurrence of parent and child initiations and their responses to the initiations. They then created two dyadic measures, mutual play initiation and mutual play compliance, from the individual partners' initiation and compliance scores. They operationalized mutuality as the relative

balance in rate of play initiations between parent and child and balance in rate of their compliance to initiations. That is, when the rate of parent compliance to child is .50 and the rate of child compliance to parent is also .50, their interaction was considered as balanced. Inter-rater agreement (kappa) was reported as .95 for initiation codes and .89 for response codes. The inter-rater reliability for the global rating of synchrony was .91. Their study found that father-child globally rated synchrony was significantly related to father-child mutual initiation ($r = .46$, $p < .01$) and marginally related to father-child mutual compliance ($r = .23$, $p < .10$). On the other hand, mother-child synchrony was not significantly associated with mother-child mutual initiation ($r = .14$) and only marginally significantly associated with mother-child mutual compliance ($r = .26$, $p < .07$). It is not clear why the two operationalization approaches of synchrony were not more highly correlated. The authors indicated that their event-based mutual initiation and mutual compliance and global rating of synchrony tapped similar but non-identical aspects of dyadic reciprocity. It is likely that global ratings capture a broader range of behaviors than only mutual initiation and mutual compliance.

Lindsey, Cremeens, Colwell, and Caldera (2009) examined dyadic synchrony between toddlers and each of their parents during a 15-min play interaction using the subset of NICHD SECCYD data from the Kansas site. They adapted the global and event-based coding structure from the study in Lindsey et al. (1997) and modified the event-based scheme to include non-verbal communication events that are normative for toddlers such as gestures, pointing, vocalization, and eye gaze. In addition, they included a microanalytic measure of shared positive emotion between each parent and the child. Both partners' emotion was coded on 5-point scales in every 30-second interval of

interaction. A dyadic measure of shared positive emotion was then determined as the proportion of intervals in which both parent and child expressed a positive emotion out of the total number of intervals in which positive or negative emotion was displayed by either partner. In this study, they used the global rating of dyadic reciprocity as well as the microanalytic measures of shared emotion, mutual initiation, and mutual compliance as indicators of dyadic synchrony. For mother-child dyads, inter-rater reliability (kappa) was .82 for dyadic reciprocity, .87 for shared positive emotion, .77 for initiations, and .82 for responses. For father-child dyads, inter-rater reliability (kappa) was .84 for dyadic reciprocity, .85 for shared positive emotion, .79 for initiations, and .84 for responses. They found that for father-child dyads, global ratings of dyadic reciprocity were significantly correlated with shared positive emotion ($r = .55$, $p < .001$), mutual initiation ($r = .38$, $p < .01$), and mutual compliance ($r = .35$, $p < .01$). However, for mother-child dyads, global ratings of dyadic reciprocity were only significantly correlated with shared positive emotion ($r = .50$, $p < .001$) and mutual initiation ($r = .41$, $p < .01$) but not with mutual compliance ($r = -.15$). Again, it is likely that the global rating of synchrony might capture not just mutual initiation, mutual compliance, and shared affect, but also other behaviors that reflect mutual responsiveness between parent and child.

In conclusion, both global and microanalytic coding systems have been applied to observations of parent-child interaction to assess dyadic synchrony. Researchers also have utilized transcripts from parent-child interaction to measure synchrony. The above described approaches studies all proved able to capture the dyadic nature of parent-child interaction from infancy to childhood through different levels of coding systems. There appears to be no single approach that is judged to be the best in capturing parent-child

dyadic synchrony. This study will use global ratings to assess mutual positive affect, mutual focus, and relative balance of interaction in mother-child dyads.

Dyadic Synchrony as a Predictor of Child Outcomes. The salience of synchronous parent-child interaction has been demonstrated in the empirical literature in relation to children's adjustment outcomes. During infancy, the involvement in high levels of dyadic synchrony is found to facilitate secure attachment. For example, as described previously, Isabella et al. (1989) observed 30 mother-infant pairs in the home under naturalistic conditions when the infant was 1, 3, and 9 months of age and the quality of mother-child attachment at 12 months of age. Each dyad was videotaped during the 12-month Strange Situation (Ainsworth & Wittig, 1969) and later classified as securely attached, insecure-resistant, or insecure-avoidant. The researchers found that interactional synchrony at 1 and 3 months was significantly associated with attachment quality at 1 year. Specifically, more frequent synchronous interactions between mother and infant at 1 month and 3 months predicted child secure attachment at 12 months, whereas asynchronous interactions predicted insecure attachment. Isabella and Belsky (1991) followed the same procedures and replicated the results in a larger sample (N = 153) based on dyadic synchrony measures at 3 and 9 months and attachment security at 12 months. Their results indicated that dyads characterized as secure exhibited higher levels of synchronous co-occurrences of mother and infant behavior, whereas insecure dyads experienced more asynchronous co-occurrences. Synchrony-inhibiting or synchrony-disrupting maternal behaviors that were intrusive, overstimulating, inconsistent, and unresponsive were more common among the insecurely attached infant-mother dyads.

It has also been demonstrated that dyadic synchrony is predictive of preschool and school-age children's social skills and conduct problems. For instance, Mize and Pettit (1997) investigated mother-child interactional style and preschoolers' peer competence. Mother-child interactions were observed during a 10-min semistructural laboratory play session, which were then rated using global ratings. Children's peer competence was measured by the Teacher's Checklist of Peer Relationships (Coie & Dodge, 1988) and sociometric ratings from each child. They revealed in their first study (n = 43) that mother-child synchrony was related to higher levels of peer acceptance and lower levels of aggression. In their second study (n = 62) with a more diverse sample, they found similar results in that children from higher interactional synchrony dyads had higher peer acceptance, higher social skills, and lower aggression.

Lindsey et al. (1997) also examined the association between synchrony and preschool age children's social competence (N = 35). Separate mother-child and father-child interactions were observed and videotaped during a 10-min laboratory play session. Synchrony was measured by global rating as well as event-based dyadic measures of mutual initiation and mutual compliance. Children's classroom peer acceptance was assessed by sociometric interviews (Asher et al., 1979) in which each child rated classmates as like a lot, like only a little, or don't like very much. Teachers also completed the 17-item Teacher's Checklist of Peer Relationships (Coie & Dodge, 1988) for each child, which assessed the child's aggression, peer acceptance, and social skills. The authors found that father-child dyads that were rated as more synchronous had children who were rated more socially competent by teachers. Children of more synchronous mother-child dyads were better liked by peers. In addition, father-child

dyads with more balanced levels of mutual compliance had children who were rated as more competent by teachers and better liked by peers. Children in mother-child dyads with more balanced mutual compliance were better liked by peers. However, their study indicated that father-child and mother-child mutual initiation were not associated with children's social competence. To examine whether mutual compliance reflected the quality of dyadic interaction or merely the contribution of individual partners' behavior, they also conducted hierarchical regression analyses. The results revealed that dyadic measure of father-child mutual compliance predicted social competence and peer acceptance even after controlling for individual father and child behavior. Similar, but less conclusive, results were also found in mother-child dyads. In conclusion, the Lindsey et al. study showed that synchrony was significantly related to higher levels of social skills and peer acceptance and lower levels of child aggression and that synchrony is distinct from individual partners' behavior.

Harrist et al. (1994) also examined the link between dyadic synchrony and kindergarten children's peer adjustment. Parent-child interactions at home were observed and detailed narratives were made for coding dyadic synchrony. The interaction was categorized as positively synchronous, nonsynchronous, or negatively synchronous. Children's school adjustment was assessed by teacher ratings, peer nominations, and observation of free play at school. Teachers completed the Teacher's Report Form (TRF) of the Achenbach Child Behavior Checklist (Achenbach & Edelbrock, 1986) and the Teacher's Checklist of Peer Relationships (Dodge, 1986), which were used to assess child competence, aggression, and withdrawal. Peers were interviewed to nominate each child as aggressive or competent. Direct observations of free play at the schools were

conducted to assess children's withdrawn behavior. Their results revealed that high levels of positive synchrony and low levels of nonsynchrony were associated with a lack of adjustment problems in kindergarten. Specifically, children who engage in synchronous interactions with their mothers at home were rated as competent by teachers, non-aggressive by teachers and peers, and non-withdrawn by observers.

Similarly, Criss et al. (2003) examined mother-child synchrony and its link with school age children's adjustment. A parent-child interaction task of discussing conflictual issues was observed and videotaped when the children were 10 years old. The mothers and children reported their relationship quality in terms of openness and conflict. They also reported parental monitoring and harsh discipline. Children's aggressive responses in responding to conflicts were measured by their response to a set of questions after viewing a series of eight vignettes. Child adjustment was assessed by child-report of antisocial behavior at age 8 and age 10, child-report of the extent to which their best friends engaged in antisocial behavior at age 8 and age 10, child-report of anxiety/depression at age 10, and mother-report of social skills at age 10. The authors found that parent-child synchronous interactions were significantly related to higher levels of positive and open communication, child social skills, and parental monitoring, and to lower levels of harsh and conflictual relationships, generation of aggressive responses, and child and best friend antisocial behavior. The association between synchrony and child antisocial behavior at age 10 remained significant after controlling for prior child adjustment at age 8 and characteristics of the child (i.e., aggressive response decisions), parent (i.e., harsh discipline, parental monitoring), and parent-child relationship (i.e., conflict, openness).

The experience of dyadic synchrony may also serve to facilitate autonomy and self-control by providing children an opportunity to practice self-regulatory skills as they learn to comply with adult wishes (Harrist & Waugh, 2002). For instance, Feldman et al. (1999) examined the association between mother-infant affect synchrony and the emergence of child self-control. Mother-infant face-to-face interaction at 3 and 9 months were videotaped and coded for affect synchrony. Child temperament was rated by mothers and observers. Child self-control at age 2 was based on the measures of child compliance during a toy pickup task and their ability to delay acts on request during a temptation procedure. Maternal synchrony with infant affect at 3 months and mutual synchrony at 9 months were each related to higher levels of self-control at age 2 after controlling for child temperament, IQ, and maternal disciplinary style. Rocissano, Slade, and Lynch (1987) examined the relation between dyadic synchrony and child compliance in a sample of toddlers and their mothers. Each dyad was videotaped while the mothers taught their children a tea-party script. Mother-child interactions were categorized as synchronous if the partner's focus of attention was maintained or as asynchronous if not. They found that synchrony was positively correlated with child compliance in that toddlers were more likely to comply with synchronous maternal instructions than with asynchronous instructions.

Furthermore, parent-child dyadic synchrony also appears to facilitate language acquisition and communication skills (Harrist & Waugh, 2002). For instance, in addition to examining the association between dyadic synchrony and children's self-control, Lindsey et al. (2009) also examined the link between dyadic synchrony and children's communication competence during toddlerhood using the subsample of the NICHD

SECCYD dataset. Interactions of mother-child dyads were observed at the laboratory at 15 months while father-child interactions were observed at 18 months. Children were administered the Reynell Developmental Language Scales (Reynell, 1990) at 36 months, which assessed verbal comprehension and expressive language. Children's self control was measured during the Forbidden Toy Task at 36 months, which assessed their ability to resist temptation. The authors found that dyadic reciprocity and shared positive emotion were associated with higher levels of expressive language and verbal comprehension and lower levels of active engagement with the forbidden toy. For mother-child dyads, dyadic reciprocity made an independent contribution to children's verbal comprehension whereas both dyadic reciprocity and shared positive emotion made unique contributions to children's expressive language. For father-child dyads, dyadic reciprocity and mutual compliance predicted children's verbal comprehension whereas dyadic reciprocity and shared positive emotion made unique contributions to the prediction of children's expressive language.

Feldman and Greenbaum (1997) examined the association between synchrony and children's symbolic competence, which included symbolic play, language, and internal state talk. Ten min of mother-infant face-to-face free play in the laboratory were videotaped at 3 and 9 months and were coded for synchrony, maternal affect attunement, and child affect regulation. During the 24-month laboratory visit, mother-child dyads were observed for 90 min in various play contexts, which tapped dyadic interaction, symbolic skills, and nonsymbolic skills. Children's verbal competence (verbal IQ) was measured by the Verbal Reasoning score of the Stanford-Binet Intelligence Scale at 24 months (Thorndike, Hagen, & Scattler, 1986). Synchrony at both 3 and 9 months was

found to be significantly associated with symbolic play at 24 months, whereas only 9-month synchrony was related to internal state talk. Synchrony at 3 months predicted symbolic play above and beyond the effects of maternal affect attunement and child affect regulation at 3 months. In addition, synchrony at 9 months made a unique contribution to the prediction of child internal state talk at 24 months and child affect regulation at 9 months. This suggested that synchrony is distinct from an individual's behavior, but rather a dyadic phenomenon that is con-constructed by both partners.

In sum, the discussed literature suggests that dyadic synchrony is a powerful predictor of children's later socioemotional and adjustment outcomes. The influential impact of synchrony raised the question of what might contribute to parent-child dyadic synchrony, which later influences children's outcomes. The next section will present research on the predictions of dyadic synchrony.

Predicting Dyadic Synchrony. Empirical research described previously implies that although some parent-child dyads frequently engage in synchronous interaction, some dyads seem to have more difficulty in doing so. Given the importance of dyadic synchrony in relation to children's adjustment, however, there is very little research regarding the factors that might facilitate the development of dyadic synchrony between parent and child. Since the nature of synchrony is dyadic and co-constructed, the capacity to achieve synchrony may be a function of individual differences in both members of the dyad. In Belsky's (1984) ecological process model of parenting, he argued that parental psychological functioning and personality contribute to parenting behaviors and child development. In fact, Belsky regarded parental psychological functioning as the most influential determinant of parental behavior. For young children, one of the most studied

aspects of maternal psychological functioning is maternal depression and its effects on parental responsiveness toward the child and later child functioning (e.g., NICHD, 1999). Given that children are more dependent upon stimulation, nurturance, and scaffolding from primary caregivers when they are young (Beardslee et al., 1983), the effects of maternal depression on child development may be particularly evident during infancy and toddlerhood (Lovejoy et al., 2000).

On the other hand, Belsky's model also emphasized the influence of the child's characteristics on parenting behaviors such that parents who perceive their children as having difficult temperaments tend to be less responsive or respond negatively. In addition, the context of the parent-child relation also exerts an impact on parental behaviors in Belsky's model. For example, previous studies have indicated that the effects of maternal depressive symptoms are most pronounced when combined with other risk factors such as lower SES. Drawing upon Belsky's ecological model, this study will examine maternal (i.e., depressive symptoms, responsiveness) and child (i.e., temperament) factors along with a key contextual factor (i.e., SES) in relation to dyadic synchrony. In the following section, literature pertinent to the focus of this study will be discussed.

Maternal Depressive Symptoms

Depression is prevalent in women of childbearing age (Kessler et al., 2003). It is reported that 8% to 10% of women between the age of 25 and 44 suffer from depression (Kessler et al., 1996). Maternal depression has been defined in studies using interview-based clinical diagnosis, such as Schedule for Affective Disorders and Schizophrenia (SADS) and criteria from *Diagnostic and Statistical Manual of Mental Disorders* (DSM-

IV-TR), or self-report depressive symptoms measures, such as the Center for Epidemiological Studies Depression Scale (CES-D) and the Beck Depression Inventory (BDI). Maternal depression compromises mothers' ability to read and respond to infants' signals and the ability to facilitate synchronous interactions with their infants. Studies have found that depressed mothers engage in less play, provide less stimulation, show less positive affect, and are more disengaged, intrusive, and negative during social interaction with their infants (e.g., Cohn et al., 1986; Field et al., 1990; Murray et al., 1996). Maternal depression has been demonstrated to be a risk factor for children's cognitive, socioemotional, and behavior outcomes (e.g., Beardslee et al., 1983; Cummings & Davies, 1994; Downey & Coyne, 1990; NICHD ECCRN, 1999).

Lovejoy, Graczyk, O'Hare, and Neuman (2000), in a meta-analysis of 46 studies with samples of mothers with children from infancy through school-age, identified three domains of parenting behaviors that have been associated with maternal depression. These included negative/coercive behaviors (e.g., negative affect, negative facial expression, expressed anger, intrusiveness), disengagement (e.g., neutral affect, ignoring, withdrawal), and positive interactions (e.g., play, praise, affectionate contact). They found that maternal depression has a moderate effect on maternal negative behaviors (r = .20, d = .40), a small to moderate effect on disengagement (r =.14, d = .29), and a small effect on positive interactions (r = .08, d = .16). Their meta-analysis further indicated that studies examining maternal disengagement primarily focus on mothers and their young children. In addition, the authors found that child age moderated the effects for maternal positive behaviors. There was a moderate effect size (r = .23, d = .47) of maternal depression on maternal positive behaviors for mothers with infants, and a small effect

size (r = .10, d = .19) for mothers with toddlers and preschool-aged children. This pattern reflects infants' dependence on their mothers to initiate interaction and maintain contact that is coordinated with the child's affect and behavioral states. In contrast, toddlers and preschool children seem more able to affect the quality of the parent-child interaction.

Depressive symptoms and dyadic synchrony link. In addition to affecting maternal behaviors, maternal depressive symptoms also interfere with parent-child synchronous interaction. For instance, Beck (1995), in another meta-analysis, examined the effects of postpartum depression on maternal, child, and dyadic behavior. Her study reveals that postpartum depression has a moderate effect on maternal interactive behavior (r = .36), a moderate effect on child interactive behavior (r = .38), and a large effect on mother-infant interaction (r = .50) during the first year. In addition, Albright and Tamis-Lemonda (2002) investigated the relation between maternal depressive symptoms and mother-child interaction in low-income mothers and their 18- to 30-month-old toddlers. The authors indicated that maternal depressive symptoms were related to maternal, child, and dyadic interaction. Mothers with higher depressive symptoms were less flexible, sensitive, engaged, and displayed less positive affect. Children of mothers with higher depressive symptoms were less gentle, compliant, and engaged. In particular, mother-child dyads characterized by lower level of reciprocity, less mutual enjoyment, and less mutual communication were more likely to have mothers with depressive symptoms.

Lunday (2002) examined the relations among maternal depressive symptoms, dyadic synchrony, and infant attachment. Their results showed that more maternal depressive symptoms were associated with less mother-infant synchrony at 6 months. Dyadic synchrony was then predictive of lower mother-infant attachment level at 13

months. Feldman (2003) examined the predictors of mother-infant synchrony. The author found that maternal depressive symptoms and the infant's social orientation (i.e., the infant's positive arousal that is socially directed and focused on the mother's face) predicted unique variance in mother-son synchrony, whereas infants' negative emotionality and social orientation predicted mother-daughter synchrony. Feldman and Eidelman (2007) investigated the predictors of mother-infant synchrony in preterm and full-term infants. They revealed that mother-infant synchrony was predicted by child's vagal tone and maternal affiliative behavior in full-term groups. For preterm groups, maternal depressive symptoms and home environment predicted mother-infant synchrony above and beyond the effects of vagal tone and maternal affiliative behavior. Field, Healy, Goldstein, and Guthertz (1990), on the other hand, examined mothers' and infants' behavior-state matching and synchrony of interactions among depressed and non-depressed dyads. They found that depressed mothers spent more time in the anger and disengaged states, and less in the play state. Infants of depressed mothers also spent more time in the protest and less time in the play state. Moreover, the depressed mother-infant dyads displayed more matched behavior states of protest and disengagement and fewer matched play states. The above findings are in accord with other studies in suggesting that synchrony of positive interaction behaviors are less likely to occur in depressed mother-child dyads (e.g., Feldman, 2003; Field et al., 1989).

As reviewed above, depressed mothers exhibit more negative affect and less positive affect. Maternal depression then leads to more matching of negative emotion states between mother and child. Research findings have shown that depressed mothers' negative affect is strongly related to their children's affect in that they exhibit shared

negative affect more often and shared positive affect less often than dyads of non-depressed mothers and infants (Cohn et al., 1990; Field et al., 1990; Radke-Yarrow, Nottelmann, & Belmont, 1993; Weinberg et al. 2006). Gender of the child has also been linked to the matching of negative affect between mother and child. However, findings from previous studies are inconsistent. While some studies found the matching of negative affective states among mother and son dyads (Carter et al., 2001; Feldman, 2003; Weinberg et al., 2006), others found similar results among mother and daughter dyads instead (Radke-Yarrow, Nottelmann, & Belmont, 1993). Since the effect of child gender is not the focus of this study, it will be considered as a control variable in the analyses.

Patterns of depressive symptoms over time. The chronicity and severity of maternal depressive symptoms may also affect maternal behavior, parent-child interaction, and child development. Women with chronic symptoms are less positive, less sensitive, less engaged, and more negative with their children (Campbell, Cohn, & Meyers, 1995; Frankel & Harmon, 1996). Children of chronically depressed mothers are found to exhibit more emotional and behavioral disturbance, exhibit delays in cognitive development and expressive language development, and are at higher risk of developing insecure attachment. For instance, using a clinically diagnosed sample at 2 months postpartum, Campbell et al. (1995) found that depressed mothers and comparison nondepressed mothers did not differ across face-to-face interaction, feeding, and play at 2 and 4 months. However, after examining the effect of depression chronicity, the authors revealed that mothers who were chronically depressed from postpartum through 6 months were relatively less positive and sensitive during feeding and play at 2, 4, and 6 months than mothers with remitted symptoms by 6 months. Frankel and Harmon (1996) found

similar result in that many depressed mothers did not perform differently in laboratory tasks with their children than nondepressed mothers. However, mothers with severe or chronic depression were rated as significantly less emotionally available and were more likely to have insecurely attached children. The NICHD ECCRN (1999) study used cutoff scores (i.e., 16 or greater) of self-report depressive symptoms to categorize chronicity groups from child age 1 to 36 months. They found that mothers who reported chronic symptoms were especially insensitive at the 24-month parent-child interaction compared to mothers with intermittent symptoms or no reported symptoms. Children of mothers with chronic depressive symptoms, as a result, performed more poorly on measures of cognitive functioning and expressive language at 36 months. In short, chronic maternal depressive symptoms may present as a greater risk for children in early childhood because children of chronically depressed mothers are exposed to prolonged maternal disengagement and negative affect (NICHD ECCRN, 1999).

A further complication is that the timing and course of depressive symptoms may have significant effects on maternal behaviors and children's adjustment outcomes. For instance, concurrent depressive symptoms may have a stronger effect on parenting behaviors and the child's adjustments than earlier symptoms. Brennan et al. (2000) investigated maternal depressive symptoms at four time points and child outcomes at age 5 ($N = 4953$). They found significant relationships between chronic and severe maternal depressive symptoms and higher behavior problems and lower vocabulary scores in children at age 5. Children especially had significantly more behavior problems when their mothers had both chronic and severe depressive symptoms. Moreover, their study showed that higher maternal reports of depressive symptoms at age 5 were more strongly

associated with behavior problems in children at age 5 than were reported depressive symptoms during pregnancy or at birth. McLearn et al. (2006) in another study (N = 3412) also found similar results. They revealed that mothers with concurrent depressive symptoms had decreased odds of engaging in age-appropriate safety practice and being nurturing and had increased odds of using harsh discipline at 30 to 33 months. The effects of maternal depressive symptoms at 2 to 4 months on harsh practice at 30 to 33 months were non-significant, whereas the effects on maternal nurturing were significant.

Campbell et al. (2004) in one NICHD study investigated the relations among the course of maternal depressive symptoms, maternal sensitivity, and attachment security. Their study revealed that mothers in the chronic and intermittent (i.e., at least twice reported elevated symptoms from 1 to 36 months, separated by a period of lower score) depressive symptoms groups were significantly less sensitive across 6-36 months than mothers in the early (i.e., elevated symptoms at 1, 6, and/or 15 months) and late (i.e., elevated symptoms at 24 and/or 36 months) groups, but that the later two groups did not differ from each other. Mothers with intermittent and chronic depressive symptoms were more likely to have insecurely attached children. More importantly, they found the course and timing of maternal depressive symptoms interacted with maternal sensitivity in predicting child attachment security. Mothers with late, chronic, or intermittent depressive symptoms who were also low in sensitivity were more likely to have children who were insecurely attached.

In another NICHD study, Campbell et al. (2007) utilized Nagin's (1999; 2005) group-based trajectory analysis for maternal depressive symptoms from child age 1 month to 7 years, and examined the trajectories in relation to maternal sensitivity and

child functioning. Six trajectory groups were identified: low-stable, moderate-stable, intermittent, moderate-increasing, high-decreasing, and high-chronic. Their results are consistent with previous studies in suggesting that maternal sensitivity over time is linked to maternal depressive symptoms trajectories. For example, maternal sensitivity was generally lower and decreased when maternal depressive symptoms were high or increasing, and vice versa. Child outcomes were also found to differ as a function of trajectory group. Mothers with chronic, moderate-increasing, or high-decreasing depressive symptoms were more likely to have children with poorer school adjustment at age 7 than were mothers with low-stable depressive symptoms. Moreover, instead of finding a mediating effect of maternal sensitivity, they found that both membership in trajectory groups of depressive symptoms and maternal sensitivity independently predicted children's social skills and cognitive functioning.

Ashman, Dawson, and Panagiotides (2008) also investigated the trajectories of maternal depression over the child's first 6.5 years of life in relation to later child outcomes (N = 133). Latent growth mixture modeling was conducted to identify subgroups of depressed mothers with varying longitudinal course. The authors identified 3 depression trajectory groups, which were decreasing, chronic, and stable mild. Their results showed that child behavioral outcomes varied as a function of maternal depression trajectory. Children of chronically depressed mothers had higher levels of externalizing problems and lower social competence compared to children of nondepressed, stable mild, and decreasing depressed mothers.

In conclusion, severity, chronicity, timing, and the change of maternal depressive symptoms over time are crucial to the prediction of sensitive maternal behaviors and

child outcomes. In particular, the above reviewed studies suggest the importance of looking at both maternal depressive symptoms and maternal sensitive responses because maternal sensitivity is predicted by and moderates the effects of maternal depressive symptoms.

Responsiveness

Responsiveness is defined as parents' prompt, contingent, and appropriate reactions to their children (e.g., Ainsworth et al., 1974; Bornstein, 1989; De Wolff & van IJzendoorn, 1997). Tamis-LeMonda and Bornstein (2002) described three aspects of responsiveness. Promptness refers to the rapid timing of maternal responses in relation to the child's overture. Contingency refers to dependence of maternal reactions on child behavior evolving out of moments of shared attention that bear meaning to the child's initiative. Appropriateness stands for maternal reactions that are conceptually and positively connected to the child's behavior. Responsiveness involves perceiving the child's cues, interpreting them accurately, in addition to selecting an appropriate response, and responding in a prompt, contingent manner (Ainsworth et al., 1978). Responsive and sensitive maternal interactions promote the development of healthy parent-child relationships and secure infant attachment (e.g., Ainsworth et al., 1978; De Wolff & van Ijzendoorn, 1997; Isabella, Belsky, & von Eye, 1989). It has been found that mothers of secure infants are more responsive to their infants' vocalization and distress signals than are mothers of insecure infants. Hence, responsive mothers have infants with less crying and fussing (Crockenberg & Smith, 1982). Responsiveness in the first few years of life also provides a foundation for the development of behavioral regulation and social competence in young children (Kochanska, 1997). In contrast, inappropriate

responsiveness or stimulation may be intrusive or inconsistent with the child's signals, which may interfere with the child's attempts to organize his or her behavior. For instance, Bradley, Caldwell, and Rock (1988) found that maternal responsiveness at 6 months predicted children's social behaviors at age 10, controlling for concurrent responsiveness. Similarly, Wakschlag and Hans (1999) found that maternal responsiveness in infancy was negatively associated with behavior problems in middle childhood, controlling for concurrent parenting. Maternal responsiveness also has been shown to have an effect on children's cognitive development (e.g., Bradley et al., 1988; Landry et al., 2001). Mothers who were more often responsiveness to their children had children with greater language and cognitive abilities months and years later (Milgrom et al., 2004; Tamis-LeMonda et al., 2001).

Bornstein et al. (2008) examined some basic characteristics of maternal responsiveness, which included its internal structure, individual variation, and continuity through time, in mothers to their infants' activities during play interactions at 10, 14, and 21 months. Child behaviors were coded as exploration, play, bidding to or looking at mother, and vocalizing. In addition to coding the three features of maternal responsiveness (i.e., promptness, contingency, and appropriateness), maternal response types were coded into six categories: (1) affirmation of child action, (2) imitations/expansions of child vocalization, (3) descriptions of an object, event, or activity, (4) questions about an object, event, or activity, (5) play prompts, and (6) exploratory prompts. They found that mothers' response types rarely correlated with each other and that, on average, the correlation coefficients were small and non-significant. Changing patterns of these dimensions of maternal responsiveness also emerged. For

instance, descriptions and exploratory prompts decreased and imitations and expansions, questions, and play prompts increased across the three time points. The results supported their proposition that parental responsiveness is best conceptualized as multidimensional and specific in structure. They suggested that the different maternal response types rise to prominence at different developmental periods that align with the changing competencies of children. This view also accords with previous research findings that specific forms of maternal responsiveness are related to specific abilities in young children (Bornstein, 1995; Tamis-LeMonda et al., 1996). For instance, mothers' responses to children's vocalization are associated with children's advances in language, whereas mothers' responses to children's play are related to children's advance in play (e.g., Paavola et al., 2005; Tamis-LeMonda et al., 1996).

Responsiveness and dyadic synchrony link. Parental responsiveness facilitates a positive reciprocal stance in the child and initiates a cycle of positive mutuality in the parent-child dyad (Maccoby, 1983). Skuban et al. (2006) examined the correlates of synchrony with a sample of high risk and low-income toddler boys. Using the Home Observation for Measurement of the Environment (HOME; Caldwell & Bradley, 1984), they found that higher maternal nurturance, which was a composite score of maternal responsivity and acceptance, lower maternal aggressiveness, and children's greater expressive language and greater tolerance for frustration were significantly correlated with higher levels of dyadic synchrony. In particular, maternal nurturance and child expressive language ability accounted for unique and significant variance in synchrony (75% in higher synchrony dyads and 70% in lower synchrony dyads). Their findings support the assertion that synchrony is co-constructed by both partners' attributes and that

synchrony is distinct from measures of parenting or maternal sensitivity. Kochanska, Barry, Aksan, and Boldt (2008) investigated maternal and child contributions to child disruptive conduct using longitudinal data. They found that maternal responsiveness in infancy predicted children's responsive stance toward mothers at 25-38 months. Their study indicated that children's responsiveness became enduring and generalizing and then led to children's embracing and internalizing maternal values and standards at 52 months, which later negatively predicted children's disruptive behavior at 67 months.

Empirical evidence also indicates the link between maternal responsiveness and child compliance. In an experimental study, Parpal and Maccoby (1985) investigated preschool-age children's compliance with mothers' instructions. The mother-child dyads were divided into one of the three conditions: responsive play, free play, and noninteractive. They found that mothers who had been taught the responsive play techniques had children with higher levels of compliance than mothers who had not been trained in the experimental condition. The results indicated that maternal responsiveness accounted for the effectiveness in gaining children's compliance. They suggested that maternal responsiveness enhances children's sense of being involved in a mutual relationship and thus makes the scripts of cooperation available to the child. Goin and Wahler (2001) also examined children's willingness to comply with mothers' instructions using a sample of 8-year-old children and their mothers. They found that maternal responsiveness was significantly highly correlated with child compliance. Maternal responsiveness accounted for 46% of the variance in the prediction of child compliance while children's personal narrative coherence (i.e., child's ability to recount home life experiences in a coherent summary) accounted for another 10% of the variance in child

compliance. They argued that maternal responsiveness induces child compliance in that, by reviewing the past dyadic relationship quality and using the input, children can decide whether or not to comply with parents' current instructions.

Kochanska, Aksan, and Carlson (2005) investigated 15-month-old children's receptive cooperation (i.e., a willing and eager stance toward parents) during a toy cleanup session and naturalistic interaction. The authors found that mothers' responsiveness to the child at 7 months was positively associated with children's receptive cooperation at 7 months and 15 months. Specifically, they found maternal responsiveness explained unique variance in children's receptive cooperation. This effect was later moderated by children's proneness to anger (more information on the moderation effect will be discussed in the temperament section). In conclusion, maternal sensitive responsiveness that acts upon children's cues enhances children's responsive stance and willingness to comply, which promotes the reciprocal and synchronous interaction in the mother-child dyad.

Depressive symptoms and maternal responsiveness link. Studies examining parental behavior have indicated that maternal depressive symptoms influence individual differences in responsiveness (e.g., Cohn & Tronick, 1987; Milgrom et al., 2004; Wilfong et al., 1991). Depression interferes with a mother's ability to respond sensitively and contingently to the infant's needs and emotional states (Weinberg & Tronick, 1997). Depressed mothers' responses to the child tend to be delayed, less sensitive, and less consistent (e.g., Cohn et al., 1986). Cox et al. (1987) found that depressed mothers are less able to sustain social interaction and less often picked up on their children's cues. For instance, Wilfong, Saylor, and Elksnin (1991) observed mothers' interaction with their 3-

month-old premature infants. They found that maternal responsiveness at 3 month was negatively correlated with maternal depressive symptoms and positively correlated with maternal cognitive skills. Maternal depressive symptoms accounted for significant variance in the prediction of maternal responsiveness, controlling for maternal cognitive skills, whereas maternal cognitive skills did not predict maternal responsiveness, controlling for the effects of depressive symptoms.

Drawing from a community sample consisting of depressed and well mothers, Stanley, Murray, and Stein (2004) revealed that depressed mothers showed less contingent positive responsiveness (e.g., empathizing) and more contingent negative responsiveness to their infants (e.g., rejecting infant's behaviors), compared to well mothers. In examining the effects of maternal depression on infants' outcomes, they found that maternal depression did not adversely affect infants' performance during still-face procedure and instrumental learning assessment. However, maternal contingent positive responsiveness was found to predict infants' instrumental learning at 3 months. Moreover, Milgrom, Westley, and Gemmill (2004) examined the associations between postnatal depression, maternal responsiveness, and child outcomes. Their study showed that maternal responsiveness at 6 months differed between the depressed group and the non-depressed group in that mothers who were depressed had lower levels of maternal responsiveness. Particularly, they found that postnatal depression at 15.8 weeks predicted maternal responsiveness at 6 months, which later predicted children's IQ score at 42 months.

In sum, the above reviewed studies suggest maternal depressive symptoms as a risk factor in affecting mother-child dyadic interaction (e.g., Lundy, 2002) and maternal

responsiveness (e.g., Cohn & Tronick, 1987). On the other hand, maternal responsiveness has also been demonstrated to be associated with dyadic synchrony (e.g., Albright & Tamis-Lemonda, 2002). The link between depressive symptoms and dyadic synchrony is likely connected through the effects of maternal depressive symptoms on maternal responsiveness in the sense that mother-child dyads cannot achieve synchrony if there is no history of parental responsiveness to the child. However, the possible mediation effect is still unexamined in the empirical literature.

Family SES

Previous studies have indicated significant correlations between maternal depressive symptoms and demographic characteristics of mothers. For instance, Horwitz et al. (2007) found that lower maternal education, younger maternal age, and unemployment were associated with self-report elevated maternal depressive symptoms. Using a nationally representative sample, Mayberry et al. (2007) also found similar results in that mothers who were younger and not employed full time and mothers who had lower incomes, lower education, and more children were more likely to report significant depressive symptoms 2 years after birth. Campbell et al. (2007) found that mothers in different depression trajectory groups varied on educational level and family income. Mothers with stable low levels of depressive symptoms had higher education levels and higher income. In contrast, mothers with stable high levels of depressive symptoms were less educated and had lower levels of family income. Similarly, Segre, O'Hara, Arndt, and Stuart (2007) investigated postpartum depression in relation to the social status indices. They indicated that income and occupational prestige were significant predictors of postpartum depression, with income being the strongest predictor.

In another NICHD study, Dearing, Taylor, and McCartney (2004) examined the link between family income and maternal depressive symptoms during the first 36 months of children's lives. They found that change in family income was associated with change in maternal depressive symptoms. Specifically, family income and maternal depressive symptoms negatively covaried over time, with the trajectories being mirror images. In examining the interaction effect, they further found that the association between change in family income and change in depressive symptoms significantly differed by poverty status. The negative effect of change in family income on depressive symptoms was significantly larger for chronically poor mothers than for mothers who were never poor.

Poverty not only makes depressive symptoms more likely to occur, it also can exacerbate the negative consequences of depressive symptoms on maternal behaviors and parent-child interaction. This is supported by empirical evidence, which suggests that the impact of maternal depression is most evident if the mother is from an economically disadvantaged background. For instance, Lovejoy et al. (2000) in their meta-analysis found that socioeconomic status moderated the relation between maternal depression and maternal positive behaviors. Specifically, for mothers from economically disadvantaged backgrounds, maternal depression had a moderate effect ($r = .21$, $d = .42$, $p < .001$) on the levels of positive parenting behaviors (e.g., praise, play, affection). However, the effect of maternal depression on positive behaviors was zero ($r = .03$, $d = .06$, $p > .05$) for mothers from nondisadvantage backgrounds. NICHD ECCRN (1999) also indicated that family income-to-needs ratio functioned as a moderator of the relations between maternal depressive symptoms and maternal sensitivity at 6, 15, 24, 36 months. Family income was more strongly associated with maternal sensitivity among mothers with elevated

depressive symptoms than among non-depressed mothers. Non-depressed mothers were sensitive to their children regardless of their income levels. The moderation effect was more evident among chronically depressed mothers. The investigators found that chronically depressed mothers with higher family income were more sensitive than chronically depressed mothers with lower income, who were the least sensitive. They suggested that having adequate economic resources seemed to buffer the effects of depressive symptoms on parental behaviors such that mothers with higher income are less worried about life and are better able to cope and respond to the child's need.

In conclusion, based on previous literature, this study examines the moderating role of family SES (i.e., family income and maternal education) in the mediated pathway from depressive symptoms to dyadic synchrony through maternal responsiveness using a longitudinal design. It is expected that the mediation pathway would fit differently in low and high SES groups. Specifically, the effects of maternal depressive symptoms on maternal responsiveness would have a stronger association for mothers with low SES than for mothers with high SES.

Temperament

Another factor that may affect the strength of the relation between maternal behaviors and parent-child interaction is children's temperament. Temperament is defined as biologically rooted individual differences in behavior tendencies that are present early in life and are relatively stable across various kinds of situations and over the course of time (Bates, 1989). Temperament includes dimensions such as negative emotionality, difficultness, adaptability, activity level, self-regulation, reactivity, and sociability (Bates, 1989). Temperament has been measured via parent report and observer

ratings. Bates (1994) argued that parental report of their child's temperament are not purely subjective, but also assess real existing differences in individual child characteristics. This is supported by previous empirical research, which indicated significant moderate levels of relation between parent report measures and objective laboratory assessments (Rothbart & Bates, 1998; Slabach et al., 1991; Wachs, 2006). Furthermore, child temperament has been demonstrated to have moderate stability in studies that use parent report or laboratory assessment (Rothbart et al., 2000; Wachs, 2006).

Children are not passive recipients of environmental influences. Rather, they are active participants in shaping their own developmental outcomes and trajectories. In Belsky's (1984) process model of parenting, he indicated that child temperament may affect parental functioning, in addition to the parental and contextual contributions. Particularly, children with specific temperamental characteristics may elicit specific patterns of reactivity or response from their parents (Crockenberg, 1986; Thomas, Chess, & Birch, 1968). For instance, Crockenberg and Acredolo (1983) indicated that children who are perceived as more difficult over time tend to have mothers who are less sensitive. van den Boom and Hoeksma (1994) examined mother-infant interaction using longitudinal data. They found that mothers of irritable infants over time tend to have lower levels of visual and physical contact, effective stimulation, soothing, involvement, and responsiveness to children's positive signals, whereas mothers of non-irritable infants tend to be more systematically positive.

Moreover, children's differences in temperament may interact with parental behaviors in predicting parent-child interaction. For instance, based on Crockenberg and

Smith's (1982) study, Ziv and Cassidy (2002) proposed that parental responsiveness may vary as a function of infant characteristics, and that parental responsiveness may result in part from the infants' attractiveness in the eyes of the parent. Crockenberg and Smith (1982) found that mothers were more responsive to their 3-month-old female irritable infants than to male irritable infants. In addition, female infants were significantly more alert than male infants. The authors suggested that, despite their irritability, alert female infants may have been more attractive to mothers since they are available for reciprocal interaction and for smiling and eye contact. Mothers may perceive interacting with alert and responsive infants as more rewarding. Thus, the Crockenberg and Smith (1982) study supported Ziv and Cassidy's (2002) proposition that an infant's characteristics may interact to predict maternal responsiveness.

Ziv and Cassidy (2002) also proposed that the impact of parental responsiveness may vary as a function of child characteristics. Similarly, Thomas, Chess, and Birch (1968) also hypothesized that infant characteristics may interact with parenting in predicting poor or better child outcomes. These viewpoints corresponded with Belsky's (1997) differential susceptibility hypothesis, which suggests that children with difficult temperament are most affected by rearing influences. For instance, Belsky, Hsieh, and Crinc (1998) found that intrusive and affectively negative parenting during toddlerhood was a strong predictor of children's externalizing problems and inhibition at age 3 for children who were highly negative as infants. Kochanska, Aksan, and Carlson (2005) found that maternal responsiveness at 7 months significantly predicted higher levels of child receptive cooperation with the mother at 15 months for children highly prone to anger. Specifically, they found that maternal responsiveness was important for highly

difficult or angry infants. Highly anger-prone children with more responsive mothers were more cooperative 8 months later, whereas angry children with unresponsive mothers were uncooperative. van Zeijl et al. (2007) found that higher levels of positive maternal discipline predicted lower externalizing problems in children with difficult temperament, but positive discipline was not related to externalizing behaviors in easy temperament children. Higher levels of negative discipline predicted more externalizing problems for children with difficult temperament, an association that was not found for easy temperament children. The authors concluded that children with difficult temperament were more susceptible to both negative discipline and positive discipline, compared to children with easy temperament.

In conclusion, the above reviewed studies suggested the moderating role of child temperament in examining the effects of maternal behaviors. This study examines whether child temperament would moderate the mediated pathway from depressive symptoms to dyadic synchrony through maternal responsiveness. It is expected that the mediation model would fit differently in easy and difficult temperament groups. The association between maternal responsiveness and parent-child dyadic synchrony would be weaker for children with difficult or easy temperament than for children with average temperament.

Other Risk and Protective Factors: Parenting Stress, Partner Status, and Social Support

Previous literature also suggests other risk and protective factors that might influence the effects of maternal depressive symptoms, maternal behaviors, and mother-child interaction. For instance, Beck (2001) examined the predictors of postpartum

depression utilizing meta-analysis. The author found that social support, childcare stress, marital relationship, and life stress had a moderate effect size on postpartum depression, while marital status had a small effect size. This study duplicated findings from O'Hara and Swain's (1996) meta-analysis, which revealed that low social support, poor marital relationships, and stressful life events were among the strongest predictors of postpartum depression. In addition to income and occupational prestige, Segre et al. (2007) also indicated that marital status and number of children were significant predictors of postpartum depression.

Cornish et al. (2006) investigated the link between maternal depression and mothers' experience of parenting. They found that mothers with brief and chronic depression reported significantly higher levels of parenting stress than never depressed mothers and that parenting stress was related to difficulties in their role as a parent, the family context, and the quality of the mothers' relationships. Similarly, Horwitz et al. (2007) examined the correlates of maternal depression using a secondary dataset with a birth cohort design. In addition to low maternal education and younger maternal age, they revealed that single parenting, high parenting stress, high parental stressful life events, and low social support were significantly associated with elevated maternal depressive symptoms. Among mothers with partners, partner involvement and quality of the relationship were significantly correlated with initial elevated depressive symptoms.

Lee et al. (2006) investigated the effects of social support and childcare (from other adults) on links between maternal depressive symptoms and preschool children's behavior outcomes. They revealed the significant moderating roles of social support and childcare. At lower levels of maternal depressive symptoms, higher social support was

associated with lower levels of children's externalizing behavior problems. However, at higher levels of maternal depressive symptoms, the protective effect of social support diminished. Specifically, children's externalizing behavior problems did not significantly differ at different levels of social support when the mothers reached clinical levels of depression. Moreover, childcare hours moderated the relation between maternal depressive symptoms and children's internalizing behavior problems. At higher levels of depressive symptoms, more hours of other provided childcare were associated with lower levels of internalizing problems in children.

Belsky's model (1984) also emphasized the importance of social support and marital relationship on parenting behaviors. For instance, Mertesacker, Bade, Haverkock, and Pauli-Pott (2004) investigated maternal sensitivity with their infants. They found that, with higher levels of social and emotional support, mothers' sensitivity did not differ from 4 to 8 months, regardless of how they described their infants. In contrast, with lower social support, mothers were relatively high in sensitivity if they perceived their infants as low in negative emotionality, whereas mothers exhibited lower sensitivity if they perceived the infants as high in negative emotionality. Furthermore, previous research also has indicated the positive effects of paternal support and involvement on mothers (Kalil, Ziol-Guest, & Coley, 2005) and on children (McBride, Schoppe-Sullivan, & Ho, 2005). Having significant others or tightly knit social network contacts can provide the emotional support and instrumental support, such as childcare, that mothers need. Thus, social support and childcare may directly or indirectly affect parenting behaviors and parent-child interaction.

This study attempts to examine the sole effects of maternal depressive symptoms on subsequent maternal responsiveness and mother-child interaction. Therefore, risk factors and protective factors such as partner status, parenting stress, social support, and number of adults living in the home that may affect the relationships among the constructs of interest will be included as control variables in the analyses.

Rationale & Longitudinal Research Design

Despite the importance of dyadic interaction quality to children's adjustment, there is little research examining the factors that facilitate or hinder the development of dyadic synchrony. The few studies that have examined parental and child characteristics in relation to dyadic synchrony are primarily cross-sectional studies (e.g., Feldman, 2003; Skuban et al. 2006). In addition, contextual factors such as socioeconomic status have seldom been examined along with parental and child factors. The above documented empirical literature has indicated maternal depressive symptoms to be a risk factor for maternal responsiveness (e.g., Cohn & Tronick, 1987) and dyadic synchrony (e.g., Albright & Tamis-Lemonda, 2002). Maternal responsiveness was also linked to dyadic synchrony in the literature (e.g., Skuban et al., 2006). However, the question of whether responsiveness mediates the link between maternal depressive symptoms and dyadic synchrony is still unexamined. This study will be the first to explicitly examine the mediating role of maternal responsiveness and factors that might alter the mediational path. In addition, although previous studies have examined maternal depression and child outcomes, the change of depressive symptoms has not been studied over time in relation to later maternal responsiveness and parent-child dyadic synchrony.

This study attempts to examine how maternal, child, and contextual factors independently and interactively predict dyadic synchrony between mothers and their children followed from 1 to 54 months in the NICHD Study of Early Child Care and Youth Development (SECCYD) longitudinal dataset. Fifty-four month mother-child dyadic synchrony was selected because it permits us to examine the course of depressive symptoms in infancy and toddlerhood and to assess dyadic synchrony at a time when parent-child interaction is more co-constructed and balanced, due to children's improved communication skills and greater cognitive functioning to engage in dyadic interaction with the parent.

Research Questions & Hypotheses

RQ1: Based on empirical research findings showing the links between maternal depressive symptoms and maternal responsiveness, between responsiveness and synchrony, and between depressive symptoms and synchrony, does maternal responsiveness mediate the link between trajectory of maternal depressive symptoms during infancy and toddlerhood and mother-child dyadic synchrony in early childhood?

Hypothesis 1: It is hypothesized that trajectory of maternal depressive symptoms from 6 to 24 months will predict maternal responsiveness at 36 months, which will, in turn, predict mother-child dyadic synchrony at 54 months.

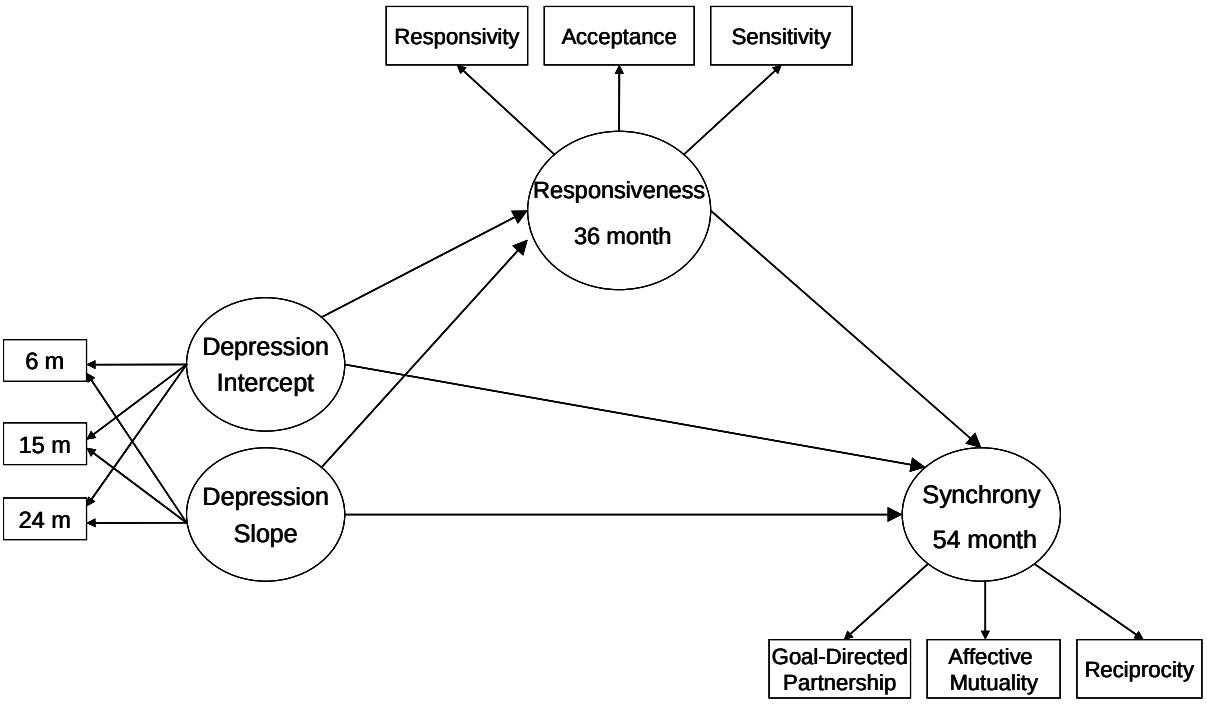


Figure 1. The Conceptual Model of the Mediated Pathway

RQ2: Does SES moderate the mediated pathway from depressive symptoms to dyadic synchrony through maternal responsiveness?

Hypothesis 2: It is hypothesized that the mediated pathway will fit differently as a function of SES groups. Specifically, the path from maternal depressive symptoms to maternal responsiveness will vary by SES. The growth parameters of maternal depressive symptoms will have stronger associations with maternal responsiveness for mothers with low SES than for mothers with high SES. There is no specific hypothesis for mothers with average SES.

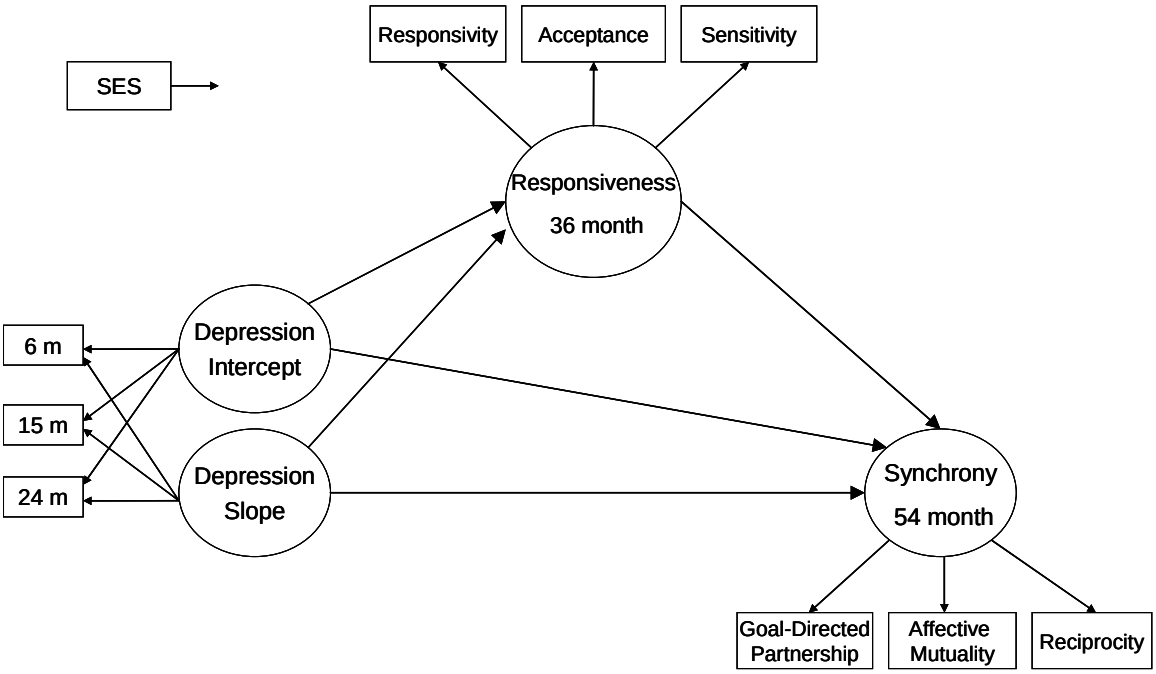


Figure 2. The Conceptual Model of the Moderation Effect (SES)

RQ3: Does child temperament moderate the mediated pathway from depressive symptoms to dyadic synchrony through maternal responsiveness?

Hypothesis 3: It is hypothesized that the mediated pathway will fit differently by child temperament groups. Specifically, the path from maternal responsiveness to dyadic synchrony will vary by child temperament. It is expected that maternal responsiveness will have less effect when the child has a difficult temperament, which in turn will predict less dyadic synchrony. Children with easy temperaments are more likely to develop dyadic synchrony with mothers regardless of the degree of maternal responsiveness. Thus, the association between maternal responsiveness and parent-child dyadic synchrony is expected to be weaker for children with difficult or easy temperaments than for children with average temperaments.

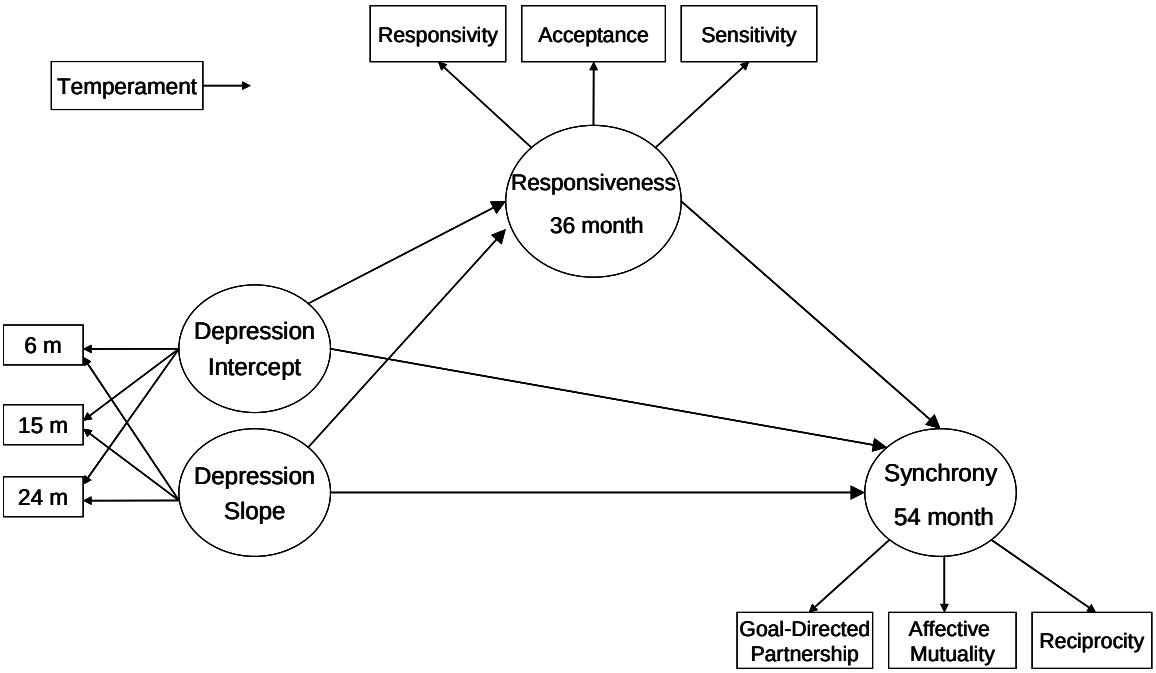


Figure 3. The Conceptual Model of the Moderation Effect (Temperament)

3. METHOD

Participants

The mothers and children of this study were participants of the National Institutes of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD). NICHD SECCYD is a comprehensive longitudinal study initiated in 1989. Participants in the NICHD Study of Early Child Care were recruited in 1991 in hospitals at 10 data collection sites across the United States: Little Rock, AR; Irvine, CA; Lawrence and Topeka, KS; Boston, MA; Philadelphia, PA; Pittsburgh, PA; Charlottesville, VA; Morganton and Hickory, NC; Seattle, WA; and Madison, WI. During the sampling period, 8986 women who had given birth were visited in the hospital to determine their eligibility for the study. Participants were excluded from the sample if the mother was under 18, unable to speak English, hospitalized for more than 7 days, planned to move, delivered multiple births, or had a known substance abuse problem. Of those visited in the hospital in the initial sampling periods, 5265 met the eligibility criteria for the study.

A conditional random sampling technique was used to select the final sample and ensure diversity in the economic, educational, ethnic, and family structural characteristics. Final recruitment occurred when the children were 1 month old, resulting in 1,364 participating families. The recruited families included 24% ethnic minority children, 11% mothers without a high school education, and 14% single mothers. The sample was not designed to be nationally representative. However, the sample was similar to families in

the same census tracts on demographic variables of household income and ethnicity at the time of sampling (NICHD ECCRN, 2003). Nevertheless, due to the sample selection criteria and the fact that the majority of participants lived near colleges, this sample has a higher than average SES, which may be considered as a limitation of this study.

Procedure

Data included in this study were collected during home visits to the families when the children were 1, 6, 15, 24, and 36 months old and during a 54-month laboratory visit. During the 1-month visit, demographic information including mother's age, educational level, marital status, and family income was collected. Information on the family was updated using phone calls and also during each visit. Maternal reports of depressive symptoms were obtained during the home visits at 6, 15, and 24 months. Observations of maternal responsiveness were conducted during the 36-month home visit. Mothers reported on child temperament when children were 1 and 6 months of age. Videotaped observations of mother-child interaction were conducted at a laboratory visit when children were 54 months old and were used to derive synchrony measures.

Measures

Dyadic synchrony. At 54 months, mother-child interaction was observed and videotaped during a 15-min semi-structured laboratory visit. The mother-child interaction consisted of three activities, two of which were too difficult for the child to accomplish independently and required the parent's instruction and assistance. The first activity involved completing a maze using an Etch-A-Sketch that had been altered by attaching a maze to the screen. The second activity was to form identically-shaped rectangular towers from irregularly shaped wooden blocks. The third activity was designed to stimulate

pretend play between mother and child with a set of six hand puppets.

Three indicators of synchrony were derived from measures of mother and child behavior during this session. Two of these indicators, *affective mutuality* and g*oal-directed partnership*, were dyadic measures coded by the NICHD. The third indicator, *reciprocity*, was computed for this study from the mother-child interaction ratings. These indicators will be described in the section following mother and child ratings.

The mother-child interaction was rated on 7-point global scales. Mothers were rated on their supportive presence (i.e., expression of positive regard and emotional support to the child), respect for autonomy (i.e., acknowledge the validity of the child's individuality and allow a mutually negotiated interaction), stimulation of cognitive development (i.e., effortful teaching that facilitates learning), quality of assistance (i.e., effectiveness of mothers' instruction and hint for the child to understand the task), hostility (i.e., expression of anger or rejecting), and confidence (i.e., believe that she can successfully engage the child in the activities). A composite score of *maternal positive caregiving* was formed in this study as the average rating of supportive presence, respect for autonomy, and reversed hostility ($\alpha = .84$), which was later used to compute the third dyadic measure.

Children were rated on their agency (i.e., display of vigor, confidence, and eagerness to do the tasks), negativity (i.e., display of anger, hostility toward mother), persistence (i.e., degree of actual involvement with the toys during activities), and experience of session (i.e., feelings of competence on the tasks and confidence in having a good relationship with mother). A composite score of *child positive engagement with mother* was computed in this study as the average rating of experience of session and

reversed negativity (α = .67), which was also later used to form the third dyadic measure. Inter-rater reliabilities for mother and child ratings were reported to range from .64 (respect for autonomy) to .85 (child positive engagement with mother).

The mother-child dyads were also rated on two 7-point dyadic scales. *Affective mutuality* assessed the availability and mutuality of emotion between mother and child through verbal and non-verbal communication. *Affective mutuality* was marked by a sense of engagement and tone of voice reflective of warmth and positive regard. *Goal-directed partnership* measured the extent to which the dyad evolved and shared a common goal and was indicated by behaviors such as mother's tuning in her behaviors to the child, reciprocal verbal or non-verbal communication, child's expectation of assistance from the mother when needed, and high degree of engagement and cooperation, with a sense of interdependence between the two. In order to capture the relative balance of interaction between mother and child, a third dyadic rating, *reciprocity*, was computed for this study as the absolute value of the difference between *maternal positive caregiving* and *child positive engagement with mother*, which was later reverse coded. The absolute values of the difference could range from 0 to 6, with values closer to 0 indicating more balanced interaction. Reverse coding of the absolute value ensured that higher value indicated greater balance. The three dyadic scales, *reciprocity*, a*ffective mutuality,* and *goal-directed partnership*, served as indicators of dyadic synchrony in this study.

Maternal depressive symptoms. The Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977) was used to assess maternal depressive symptoms when the child was 6, 15, and 24 months old. The CES-D is a 20-item self-report scale designed to measure depressive symptoms in non-clinical populations.

Mothers rated the frequency of 20 symptoms during the past week. Response categories include "rarely or none of the time (less than 1 day)," "some or a little of the time (1-2 days)," "occasionally or a moderate amount of time (3-4 days),” and "most or all of the time (5-7 days).” Total possible scores range from 0 to 60, with a cutoff score of 16 or above indicating potentially serious depression. Reliability ranged from .88 to .91 in previous NICHD studies, indicating good internal consistency. Depressive symptoms scores were moderately correlated over the 3 assessments, ranging from .52 to .58. The CES-D has been widely used to examine the impact of maternal depressive symptoms on maternal behaviors and child functioning. It has been reported in the literature that CES-D exhibits concurrent and predictive validity (Weinberg et al., 2006).Research also shows that CES-D scores are related to mothers’ diagnostic status, even in community samples (Beeghly et al., 2002). A meta-analysis concluded that studies using diagnostic interviews or self-report measures yielded similar effects (Lovejoy et al., 2000).

Responsiveness. The 7-item Parental Responsivity subscale, the 4-item Acceptance subscale from the Home Observation for Measurement of the Environment (HOME) Early Childhood version (Caldwell & Bradley, 1984), and the maternal sensitivity composite derived from the 36-month mother-child interaction during the laboratory visit were used as indicators of maternal responsiveness for this study. Trained observers assessed maternal responsiveness and acceptance during home visits at 36 months. The full HOME Inventory is designed to measure stimulation and responsiveness of mothers, their involvement with and acceptance of their children, the availability of play and learning materials, and the organization and variety of the physical environment. The focus is on the child in the environment and the child as a recipient of inputs from

objects, events, and transactions occurring in connection with the family surroundings.

The HOME Responsivity subscale includes 7 items: “Mother converses with child 2 or more times during visit,” “Mother usually responds verbally to child's speech,” “Mother praises child’s qualities twice during visit,” “Mother caresses, kisses, or cuddles child during visit,” “Mother answers child’s questions or requests verbally,” “Mother helps child demonstrate some achievement during visit,” and “Parent holds child close 10-15 minutes per day.” HOME Acceptance subscale includes 4 items: “Mother does not scold or derogate or yell at child more than once during the visit,” “Mother does not use physical restraint during visit,” “Mother neither slaps nor spanks child during visit,” and “No more than one instance of physical punishment occurred during the past week.” Each item was rated as yes or no, with 1 indicating yes and 0 indicating no. Total scores of Responsivity subscale and Acceptance subscale were calculated separately to represent maternal responsiveness, with higher scores reflecting higher levels of responsiveness. Inter-rater reliability was reported to be 93% for the total scale, with internal consistency being .93 for total scale and .62 to .88 for subscales. Due to copyright restrictions, the full HOME measure will not be included in the appendix.

The third indicator, sensitivity, was derived from the mother-child interaction during the three boxes procedure of the 36-month laboratory visit. The first box included washable markers, a tablet of white blank paper, and stencils. The second box contained dress-up clothes and a cash register. The third box included Duplo blocks and a picture of a constructed model. Mothers were instructed to help child play with the items in the boxes in the order specified. Mothers were rated on their supportive presence, respect for autonomy, stimulation of cognitive development, hostility, and confidence on 7-point

scales. The sensitivity composite score in this study was computed as the average rating of supportive presence, respect for autonomy, and reversed hostility (α = .80).

SES. The composite score of thirty-six months income-to-needs ratio and maternal education was used in this study as a measure of socioeconomic status. An income-to-needs ratio was computed as family income divided by the poverty threshold for its household size. For example, an income of $13,924 in 1991 for a family of four would have an income to needs ratio of 1.0. Families living in poverty have an income to needs ratio of 1.0 or lower, whereas those living near poverty have a ratio between 1.0 and 1.99, and those living above poverty have a ratio of 2 or higher. Maternal education was operationalized as number of years of education the mother had completed at the time of recruitment when the child was 1 month old.

Child temperament. Mothers completed the Revised Infant Temperament Questionnaire (Carey & McDevitt, 1978) at 6 months. This measure included 55 items and 1 overall item of child's temperament as about average, more difficult than average, or easier than average. Mothers rated child activity, adaptability, approach, mood, and intensity on 6-point scales, ranging from 1 (*almost never*) to 6 (*almost always*). Appropriate reversal of scales was conducted so that higher scores reflect a more difficult temperament. Internal consistency was shown to be adequate (α = .81). The mean score of the 55 items was used to represent overall difficult temperament in this study.

Control variables. Child gender, child ethnicity, partner status, social support, parenting stress, and number of adults living in home were included as control variables in the analyses.

Gender. Mothers reported gender of the child at the 1-month home interview.

Child gender was dummy coded 0 for girls and 1 for boys.

Ethnicity. At 1-month interview, mothers reported child's ethnicity (European American, African American, American Indian, Asian, or Other). Ethnicity was dummy coded in this study as European American vs. Other and African American vs. Other.

Partner status. Mothers reported whether they were currently living with a partner or husband at the 1-month interview and during each home visit. Partner status at 6 months was included as time-invariant covariate in the analyses and was dichotomously coded in this study (1 = living with a partner, 0 = not living with a partner).

Social support. Mothers rated their social support at 6 months using the 11-item Relationships with Other People scale (Marshall & Barnett, 1991). This measure assessed mothers' perceived availability of support from others over the past month. Items were rated on 6-point scales, ranging from 1 (*none of the time*) to 6 (*all of the time*), with higher scores reflective of greater perceived support. The total score at the 6-month assessment was used as time-invariant covariate in the analyses.

Parenting stress. Mothers reported parenting stress at 6 months using the modified 25-item Parenting Stress Index (Abidin, 1983). This measure assessed mothers' difficulties in coping with the demands of childrearing and included two subscales, Restrictions of Role and Sense of Competence. Items were rated on 5-point scales, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The total score at 6 months was used as time-invariant covariate, with higher score indicating greater stress.

Number of adults living in home. Mothers reported the number of related and unrelated adults living in the home at each assessment. The report from 6 months was included as time-invariant covariate.

Missing Data

Full Information Maximum-Likelihood (FIML) in Mplus was utilized to handle missing data. FIML uses all available data points, even the data from partially complete cases, to compute the maximum likelihood estimation of missing values (Enders, 2001). FIML operates under the assumption of Missing at Random (MAR), meaning that the probability of a missing data on a particular variable may depend on other observed variables, but not on that particular variable itself (Arbuckle, 2007; Rubin, 1976). FIML includes the partially observed cases, resulting in more efficient and less biased parameter estimates than listwise and pairwise deletion (Enders, 2001).

Analytic Plan

Univariate and bivariate analyses were conducted first. Next, maternal depressive symptoms trajectory from 6 to 24 months, the maternal responsiveness measurement model, and the dyadic synchrony measurement model were examined. In order to examine change in maternal depressive symptoms over time in relation to maternal responsiveness and dyadic synchrony, Latent Growth Curve Modeling (LGCM) in Mplus 5.1 was conducted. LGCM allows for the use of trajectory of change in depressive symptoms over time to be predicted as well as to predict subsequent outcomes. LGCM also considers the measurement error from observed variables and thus provides true unbiased parameter estimations.

To test the mediation model, both the direct effect of maternal depressive symptoms on dyadic synchrony and the indirect effect through maternal responsiveness were examined. Time-invariant covariates from the 1-month report (i.e., ethnicity, gender) and the 6-month assessment (i.e., partner status, social support, parenting stress, number

of adults living in home) were included as exogenous variables that predicted maternal depressive symptoms intercept and slope. The paths from depressive symptoms to responsiveness (predictor to mediator), from responsiveness to synchrony (mediator to outcome), and from depressive symptoms to synchrony (predictor to outcome) were fitted simultaneously in one model (unconstrained model). With maternal responsiveness in the model, the direct path from maternal depressive symptoms to dyadic synchrony was expected to be nonsignificant. To further examine the mediation effect, a constrained model was fitted in which the direct effect of depressive symptoms on dyadic synchrony was constrained to zero. Delta chi-square value was used to examine the model fit of unconstrained and constrained model. It was expected that, even with the direct path constrained to zero, the two models would not show significant difference (i.e., cannot reject the null hypothesis in the constrained model that direct effect of maternal depressive symptoms on synchrony is zero in the population), thus supporting the mediation model that maternal responsiveness mediates the association between the growth parameters of maternal depressive symptoms and parent-child dyadic synchrony.

To examine the moderating effect of SES in the mediation link, multiple group analysis within LGCM framework was conducted to test group differences in the mediated model. Sample was divided into low, average, and high SES groups. First, an unconstrained mediation model was fitted simultaneously to the three SES groups in which all the paths were free to vary. Next, a constrained model was fitted in which all the paths were constrained to equal across groups. Delta chi-square test was conducted to examine model fit of unconstrained and constrained model. It was expected that the chi-square difference would be significant, indicating that the mediated pathway is not equal

across groups and thus supporting the moderation effect. To further examine where the moderation effect occurs, constraint was added to each path. It was expected that the growth parameters of maternal depressive symptoms will have stronger associations with maternal responsiveness for mothers with low SES than for mothers with high SES. To examine the moderating role of child temperament, similar procedures of multiple group analysis within LGCM framework was performed to examine group differences in the mediated pathway for easy, average, and difficult temperament groups. It was expected that maternal responsiveness will have less effect when the child has a difficult temperament, which in turn will predict less dyadic synchrony. Fit statistics such as chi-square, CFI, TLI, RMSEA, and SRMR were used to evaluate model fit.

4. RESULTS

Preliminary Analyses

Univariate analyses were conducted to examine the study variables. The descriptive statistics of the key variables and control variables are presented in Table 1 and Table 2, respectively. For maternal depressive symptoms, the mean score was lowest at 6 months and it slightly increased over time. On average, mothers were below the clinical cutoff score of 16 at all time points. The values of skewness and kurtosis indicated that the distributions of maternal depressive symptoms from all 3 time points were skewed. The stem-and-leaf plots further revealed that maternal depressive symptoms were positively skewed, indicating the majority of the mothers were at the lower end of the scale. It has been suggested that skewness less than absolute value of 3 and kurtosis less than absolute value of 8 are within acceptable range (Kline, 2005). Moreover, previous NICHD studies that examined the trajectory of maternal depressive symptoms used original raw data instead of transforming the skewed variables (e.g., Campbell et al., 2007; NICHD SECC, 1999). Because the present sample is not a clinical sample, it is expected that the maternal depressive symptoms would exhibit right skewed distributions rather than normal distribution. Therefore, it was decided not to transform the depression variables.

For maternal responsiveness, the mean scores showed that mothers exhibited relatively high levels of responsiveness. The stem-and-leaf displays revealed that maternal responsiveness indicators were negatively skewed. Mean scores of dyadic

synchrony indicated that the mother-child dyads, on average, exhibited moderate to high levels of dyadic synchrony. The stem-and-leaf plots of goal-directed partnership and affective mutuality showed that the distributions seem symmetric enough, whereas the third indicator, reciprocity, was negatively skewed. Skewness and kurtosis indexes of maternal responsiveness and dyadic synchrony indicators were all within acceptable ranges (-1.77 to 3.62).

The descriptive statistics of SES showed that, on average, mothers were in middle SES. The positive skewed distribution of SES indicated that the majority of the mothers were from middle SES families while a small number of mothers were from extremely high SES families. On average, children in the current sample exhibited average temperament. The stem-and-leaf display showed that the distribution of child temperament was sufficiently symmetric.

Correlations

Table 3 shows correlations among the key variables. Maternal depressive symptoms scores seemed to be stable over time (*rs* = .52 to .58) and mothers also seemed to remain in their rank order of the depressive symptoms from 6 to 24 months compared with other mothers in the sample. As expected, higher levels of maternal depressive symptoms were associated with lower maternal responsiveness and lower dyadic synchrony. Mothers with greater depressive symptoms tended to have lower SES and have children with more difficult temperament. On the other hand, higher levels of maternal responsiveness were associated with higher dyadic synchrony and higher SES. Mothers of temperamentally easier children tend to have higher levels of responsiveness and the dyads also exhibited greater dyadic synchrony.

Table 1
Descriptive Statistics of Study Variables

	N	Mean	SD	Min	Max	Skewness	Kurtosis
Depressive Symptoms							
6 Months	1278	8.97	8.34	0	52.00	1.72	3.62
15 Months	1241	9.05	8.18	0	54.00	1.55	2.80
24 Months	1119	9.40	8.63	0	51.00	1.59	2.80
Responsiveness							
Responsivity[a]	1179	5.61	1.36	0	7.00	-1.11	1.27
Acceptance[b]	1179	3.39	0.92	0	4.00	-1.77	3.09
Sensitivity[c]	1161	5.73	0.93	1.33	7.00	-1.37	2.77
Dyadic Synchrony							
Goal-Directed Partnership[d]	1040	4.72	1.35	1.00	7.00	-0.60	0.22
Affective Mutuality[d]	1040	5.19	1.28	1.00	7.00	-0.97	1.15
Reciprocity[e]	1040	6.42	0.52	3.33	7.00	-1.56	3.48
SES[f]	1363	17.43	4.83	7.63	46.50	1.14	2.81
Temperament[g]	1279	3.18	0.40	1.54	4.72	-0.13	0.48

Note. [a]Observer ratings of 7 items from HOME inventory on dichotomous scale. [b]Observer ratings of 4 items from HOME inventory on dichotomous scale. [c]Composite scores from mother-child interaction during the 36-month laboratory visit on 7-point scales. [d]Observer ratings of mother-child interaction during the 54-month laboratory on 7-point scales. [e]Composite scores from mother-child interaction during the 54-month laboratory visit on 0-6 scale. [f]Composite scores of maternal years of education and income-to-needs ratio. [g]Maternal ratings of child difficult temperament on 4-point scales.

Table 2
Descriptive Statistics of Control Variables

	N	%	Mean	SD	Min	Max
Social Support	1276		5.02	0.72	2	6
Parenting Stress	1275		50.23	9.90	26	83
Number of Adults Living in home	1279		2.14	0.69	1	8
Partner Status						
Live with partner	1101	86.3				
Not live with partner	175	13.7				
Child Gender						
Male	705	51.7				
Female	659	48.3				
Child Ethnicity						
European American	1097	80.4				
African American	176	12.9				
Other	91	6.7				

Table 3
Correlations among Maternal Depressive Symptoms, Maternal Responsiveness, Dyadic Synchrony, SES, Child Temperament, and Control Variables

	1	2	3	4	5	6	7	8	9	10	11
Depressive Symptoms											
1. 6 Months	-										
2. 15 Months	.58**	-									
3. 24 Months	.52**	.53**	-								
Responsiveness											
4. Responsivity	-.16**	-.12**	-.17**	-							
5. Acceptance	-.17**	-.17**	-.20**	.23**	-						
6. Sensitivity	-.20**	-.22**	-.27**	.26**	.25**	-					
Dyadic Synchrony											
7. Goal-directed partnership	-.15**	-.12**	-.18**	.18**	.17**	.33**	-				
8. Affective mutuality	-.17**	-.16**	-.21**	.20**	.19**	.42**	.72**	-			
9. Reciprocity	-.04	-.04	-.08*	.06	.11**	.21**	.35**	.45**	-		
Moderators											
10. SES	-.23**	-.24**	-.28**	.30**	.23***	.41**	.24**	.25**	.06*	-	
11. Temperament	.22**	.15**	.16**	-.12**	-.08*	-.14**	-.11**	-.14**	-.05	-.16**	
Control Variables											
12. Number of adults	-.00	.05	.05	.00	-.05	-.10**	-.04	-.02	-.00	-.10**	.08**
13. Social support	-.45**	-.36**	-.30**	.07**	.12**	.11**	.10**	.16**	.07*	.08**	-.15**
14. Gender	-.03	-.01	-.01	-.04	-.07*	-.09**	.04	.02	.01	-.06*	-.05
15. Parenting stress	.44**	.37**	.33**	-.10**	-.10**	-.15**	-.12**	-.14**	-.09**	-.11**	.26**
16. African American	.14**	.10**	.15**	-.18**	-.09**	-.30**	-.20**	-.21**	-.12**	-.25**	.18**
17. European American	-.17**	-.13**	-.17**	.21**	.08**	.29**	.21**	.23**	.10**	.22**	-.19
18. Partner status	-.18**	-.14**	-.20**	.20**	.11**	.26**	.15**	.14**	.09**	.31**	-.10**

Note. Sample size ranges from 957 to 1279.
* $p < .05$ ** $p < .01$

Table 3 (continued)
Correlations among Maternal Depressive Symptoms, Maternal Responsiveness, Dyadic Synchrony, SES, Child Temperament, and Control Variables

	12	13	14	15	16	17	18
12. Number of adults	-						
13. Social support	.06*	-					
14. Gender	.00	.04	-				
15. Parenting stress	.04	-.35**	.01	-			
16. African American	.06*	-.05	-.00	.03	-		
17. European American	-.09**	.08**	.02	-.06*	-.78**	-	
18. Partner status	-.01	.11**	.01	-.09	-.39**	-.37**	-

Measurement Models

The measurement models of maternal responsiveness and dyadic synchrony and trajectory of maternal depressive symptoms were first examined before conducting latent growth curve analyses to test the first hypothesis. Goodness-of-fit indices such as chi-square statistic (χ^2), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR) were used to examine model fit. A model with a small chi-square and non-significant *p*-value indicates good model fit. However, it is suggested that chi-square statistic not be used as the sole fit index because it is sensitive to sample size (Kline, 2005). Some researchers have used the ratio of chi-square to degrees of freedom to reduce the sensitivity of chi-square to large sample size. A ratio of less than 5 is considered acceptable model fit (Bollen, 1989). In addition to the chi-square statistic, values of CFI and TLI greater than .90 are considered good model fit (Hu & Bentler, 1999). A RMSEA value close to .50 with a non-significant *p*-value is considered a close fit (Browne & Cudeck, 1993). The 90% confidence interval (90% CI) is also used to assess the precision of RMSEA estimates in Mplus. A SRMR value less than .50 indicates well-fitting, whereas a SRMR value of zero indicates a perfect fit to the data (Byrne, 2006; Kline, 2005).

Confirmatory Factor Analysis. Confirmatory factor analyses were conducted to examine the measurement models of maternal responsiveness and dyadic synchrony. The maternal responsiveness measurement model with responsivity, acceptance, and sensitivity fit the data perfectly when fitted individually, due to the model being fully saturated, χ^2 (0) = 0; CFI = 1; TLI = 1; RMSEA = 0; SRMR = 0. The dyadic synchrony

measurement model with goal-directed partnership, affective mutuality, and reciprocity also fit the data perfectly when fitted individually, χ^2 (0) = 0; CFI = 1; TLI = 1; RMSEA = 0; SRMR = 0. The measurement model also fit the data well when maternal responsiveness and dyadic synchrony were fitted simultaneously, χ^2 (8) = 20.90, $p < .01$; CFI = .99; TLI = .98; RMSEA = .037, $p > .05$; SRMR = .022.

Unconditional Growth Curve Model. To examine the shape of maternal depressive symptoms change trajectory from when the child was 6 to 24 months, an unconditional growth model that specified linear growth over time was conducted. The intercept and linear slope of the latent construct were indicated by maternal depressive symptoms measured at child age of 6, 15, and 24 months. The factor loadings of the intercept indicators were all set to 1. The time measurements were centered at 6 months. The factor loadings of the linear slope indicators were then fixed to 0, 9, and 18, meaning that the first wave assessment occurred at a centered time of 0 when the children were 6 month of age. The results of the unconditional model (Table 4) showed good fit to the data, χ^2 (1) = .97, $p > .05$; CFI = 1; TLI = 1; RMSEA = 0, $p > .05$; SRMR = .006. The significant parameter estimate of the initial level (intercept = 8.969, $p = 0$) and close to significant parameter estimate of the linear rate of change (slope = .025, $p = .066$) indicated that, on average, mothers exhibited a level of 8.969 depressive symptoms at 6 months and it slightly increased over time at the rate of .025 per month (see Figure 1). Variability existed in maternal initial level of depressive symptoms ($\sigma^2 = 42.272$, $p = 0$). However, there were no individual differences in rate of change over time ($\sigma^2 = .014$, $p > .05$). Initial level of depressive symptoms was not significantly correlated with the linear rate of change ($r = -.24$, $p > .05$), indicating that greater depressive symptoms at 6

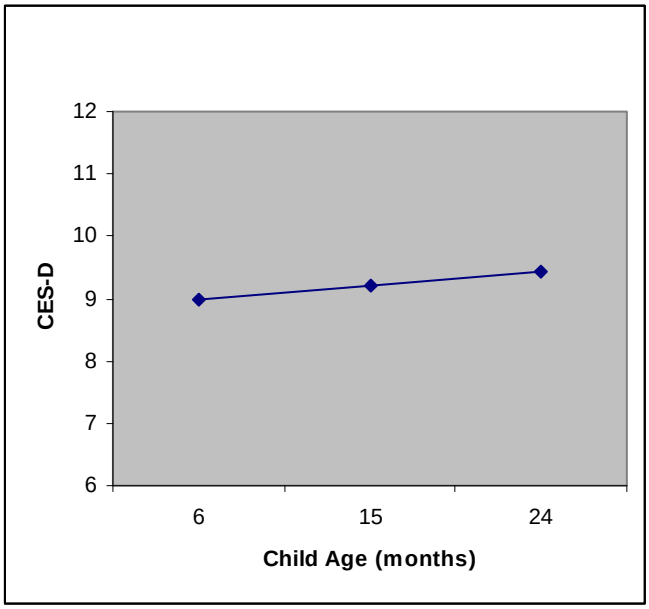
months was not associated with slower rate of decrease over time.

Table 4
Unstandardized Estimates of Maternal Depressive Symptoms Trajectory

	Estimate
Fixed Effects	
Initial Status	8.969***
Rate of Change	0.025~
Variances	
Initial Status	42.272***
Rate of Change	0.014
Goodness-of-fit Statistics	
χ^2 (1)	.967
CFI	1
TLI	1
RMSEA	0
SRMR	.006

~ $p < .10$ *** $p < .001$

Figure 4
Trajectory of Maternal Depressive Symptoms by Child Age



Testing of Hypothesis 1: Maternal Responsiveness as a Mediator

Latent Growth Curve Models. The first hypothesis postulated that maternal responsiveness at 36 months will mediate the link between trajectory of maternal depressive symptoms from 6 to 24 months and mother-child dyadic synchrony at 54 months. To test the hypothesized mediation model, a series of conditional latent growth curve models was conducted, which followed the procedures suggested by Holmbeck (1997) and Baron and Kenny (1986). In Model 1 (see Table 5), the direct effects of maternal depressive symptoms intercept and slope (predictor) on dyadic synchrony (outcome) were examined. The model fit the data well, χ^2 (8) = 7.64, $p > .05$; CFI = 1; TLI = 1; RMSEA = 0, $p > .05$; SRMR = .015. The significant path coefficient (B = -.04, $p < .001$) from the intercept suggested that mothers with higher initial level of depressive symptoms had lower mother-child dyadic synchrony. The nonsignificant path coefficient from the slope indicated that the rate of change for maternal depressive symptoms did not predict dyadic synchrony (B = -1.15, $p > .05$), which was expected since there was nonsignificant variance in the slope term.

In Model 2 (see Table 5), the direct effects of maternal depressive symptoms intercept and slope (predictor) on maternal responsiveness (mediator) were evaluated. The results revealed good fit to the data, χ^2 (8) = 11.23, $p > .05$; CFI = .997; TLI = .995; RMSEA = .018, $p > .05$; SRMR = .014. The significant path coefficient (B = -.05, $p < .001$) indicated that the initial level of maternal depressive symptoms significantly predicted maternal responsiveness. Mothers with higher initial level of depressive symptoms were less responsive at 36 months. However, the rate of change of depressive symptoms did not significantly predict maternal responsiveness at 36 months (B = -1.5, p

> .05).

In Model 3 (see Table 5), the direct effect of maternal responsiveness (mediator) on dyadic synchrony (outcome) was estimated. The model displayed adequate fit to the data, χ^2 (8) = 20.90, $p < .01$; CFI = .991; TLI = .983; RMSEA = .037, $p > .05$; SRMR = .022. The significant path coefficient ($B = 1.17$, $p < .001$) indicated that higher maternal responsiveness at 36 months predicted higher mother-child dyadic synchrony at 54 months.

In the previous three models, it had been established that there were significant associations among predictor, mediator, and outcome variable, with the exception of the paths from the slope of depressive symptoms. Therefore, in Model 4 (see Table 5), the direct effect of maternal depressive symptoms on dyadic synchrony and the indirect effect through maternal responsiveness were fitted simultaneously in the same model, including the paths from the slope. This model demonstrated a good fit to the data, χ^2 (23) = 36.90, $p < .05$; CFI = .994; TLI = .991; RMSEA = .022, $p > .05$; SRMR = .022. Due to the large sample size, the chi-square statistics in this model and the ones thereafter were all significant. The results indicated that the intercept of maternal depressive symptoms predicted maternal responsiveness in a significant way ($B = -.05$, $p < .001$), whereas the slope of depressive symptoms did not predict maternal responsiveness ($B = -1.40$, $p > .05$). Maternal responsiveness then significantly predicted dyadic synchrony ($B = 1.29$, $p < .001$). However, the significant direct path from the intercept of maternal depressive symptoms to dyadic synchrony, which was found in Model 1, was no longer significant when maternal responsiveness was in the model ($B = .02$, $p > .05$). The slope of maternal depressive symptoms still did not significantly predict dyadic synchrony ($B = .89$, p

> .05).

In Model 5 (see Table 5), the nonsignificant paths from the slope to maternal responsiveness and dyadic synchrony and the variance of the slope were all fixed to zero and fitted again. This model showed a good fit to the data, χ^2 (27) = 44.19, $p < .05$; CFI = .993; TLI = .991; RMSEA = .022, $p > .05$; SRMR = .024. Similar pattern of effects were found. The intercept of depressive symptoms significantly predicted maternal responsiveness ($B = -.04$, $p < .001$), which then significantly predicted dyadic synchrony ($B = 1.20$, $p < .001$). In the meantime, the intercept of depressive symptoms did not predict dyadic synchrony ($B = .01$, $p > .05$).

In Model 6 (see Table), after the examination of direct and indirect effects in the previous model, six time-invariant covariates (control variables) that predicted the intercept of maternal depressive symptoms were added. This model aimed to examine whether the same patterns of effects still exist after accounting for the effects of control variables. The six time-invariant covariates included partner status, social support, parenting stress, number of adults living in home, child gender, and child ethnicity. The model exhibited adequate fit to the data, χ^2 (83) = 288.35, $p < .001$; CFI = .936; TLI = .924; RMSEA = .043, $p > .05$; SRMR = .055. Similar patterns of effects were found, controlling for the six covariates. However, only four of the six covariates significantly influenced the initial level of depressive symptoms: partner status, social support, parenting stress, and child ethnicity as European American. The effects of number of adults living in home ($B = .37$, $p > .05$), child gender ($B = .001$, $p > .05$), and child ethnicity as African American ($B = .53$, $p > .05$) on initial level of depressive symptoms were not statistically significant.

In Model 7 (see Table 5), the latent growth curve model of depressive symptoms intercept predicting dyadic synchrony and the indirect effect through maternal responsiveness was fitted again with only the four significant covariates retained. The model displayed a good fit to the data, χ^2 (59) = 238.38, $p < .001$; CFI = .944; TLI = .932; RMSEA = .047, $p > .05$; SRMR = .052. Higher initial level of maternal depressive symptoms at 6 months significantly predicted lower maternal responsiveness at 36 months ($B = -.05$, $p < .001$), after controlling for partner status, social support, parenting stress, and child ethnicity as European American. Greater maternal responsiveness at 36 months then significantly predicted higher level of mother-child dyadic synchrony at 54 months ($B = 1.18$, $p < .001$), controlling for partner status, social support, parenting stress, and child ethnicity. As noticed before, with maternal responsiveness in the model, depressive symptoms intercept did not significantly predict dyadic synchrony and the nonsignificant path coefficient was close to zero ($B = .01$, $p > .05$). The results suggested that maternal responsiveness mediates the path from maternal depressive symptoms to dyadic synchrony.

To test whether the nonsignificant direct path found in Model 7 is really zero, in Model 8 (see Table 5), a constrained model was fitted in which the direct path from depressive symptoms intercept to dyadic synchrony was fixed to zero. A delta chi-square test was then conducted to compare the constrained model to the unconstrained model in Model 7. If the constrained model does not display significant improvement of model fit, it can be determined that mediation exists. The constrained model showed a good fit to the data, χ^2 (60) = 239.12, $p < .001$; CFI = .944; TLI = .933; RMSEA = .047, $p > .05$; SRMR = .052. The null hypothesis of the constrained model was that the direct path from

the intercept of depressive symptoms to dyadic synchrony is zero in the population. Compared to the unconstrained model, the constrained model did not show a significant improvement in model fit, $\Delta \chi^2$ (1) = 0.74, Critical $\Delta \chi^2$ (1) = 3.84. That is, the constrained model was not significantly different from the unconstrained model. Therefore, we fail to reject the null hypothesis that the direct path is zero in the population. The nonsignificant direct path found in Model 7 was really zero. Thus, mediation does exist.

In sum, Model 7 with the direct path (i.e., from intercept of depressive symptoms to dyadic synchrony) free to vary was tested to be the final fitted mediation model. Specifically, maternal responsiveness at 36 months was found to significantly mediate the link between the level of maternal depressive symptoms at 6 months and mother-child dyadic synchrony at 54 months. The initial level of depressive symptoms explained 26% of the variance in maternal responsiveness, while maternal responsiveness and depressive symptoms intercept explained 37.7% of the variance in dyadic synchrony. The results of the final fitted mediation model are presented in Figure 5. Summary results of the series of conditional latent growth curve models are presented in Table 5. This final mediation model was used as the basis of the subsequent moderation analyses.

The results of the latent growth curve modeling revealed that maternal responsiveness only mediated the link between depressive symptoms intercept and dyadic synchrony. To further verify the mediation finding, a structural equation modeling (SEM) with depressive symptoms measured at 6, 15, and 24 months as indicators of maternal depression was fitted as follow-up analysis (see Figure 6). The model showed good fit to the data, χ^2 (56) = 228.89, $p < .001$; CFI = .95; TLI = .93; RMSEA = .05, $p > .05$; SRMR = .05. Higher levels of maternal depressive symptoms in infancy and toddlerhood

significantly predicted lower maternal responsiveness at 36 months (B = -.04, p < .001), controlling for partner status, social support, parenting stress, and child ethnicity. Greater maternal responsiveness then significantly predicted higher levels of dyadic synchrony at 54 months (B = 1.17, p < .001). Maternal depressive symptoms did not significantly predict mother-child dyadic synchrony at 54 months (B = 0.01, p > .05), with maternal responsiveness in the model. To examine whether the effect of direct path from depressive symptoms to dyadic synchrony is truly zero, a constrained model was fitted in which the direct path was fixed to zero. The constrained model showed adequate fit to the data, χ^2 (57) = 229.56, p < .001; CFI = .95; TLI = .93; RMSEA = .05, p > .05; SRMR = .05. The null hypothesis of the constrained model was that the direct path from the depressive symptoms to dyadic synchrony is zero in the population. Comparing the constrained model to the unconstrained model, the chi-square difference of 0.67 with 1 degree of freedom was not significant, Critical $\Delta\chi^2$ (1) = 3.84, p = .05. Therefore, we fail to reject the null hypothesis that the direct path is zero in the population. That is, mediation does exist. The nonsignificant direct path (i.e., from depressive symptoms to synchrony) in the unconstrained SEM model was really zero. The mediation finding from the latent growth curve models was further confirmed. Compared to the final fitted LCGM mediation model (Figure 5), the results of the parameter estimates of the final fitted SEM model (Figure 6) are quite similar (e.g., path coefficients, % of variance).

Figure 5
Unstandardized Parameter Estimates (Standardized Estimates in Parentheses) of the Final Fitted Latent Growth Curve Model (Model 7) with Maternal Responsiveness Mediating the Link between the Intercept of Maternal Depressive Symptoms and Mother-Child Dyadic Synchrony, Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American, χ^2 (59) = 238.38, $p < .001$; CFI = .944; TLI = .932; RMSEA = .047, $p > .05$; SRMR = .052. Dashed lines indicate nonsignificant paths that are fixed to zero. *** $p < .001$

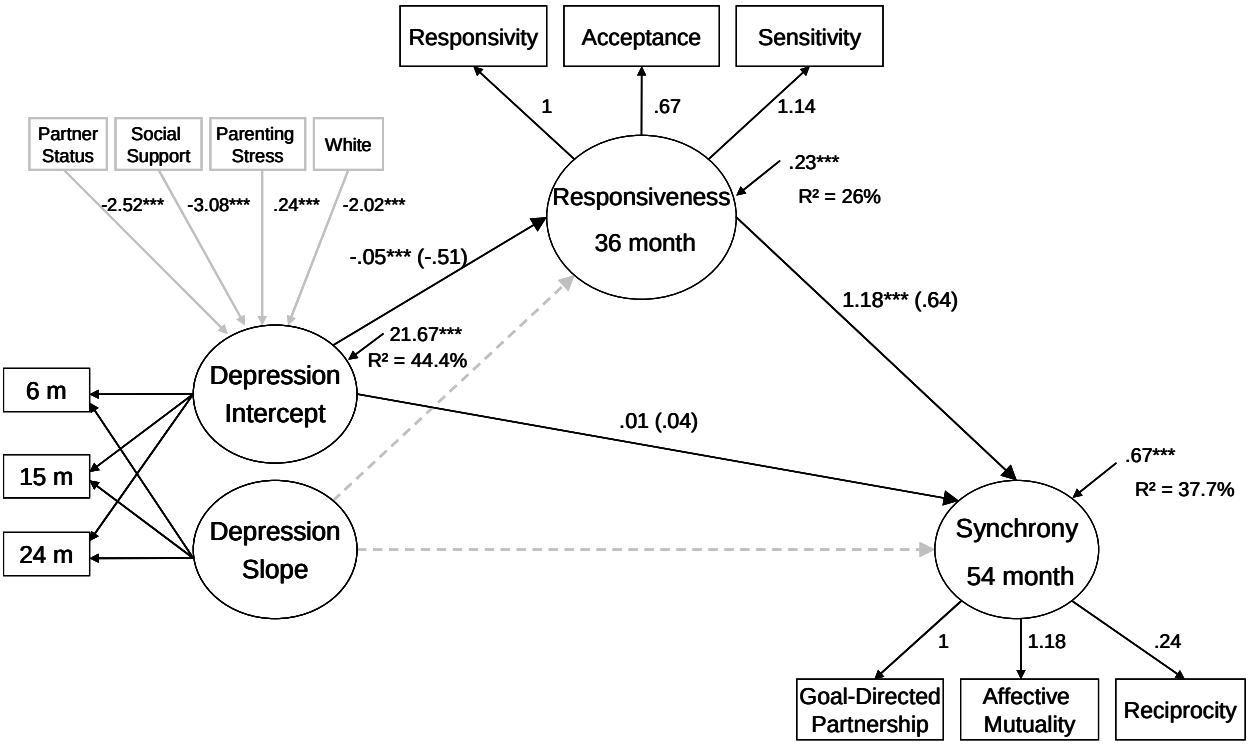


Figure 6
Unstandardized Parameter Estimates (Standardized Estimates in Parentheses) of the Structural Equation Modeling (SEM) with Maternal Responsiveness Mediating the Link between Maternal Depressive Symptoms and Mother-Child Dyadic Synchrony, Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American. *** $p < .001$

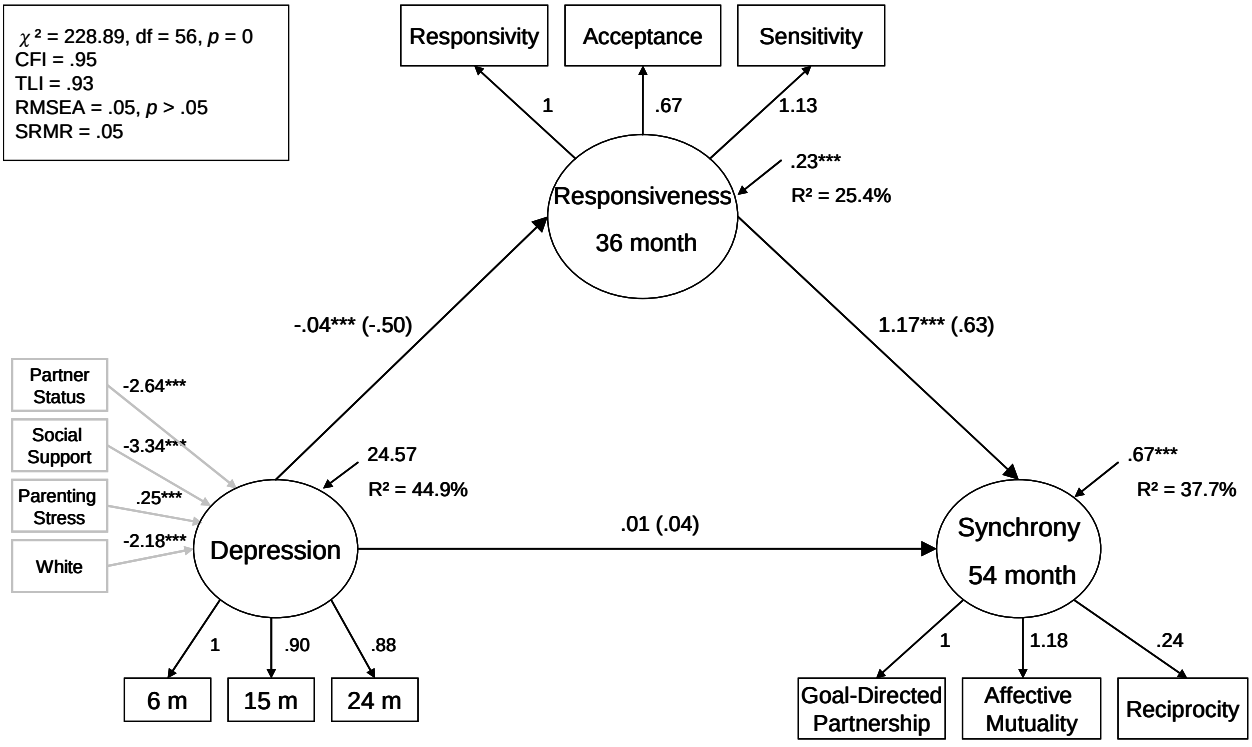


Table 5
Unstandardized (Standardized) Path Coefficients of Conditional Latent Growth Curve Models and Model Fit Statistics

	Models			
	1	2	3	4
Depression → Responsiveness				
Intercept		-.05*** (-.58)		-.05*** (-.55)
Slope		-1.50 (-.39)		-1.40 (-.40)
Responsiveness → Synchrony			1.17*** (.61)	1.29*** (.68)
Depression → Synchrony				
Intercept	-.04*** (-.28)			.02 (.10)
Slope	-1.15 (-.16)			.89 (.14)
Covariates → Depression				
Partner status				
Social support				
Parenting stress				
Adults living in home				
Gender				
White				
Black				
Goodness-of-fit Statistics				
χ^2	7.64	11.23	20.90**	36.90*
df	8	8	8	23
CFI	1	.997	.991	.994
TLI	1	.995	.983	.991
RMSEA	0	.018	.037	.022
SRMR	.015	.014	.022	.022
$\Delta\chi^2$ (Δ *df*)				

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 5 (continued)
Unstandardized (Standardized) Path Coefficients of Conditional Latent Growth Curve Models and Model Fit Statistics

	Models			
	5	6	7	8
Depression → Responsiveness				
Intercept	-.04*** (-.49)	-.05*** (-.51)	-.05*** (-.51)	-.04*** (-.49)
Slope				
Responsiveness → Synchrony	1.20*** (.64)	1.18*** (.64)	1.18*** (.64)	1.11*** (.60)
Depression → Synchrony				
Intercept	.01 (.06)	.01 (.05)	.01 (.04)	
Slope				
Covariates → Depression				
Partner status		-2.44*** (-.14)	-2.52*** (-.14)	-2.51*** (-.14)
Social support		-3.12*** (-.36)	-3.08*** (-.36)	-3.08*** (-.36)
Parenting stress		.24*** (.37)	.24*** (.38)	.24*** (.38)
Adults living in home		.37 (.04)		
Gender		.001 (0)		
White		-1.64* (-.10)	-2.02*** (-.13)	-2.02*** (-.13)
Black		.53 (.03)		
Goodness-of-fit Statistics				
χ^2	44.19*	288.35***	238.38***	239.12***
df	27	83	59	60
CFI	.993	.936	.944	.944
TLI	.991	.924	.932	.933
RMSEA	.022	.043	.047	.047
SRMR	.024	.055	.052	.052
$\Delta\chi^2$ (Δ *df*)				0.74 (1)

Testing of Hypothesis 2: SES as a Moderator

The second hypothesis posited that SES moderates the overall mediation model. To test whether the mediation model is equivalent across different SES groups, a series of multiple group analyses was conducted using Mplus. Multiple group analysis allows for the test of path invariance simultaneously across groups, which is also a test of interaction effect with the constructs in the model. A grouping variable that identifies SES group membership was created using mean and one standard deviation above and below the mean to divide the sample into low (n = 181), average (n = 981), and high (n = 201) SES groups. The analyses utilized constraints on paths to evaluate model invariance across groups and the constraints were added to the models in a nested manner. Delta chi-square tests were then conducted to compare model fit. A significant chi-square difference indicates that the model with fewer constraints fits the data better than the model with more constraints. In other words, significant delta chi-square implies that the path free to vary fits the data better than when the path is constrained to equal across groups.

In SES Moderation Model 1 (see Table 6), a baseline model was fitted simultaneously to three SES groups in which the measurement parameters were constrained to be equal across groups while the structural parameters were freely estimated. Paths from the covariates (i.e., partner status, social support, parenting stress, and child ethnicity) to the intercept of maternal depressive symptoms were also freely estimated across groups (and in the subsequent models) because it was thought that these factors affect mothers from various levels of SES differently. The factor loadings of the measurement model were constrained to be equal to ensure that the latent constructs were

measured the same way across groups. This model resulted in nonsignificant negative residual variance in one of the dyadic synchrony indicators for the high SES group, which was affective mutuality. Therefore, the residual variance of affective mutuality for the high SES group was fixed to zero and the model was fitted again. This unconstrained model fit the data well, χ^2 (194) = 343.69, $p < .001$; CFI = .947; TLI = .941; RMSEA = .041, 90% CI = .034, .048; SRMR = .06.

In Moderation Model 2 (see Table 6), to test whether the structural paths are equivalent across groups, a constrained model was fit in which both measurement parameters and structural parameters were constrained to be equal, controlling for partner status, social support, parenting stress, and child ethnicity, which were still allowed to vary across groups. The constrained model fit the data well, χ^2 (200) = 357.93, $p < .001$; CFI = .944; TLI = .940; RMSEA = .042, 90% CI = .035, .049; SRMR = .067. The null hypothesis of the constrained model was that the structural paths of the mediation model are equal across three SES groups. Comparing Model 2 to Model 1, the chi-square difference of 14.24 with 6 degrees of freedom was significant ($p < .05$), Critical $\Delta\chi^2$ (6) = 12.59. Therefore, we can reject the null hypothesis that the paths are invariant across SES groups. That is, there is indeed moderation effect in the overall mediation model.

To test where the moderation effects occur, constraints were added to the structural paths one at a time and the model fit was compared first to the unconstrained model and then to the model with tested improvement in model fit. The equivalence of the path from depressive symptoms to maternal responsiveness across groups was first evaluated since it is hypothesized that SES moderates this link. In Model 3 (see Table 6), the structural path from the intercept of maternal depressive symptoms to maternal

responsiveness was constrained to be equal across groups with the other two paths being freely estimated. The model displayed a good fit to the data, χ^2 (196) = 352.29, $p < .001$; CFI = .945; TLI = .939; RMSEA = .042, 90% CI = .035, .049; SRMR = .065. The null hypothesis of this model was that the path from the intercept of depressive symptoms to responsiveness was equal across three SES groups. Comparing Model 3 to Model 1, the chi-square difference of 8.60 with 2 degrees of freedom was significant ($p < .05$), Critical $\Delta \chi^2$ (2) = 5.99. Therefore, we can reject the null hypothesis. The path was not equivalent across low, average, and high SES groups.

In the next step, we tested whether the path is equivalent across every pair of SES groups. In Model 3a (see Table 6), the path from the intercept of maternal depressive symptoms to responsiveness was constrained to be equal for low and average SES groups. The model reflected a good fit to the data, χ^2 (195) = 348.97, $p < .001$; CFI = .946; TLI = .940; RMSEA = .042, 90% CI = .035, .049; SRMR = .063. Compared to the unconstrained model in Model 1, Model 3a resulted in significant chi-square difference, $\Delta \chi^2$ (1) = 5.28, Critical $\Delta \chi^2$ (1) = 3.84, $p = .05$. Therefore, we can reject the null hypothesis and that the path is different between low and average SES groups.

In Model 3b (see Table 6), the path from the intercept of maternal depressive symptoms to maternal responsiveness was constrained to be equal for average and high SES groups. This model exhibited a good fit to the data, χ^2 (195) = 348.15, $p < .001$; CFI = .946; TLI = .940; RMSEA = .042, 90% CI = .034, .049; SRMR = .063. Comparing Model 3b to Model 1, the chi-square difference of 4.46 with 1 degree of freedom was significant ($p < .05$), Critical $\Delta \chi^2$ (1) = 3.84. Again, we can reject the null hypothesis that the path is equal for average and high SES groups.

In Model 3c (see Table 6), the path from the intercept of maternal depressive symptoms to maternal responsiveness was constrained to be equal for low and high SES groups. The model displayed a good fit to the data, χ^2 (195) = 344.56, $p < .001$; CFI = .947; TLI = .941; RMSEA = .041, 90% CI = .034, .048; SRMR = .060. Compared to Model 1, Model 3c resulted in nonsignificant chi-square difference, $\Delta\chi^2$ (1) = 0.87, Critical $\Delta\chi^2$ (1) = 3.84. We fail to reject the null hypothesis. In other words, the strength of the path from depressive symptoms intercept to maternal responsiveness is truly equal for low and high SES groups.

In Model 4 (see Table 6), it was tested whether the path from maternal responsiveness to dyadic synchrony is equal across three SES groups, given that the path from depressive symptoms intercept to maternal responsiveness is equal for low and high SES groups. This model demonstrated adequate fit to the data, χ^2 (197) = 348.47, $p < .001$; CFI = .946; TLI = .941; RMSEA = .041, 90% CI = .034, .048; SRMR = .061. Comparing Model 4 to Model 3c, the chi-square difference of 3.7 with 2 degree of freedom was not significant, Critical $\Delta\chi^2$ (2) = 5.99. Therefore, we fail to reject the null hypothesis that the path from maternal responsiveness to dyadic synchrony is equal across groups, controlling for the path from depressive symptoms intercept to maternal responsiveness being equal for low and high SES groups.

In the final step, Model 5 (see Table 6) examined whether the direct path from the depressive symptoms intercept to dyadic synchrony is equal across three SES groups, given that the path from depressive symptoms intercept to maternal responsiveness is equal for low and high SES groups and the path from maternal responsiveness to dyadic synchrony is equal across groups. This model displayed a good fit to the data, χ^2 (199) =

351.56, $p < .001$; CFI = .946; TLI = .942; RMSEA = .041, 90% CI = .034, .048; SRMR = .062. Comparing Model 5 to Model 4, the chi-square difference of 3.09 with 2 degree of freedom was not significant, Critical $\Delta \chi^2$ (2) = 5.99. We fail to reject the null hypothesis that the path from depressive symptoms intercept to dyadic synchrony is equal across groups, controlling for the path from depressive symptoms intercept to maternal responsiveness being equal for low and high SES groups and the path from maternal responsiveness to dyadic synchrony being equal across groups.

In sum, Model 5 (see Table 6 and Figures 7 to 9) was tested as the final fitted model illustrating the moderating role of SES in the mediation pathways. The results of Model 5 indicated that SES moderated the strength of the effect of initial level of maternal depressive symptoms on maternal responsiveness in the mediation model, which was in line with the hypothesis. However, the results did not support the hypothesis with regard to the SES groups in the moderated path, which posited that maternal depressive symptoms would have stronger negative effect on maternal responsiveness for mothers with low SES than for mothers with high SES. Specifically, the results showed that the negative effect of maternal depressive symptoms at 6 month on maternal responsiveness at 36 months was slightly stronger for mothers from average SES families ($B = -0.04$, $p < .001$) than for mothers from low and high SES families, which had the same level of effects ($B = -0.02$, $p < .01$). The path from maternal responsiveness to synchrony was found to be equal across 3 groups ($B = 1.3$, $p < .001$). The nonsignificant direct path remained equal across 3 temperament groups ($B = 0.008$, $p > .05$). For average SES mothers, the indirect effect of the depressive symptoms intercept on dyadic synchrony through responsiveness was stronger ($B = -0.05$, $p < .001$) than low

and high SES mothers (B = -0.03, p < .01).

Initial level of depressive symptoms was found to account for 21.7% of the variance in maternal responsiveness for mothers from average SES background. Even though the strength of the effect of depressive symptoms intercept on maternal responsiveness was the same for low and high SES mothers, depressive symptoms intercept accounted for 17.1% of the variance in responsiveness for mothers from high SES and only 5.9% of the variance for mothers from low SES, after controlling for partner status, social support, parenting stress, and child ethnicity as European American. The dyadic synchrony variance that was accounted for by maternal responsiveness was the smallest among high SES mothers (8%). Unstandardized parameter estimates of the mediation model for low, average, and high SES groups are displayed in Figure 7 to Figure 9. Model fit indices and nested model comparisons are presented in Table 6.

Note: In Mplus, the standardized parameter estimates are computed using groups standard deviation rather than the overall standard deviation. Therefore, standardized parameter estimates are different for paths that are constrained equal across groups.

Table 6
Model Fit Statistics and Nested Model Comparisons for Multiple Group Analyses of the Mediation Model by SES

	χ^2	*df*	CFI	TLI	RMSEA	SRMR	Comparison	$\Delta\chi^2$	Δdf
M1: Paths free	343.69***	194	.947	.941	.041	.060			
M2: Paths constrained	357.93***	200	.944	.940	.042	.067	2 vs. 1	14.24*	6
M3: Dep → Res constrained	352.29***	196	.945	.939	.042	.065	3 vs. 1	8.60*	2
M3a: Dep → Res, Low = Avg SES	348.97***	195	.946	.940	.042	.063	3a vs. 1	5.28*	1
M3b: Dep → Res, Avg = High SES	348.15***	195	.946	.940	.042	.063	3b vs. 1	4.46*	1
M3c: Dep → Res, Low = High SES	344.56***	195	.947	.941	.041	.060	3c vs. 1	0.87	1
M4: Res → Syn constrained Dep → Res, Low = High SES	348.47***	197	.946	.941	.041	.061	4 vs. 3c	3.91	2
M5: Dep → Syn constrained Res → Syn constrained Dep → Res, Low = High SES	351.56***	199	.946	.942	.041	.062	5 vs. 4	3.09	2

Note. Measurement parameters (i.e., factor loadings) were constrained to be equal in all models tested. Paths from covariates (i.e., partner status, social support, parenting stress, and child ethnicity) to the intercept of maternal depressive symptoms were freely estimated in all models tested. Dep = maternal depressive symptoms intercept; Res = maternal responsiveness; Syn = dyadic synchrony. * $p < .05$ *** $p < .001$

Figure 7
Unstandardized Parameter Estimates of the Final Fitted Mediation Model (Model 5) for Low SES Mothers (Standardized Path Coefficients in Parentheses), Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (n = 181). Model fit indices: χ^2 (199) = 351.56, p < .001; CFI = .946; TLI = .942; RMSEA = .041, 90% CI = .034, .048; SRMR = .062. Dashed lines indicate nonsignificant paths that are fixed to zero.
~ p < .10 ** p < .01 *** p < .001

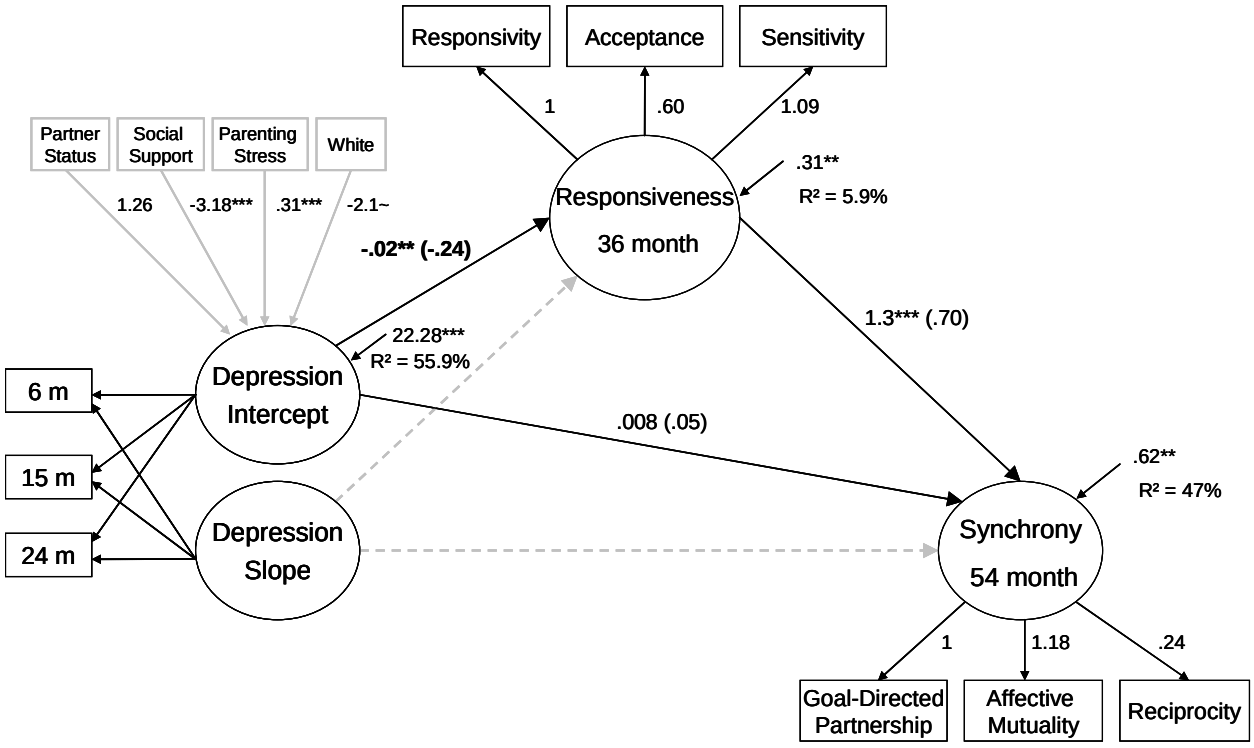


Figure 8
Unstandardized Parameter Estimates of the Final Fitted Mediation Model (Model 5) for Average SES Mothers (Standardized Path Coefficients in Parentheses), Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (n = 981). Model fit indices: χ^2 (199) = 351.56, p < .001; CFI = .946; TLI = .942; RMSEA = .041, 90% CI = .034, .048; SRMR = .062. Dashed lines indicate nonsignificant paths that are fixed to zero.
** p < .01 *** p < .001

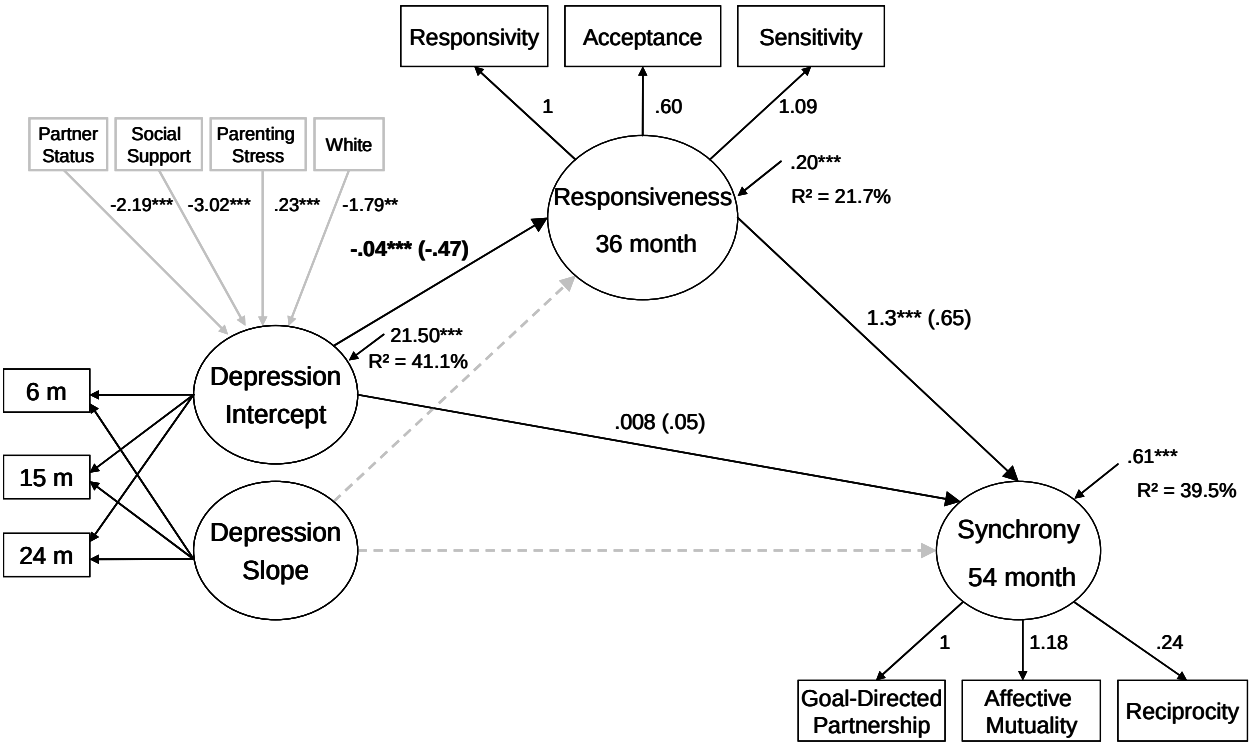
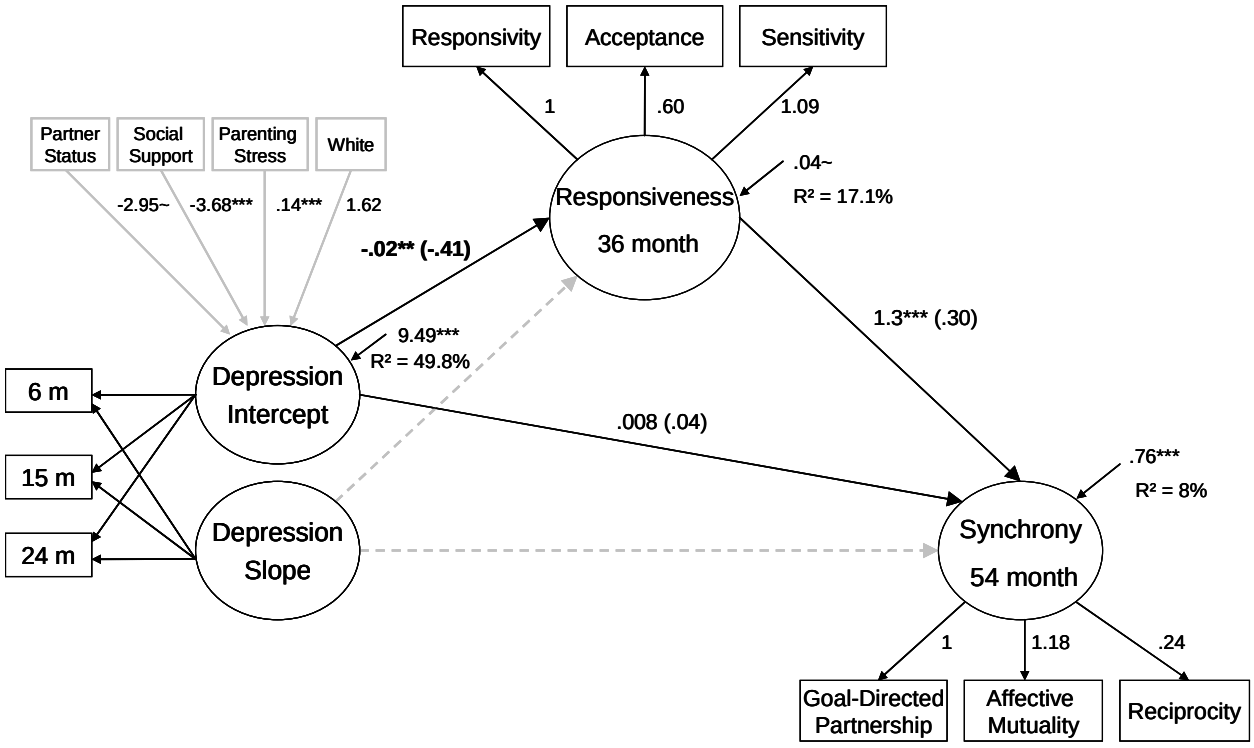


Figure 9
Unstandardized Parameter Estimates of the Final Fitted Mediation Model (Model 5) for High SES Mothers (Standardized Path Coefficients in Parentheses), Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (n = 201). Model fit indices: χ^2 (199) = 351.56, p < .001; CFI = .946; TLI = .942; RMSEA = .041, 90% CI = .034, .048; SRMR = .062. Dashed lines indicate nonsignificant paths that are fixed to zero.
~ p < .10 ** p < .01 *** p < .001



Testing of Hypothesis 3: Temperament as a Moderator

The third hypothesis postulated that child temperament will moderate the overall mediation model. To test whether the mediation model is invariant across temperament groups, similar procedures of multiple group analyses were conducted. A grouping variable that identifies temperament group membership was created using mean and one standard deviation above and below the mean to divide the sample into easy (n = 198), average (n = 901), and difficult (n = 180) temperament groups.

In Temperament Moderation Model 1 (see Table 7), a baseline model was fitted in which the measurement parameters were constrained to be equal to ensure similar measurement of latent constructs across groups while the structural paths were freely estimated across groups, controlling for partner status, social support, parenting stress, and child ethnicity, which were allowed to vary. The model exhibited good fit to the data, χ^2 (193) = 380.32, p < .001; CFI = .939; TLI = .931; RMSEA = .048, 90% CI = .041, .055; SRMR = .069.

In Moderation Model 2 (see Table 7), a constrained model was fitted in which the measurement parameters and structural parameters were constrained to be equal across three temperament groups while the path from covariates to maternal depressive symptoms intercept remained freely estimated across groups. The results of the model indicated a good fit to the data, χ^2 (199) = 394.29, p < .001; CFI = .936; TLI = .930; RMSEA = .048, 90% CI = .041, .055; SRMR = .073. The null hypothesis of this model was that the structural paths were equivalent across easy, average, and difficult temperament groups. A comparison of the model fit of baseline model and the constrained model indicated that chi-square difference of 13.97 with 6 degrees of

freedom was significant, Critical $\Delta \chi^2$ (6) = 12.59. Therefore, we can reject the null hypothesis that the structural paths are equal across groups. In other words, the mediation model is not invariant across easy, average, and difficult temperament groups.

To examine where the moderation effect occurs, constraints were added to each structural path one at a time in the subsequent analyses. Paths from covariates remained freely estimated across groups in all the models tested. It was hypothesized that temperament would moderate the link between maternal responsiveness and dyadic synchrony in the mediated pathway. In Model 3 (see Table 7), it was tested first whether the path from maternal responsiveness to dyadic synchrony is equivalent across groups while the other two paths being freely estimated. The results indicated that this model fit the data well, χ^2 (195) = 383.42, $p < .001$; CFI = .938; TLI = .932; RMSEA = .048, 90% CI = .041, .055; SRMR = .071. Comparing Model 3 to Model 1, the chi-square difference of 3.11 with 1 degree of freedom was not significant, Critical $\Delta \chi^2$ (1) = 3.84, $p = .05$. Therefore, we fail to reject the null hypothesis and that the path from maternal responsiveness to synchrony is equivalent across easy, average, and difficult temperament groups.

In Model 4 (see Table 7), it was tested whether the path from depressive symptoms intercept to maternal responsiveness is equivalent across groups, given that the path from responsiveness to synchrony is equal across groups. This model presented a good fit to the data, χ^2 (197) = 393.29, $p < .001$; CFI = .936; TLI = .929; RMSEA = .048, 90% CI = .041, .055; SRMR = .073. A comparison of the model fit of Model 4 and Model 3 indicated that the chi-square difference was significant, $\Delta \chi^2$ (2) = 9.87, Critical $\Delta \chi^2$ (2) = 5.99. Therefore, we can reject the null hypothesis that the path from initial level of

depressive symptoms to maternal responsiveness is equal across groups, controlling for the path from maternal responsiveness to synchrony being equal.

In the next step, the path from depressive symptoms intercept to maternal responsiveness was constrained to be equal between every pair of temperament groups. In Model 4a (see Table 7), it was tested whether the path from depressive symptoms intercept to maternal responsiveness is equivalent between easy and average temperament groups, given that the path from responsiveness to synchrony is equal across 3 groups. This model displayed adequate fit to the data, χ^2 (196) = 393.13, $p < .001$; CFI = .935; TLI = .929; RMSEA = .049, 90% CI = .042, .056; SRMR = .073. Comparing Model 4a to Model 3 in which only the path from responsiveness to synchrony was constrained to be equal across groups, the chi-square difference of 9.71 with 1 degree of freedom was significant, Critical $\Delta\chi^2$ (1) = 3.84, $p = .05$. Hence, we can reject the null hypothesis that the path from depressive symptoms intercept to maternal responsiveness is equal across easy and average temperament groups, controlling for the path from responsiveness to synchrony being equal across 3 temperament groups.

In Model 4b (see Table 7), it was tested whether the path from depressive symptoms intercept to maternal responsiveness is invariant between average and difficult temperament groups, given that the path from responsiveness to synchrony is equal across 3 groups. The results of this model exhibited a good fit to the data, χ^2 (196) = 383.44, $p < .001$; CFI = .939; TLI = .932; RMSEA = .047, 90% CI = .040, .054; SRMR = .071. Compared to Model 3, Model 4b resulted in nonsignificant chi-square difference, $\Delta\chi^2$ (1) = 0.02, Critical $\Delta\chi^2$ (1) = 3.84. As a result, we fail to reject the null hypothesis and that the strength of the path from depressive symptoms intercept to maternal

responsiveness is indeed equivalent across average and difficult temperament groups, controlling for the path from responsiveness to synchrony being equal across 3 groups.

In Model 4c (see table 7), it was tested whether the path from depressive symptoms intercept to maternal responsiveness is equal for easy and difficult temperament groups, given that the path from responsiveness to synchrony is equal across 3 groups. This model displayed a good fit to the data, χ^2 (196) = 387.55, $p < .001$; CFI = .937; TLI = .931; RMSEA = .048, 90% CI = .041, .055; SRMR = .071. Comparing Model 4c to Model 3, the chi-square difference of 4.13 with 1 degree of freedom was significant, Critical $\Delta\chi^2$ (1) = 3.84, $p = .05$. Therefore, we can reject the null hypothesis. That is, the path from depressive symptoms intercept to maternal responsiveness varied between easy and difficult temperament groups, controlling for the path from responsiveness to synchrony being equal across 3 groups.

Up to this point, only the path from depressive symptoms intercept to maternal responsiveness was found to vary between easy and average and between easy and difficult temperament groups. Last, in Model 5 (see Table 7), it was tested whether the direct path from maternal depressive symptoms intercept to dyadic synchrony is equivalent across 3 groups, given that the path from depressive symptoms intercept to maternal responsiveness is equal between average and difficult groups and that the path from maternal responsiveness to dyadic synchrony is equal across 3 groups. This model presented a good fit to the data, χ^2 (198) = 384.73, $p < .001$; CFI = .939; TLI = .933; RMSEA = .047, 90% CI = .040, .054; SRMR = .072. Comparing Model 5 to Model 4b, the chi-square difference of 1.29 with 1 degree of freedom was not significant, Critical $\Delta\chi^2$ (1) = 3.84, $p = .05$. As a result, we fail to reject the null hypothesis. That is, the direct

path from maternal depressive symptoms intercept to dyadic synchrony is equal across 3 groups, controlling for the path from depressive symptoms intercept to maternal responsiveness being equal between average and difficult groups and the path from maternal responsiveness to dyadic synchrony being equal across 3 groups.

In summary, Model 5 (see Table 7 and Figures 10 to 12) was tested to be the final fitted model describing the overall mediation model by child temperament. Child temperament was found to moderate the mediation model. However, the results were inconsistent with the hypothesis with regard to the specific structural path, which postulated that child temperament would moderate the link from maternal responsiveness to dyadic synchrony. Instead, the results indicated that child temperament moderated the link from maternal depressive symptoms intercept to maternal responsiveness. Specifically, the strength of the negative effect of maternal depressive symptoms at 6 months on maternal responsiveness at 36 months was slightly stronger for both mothers of children with average and difficult temperament (B = -0.05, p < .001). The negative effect of depressive symptoms on responsiveness was weaker for mothers of children with easy temperament (B = -0.02, p < .05). Contrary to the hypothesis, the strength of the path from maternal responsiveness to dyadic synchrony was equal across groups (B = 1.18, p < .001). The nonsignificant direct path from maternal depressive symptoms intercept to dyadic synchrony remained equal across groups (B = 0.009, p > .05). The indirect effect of depressive symptoms intercept on dyadic synchrony through maternal responsiveness was stronger for both average and difficult temperament groups (B = -0.05, p < .001) while the indirect effect was weaker for the easy temperament group (B = -0.02, p < .05).

Depressive symptom at 6 months was found to account for about a quarter of the variance in maternal responsiveness for mothers with average (26.8%) and difficult (24.4%) children. However, for temperamentally easy group, depressive symptoms intercept only explained 6.5% of the variance in maternal responsiveness. Among the difficult temperament group, maternal responsiveness accounted for almost half of the variance in dyadic synchrony, followed by average and easy temperament groups. Model fit statistics and nested model comparisons are presented in Table 7. Unstandardized parameter estimates of the final fitted mediation model for easy, average, and difficult temperament groups are displayed in Figure 10 to Figure 12.

Table 7
Model Fit Statistics and Nested Model Comparisons for Multiple Group Analyses of the Mediation Model by Child Temperament

	χ^2	*df*	CFI	TLI	RMSEA	SRMR	Comparison	$\Delta\chi^2$	Δdf
M1: Paths free	380.32***	193	.939	.931	.048	.069			
M2: Paths constrained	394.29***	199	.936	.930	.048	.073	2 vs. 1	13.97*	6
M3: Res → Syn constrained	383.42***	195	.938	.932	.048	.071	3 vs. 1	3.11	1
M4: Dep → Res constrained Res → Syn constrained	393.29***	197	.936	.929	.048	.073	4 vs. 3	9.87**	2
M4a: Dep → Res, Easy = Avg Temp Res → Syn constrained	393.13***	196	.935	.929	.049	.073	4a vs. 3	9.71**	1
M4b: Dep → Res, Avg = Diff Temp Res → Syn constrained	383.44***	196	.939	.932	.047	.071	4b vs. 3	0.02	1
M4c: Dep → Res, Easy = Diff Temp Res → Syn constrained	387.55***	196	.937	.931	.048	.071	4c vs. 3	4.13*	1
M5: Dep → Syn constrained Dep →Res, Avg = Diff Temp Res → Syn constrained	384.73***	198	.939	.933	.047	.072	5 vs. 4b	1.29	1

Note. Measurement parameters (i.e., factor loadings) were constrained to be equal in all models tested. Paths from covariates (i.e., partner status, social support, parenting stress, and child ethnicity) to the intercept of maternal depressive symptoms were freely estimated in all models tested. Dep = maternal depressive symptoms intercept; Res = maternal responsiveness; Syn = dyadic synchrony; Temp = temperament; Avg = average; Diff = difficult. * $p < .05$ ** $p < .01$ *** $p < .001$

Figure 10
Unstandardized Parameter Estimates of the Final Fitted Mediation Model (Model 5) for Mothers of Children with Easy Temperament (Standardized Path Coefficients in Parentheses), Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (*n* = 198). Model fit indices: χ^2 (198) = 384.73, $p < .001$; CFI = .939; TLI = .933; RMSEA = .047, 90% CI = .040, .054; SRMR = .072. Dashed lines indicate nonsignificant paths that are fixed to zero. * $p < .05$ ** $p < .01$ *** $p < .001$

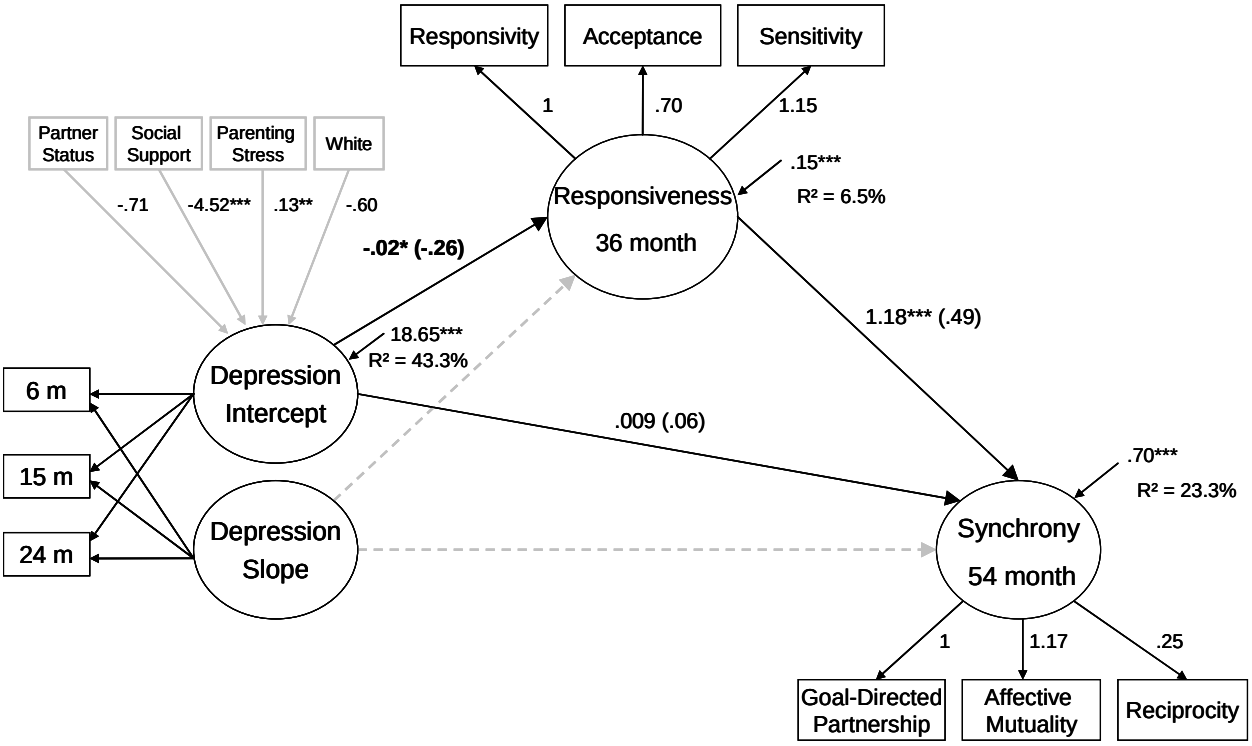


Figure 11
Unstandardized Parameter Estimates of the Final Fitted Mediation Model (Model 5) for Mothers of Children with Average Temperament (Standardized Path Coefficients in Parentheses), Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (n = 901). Model fit indices: χ^2 (198) = 384.73, p < .001; CFI = .939; TLI = .933; RMSEA = .047, 90% CI = .040, .054; SRMR = .072. Dashed lines indicate nonsignificant paths that are fixed to zero. ** p < .01 *** p < .001

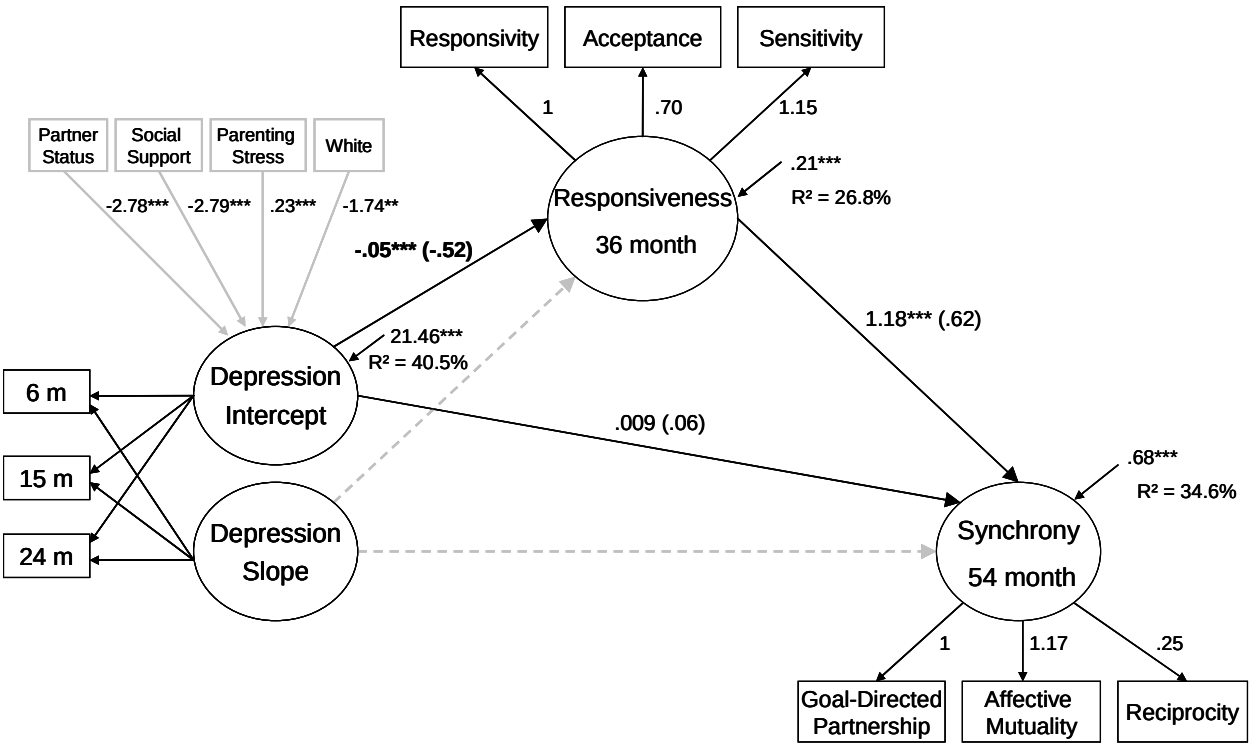
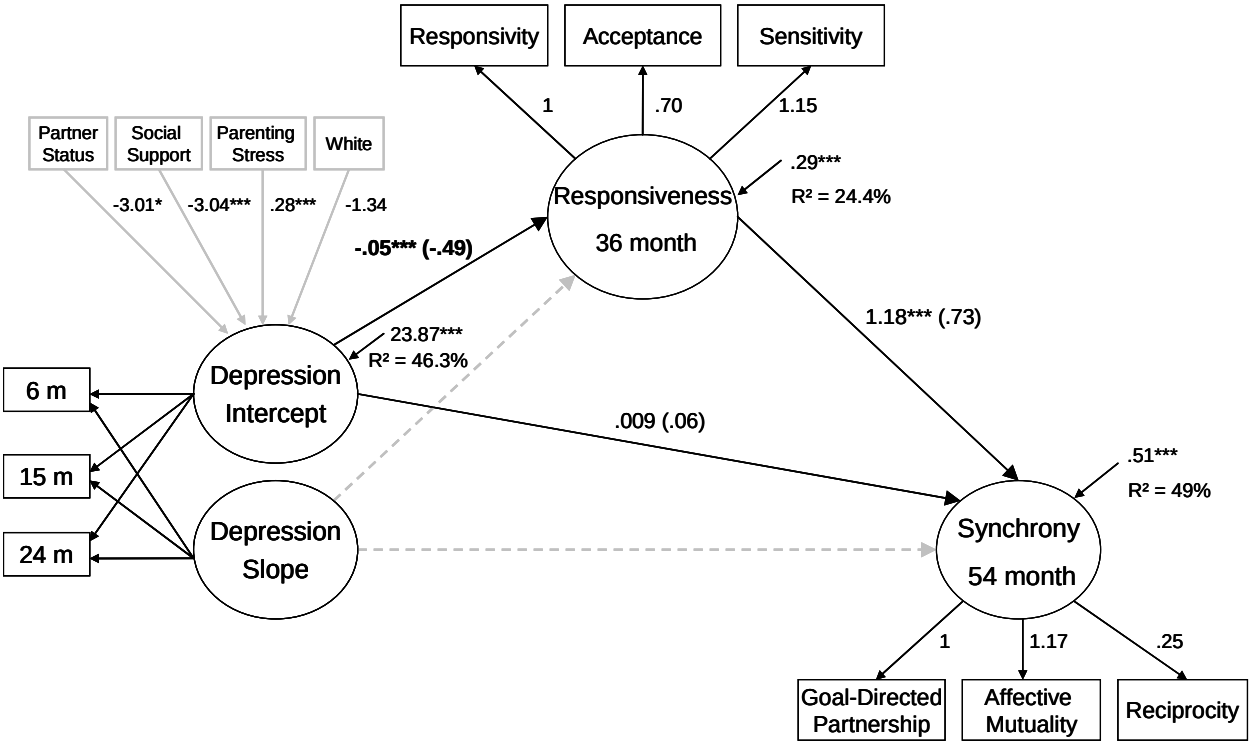


Figure 12
Unstandardized Parameter Estimates of the Final Fitted Mediation Model (Model 5) for Mothers of Children with Difficult Temperament (Standardized Path Coefficients in Parentheses), Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (n = 180). Model fit indices: χ^2 (198) = 384.73, p < .001; CFI = .939; TLI = .933; RMSEA = .047, 90% CI = .040, .054; SRMR = .072. Dashed lines indicate nonsignificant paths that are fixed to zero. * p < .05 *** p < .001



5. DISCUSSION

The purpose of this study was to investigate the antecedents of mother-child dyadic synchrony in early childhood in terms of maternal, child, and contextual factors. Previous research has mainly focused on the effects of dyadic synchrony on children's adjustment. However, we know little regarding the factors that contribute to the development of parent-child dyadic synchrony. Literature has suggested that maternal characteristics, such as maternal depressive symptoms, are linked to parent-child dyadic interaction. Studies also have indicated that maternal responsive to the child is a critical influence on synchronous parent-child interaction. There are well replicated findings of associations between maternal depressive symptoms and maternal responsiveness and between maternal responsiveness and dyadic synchrony. However, few studies have attempted to examine whether maternal responsiveness actually mediates the link between maternal depressive symptoms and dyadic synchrony. Moreover, few studies have examined the longitudinal effects of maternal depressive symptoms on parent-child dyadic interaction. Utilizing a longitudinal design and incorporating temporal order of influences into the design, this study aimed to examine whether the trajectory of maternal depressive symptoms in infancy and toddlerhood predicts later maternal responsiveness, which in turn predicts mother-child dyadic synchrony in early childhood. The present study also proposed to investigate whether SES and child temperament individually moderate the pathways in the prediction of mother-child dyadic synchrony.

Trajectory of Maternal Depressive Symptoms in Infancy and Toddlerhood

Examination of the growth trajectory revealed that, on average, mothers reported depressive symptoms that were well below the clinical level at 6 months and there was marginally significant slower rate of growth across the 3 time points. Mothers varied in their initial level of depressive symptoms, and maternal depressive symptoms seemed to be stable over time in that there was significant between individual variation in initial level of depressive symptoms but not in rate of change. As a result, initial level of depressive symptoms predicted maternal responsiveness and dyadic synchrony, but, contrary to the hypotheses, the paths from the depressive symptoms slope to maternal responsiveness and dyadic synchrony were not significant in the models tested.

The Mediating Role of Maternal Responsiveness in the Link between Maternal Depressive Symptoms and Dyadic Synchrony

Although researchers have examined the associations among depressive symptoms, responsiveness, and dyadic synchrony in separate studies, few have investigated the relationships simultaneously beyond infancy and toddlerhood. Consistent with previous studies (e.g., Cohn & Tronick, 1987; Lunday, 2002; Skuban et al., 2006), the correlation analyses revealed that maternal depressive symptoms were associated with lower maternal responsiveness and lower dyadic synchrony. Higher maternal responsiveness was found to be associated with higher dyadic synchrony. Similar patterns of the predictive relationships were also found. It is not surprising that being depressed not only affects mothers' ability to respond sensitively and contingently, but it also affects the quality of mother-child interaction.

Findings in the present study partially supported our hypotheses of the mediation

model with regard to the growth parameters. One of the main findings was that maternal responsiveness at 36 months mediates the link between the initial level of depressive symptoms at 6 months and dyadic synchrony at 54 months, even after controlling for partner status, social support, parenting stress, and child ethnicity as European American. Although initial level of depressive symptoms was also found to be predictive of dyadic synchrony, the relationship no longer existed once maternal responsiveness was taken into account. In other words, maternal depressive symptoms affect the pattern of mother-child interaction through its effect on impairing mother's ability to be sensitive and responsive to the child's cues. This finding also confirmed the importance of the role of maternal responsiveness in facilitating synchronous mother-child interaction. Although the magnitude of the path from depressive symptoms intercept to maternal responsiveness was relatively small, depressive symptoms at 6 months explained 26% of the variance in maternal responsiveness. Maternal responsiveness and depressive symptoms intercept explained 37.7% of the variance in dyadic synchrony.

Of interest is that, due to the stability of maternal depressive symptoms from child age 6 to 24 months in this sample, the linear growth was not a significant predictor of maternal responsiveness and dyadic synchrony as had been hypothesized. This may due to the fact that this sample is a community sample rather than a clinical sample. Therefore, there was little between-individual variability in growth of depressive symptoms in the first two years of child's life, especially when the 1-month depressive symptoms ratings were excluded in the analyses. Although the NICHD SECCYD dataset does contain mothers' self-report of depressive symptoms one month after childbirth, its average rating appeared to be much higher than at the other 3 time points. To ensure that the change

trajectory reflects growth of chronic depressive symptoms over time, rather than having the trajectory driven by the possible 1-month postpartum depression, it was decided to only examine the depressive symptoms trajectory from 6 to 24 months in this study.

The present study also revealed several significant effects of covariates on initial level of maternal depressive symptoms in the mediation model. Consistent with previous literature (e.g., Beck, 2001; O'Hara & Swain, 1996; Segre et al., 2007), having a partner who can share child care responsibility and having greater perceived social support were predictive of lower self-report maternal depressive symptoms at 6 months. In addition, being European American was also predictive of exhibiting lower initial level of depressive symptoms. Non-European minority mothers may experience higher life stress and have fewer resources and, as a result, tend to display higher depressive symptoms. This is in line with previous studies, which have suggested that minority mothers are at higher risk of having elevated depressive symptoms (e.g., Campbell et al., 2007; Horwitz et al., 2007; Poehlmann et al., 2009). In fact, it has been found that postpartum depressive symptoms are more prevalent in African American and Hispanic mothers than in European American mothers (e.g., Howell, Mora, Horowitz, & Leventhal, 2005).

On the other hand, parenting stress is normally regarded as a risk factor. Consistent with previous research (e.g., Beck, 2001; Horwitz et al., 2007), findings in the present study revealed that higher parenting stress was predictive of higher maternal depressive symptoms at child age of 6 months. The four significant covariates (i.e., partner status, social support, ethnicity as European American, and parenting stress) illustrate both risk and protective factors and they collectively explained 44.4% of the variance in maternal depressive symptoms intercept.

In sum, only the intercept of maternal depressive symptoms was predictive of maternal responsiveness and dyadic synchrony. Maternal responsiveness only mediated the link between depressive symptoms intercept and dyadic synchrony. It is noteworthy that the mediating role of maternal responsiveness was also found when using structural equation modeling and treating 6, 15, and 24 months measures as indicators of maternal depressive.

The Moderating Role of SES

Previous research has indicated the association between demographic characteristics and maternal depressive symptoms. It has been found that mothers with lower socioeconomic status such as lower education level, lower income, single marital status, and unemployment tend to report higher depressive symptoms than mothers with higher socioeconomic status (Beeghly et al., 2003; Goyal, Gay, & Lee, 2010; Horwitz et al., 2007). In studies examining postpartum depression, factor such as family income, occupational prestige, marital status, and socioeconomic status were also found to be significant predictors of postpartum depression (e.g., Beck, 2001; Segre, O'Hara, Arndt, & Stuart, 2007). Campbell et al. (2007) previously examined the trajectory of maternal depressive symptoms over the first seven years postpartum using NICHD dataset, and their study also revealed that mothers in different trajectory groups varied in demographic risk. Similarly, Seto et al. (2005) found that mothers who were chronically depressed across 10 years tend to have less education, lower family income, and are less likely to be married, compared to mothers who were never depressed. It has been suggested that the positive association between demographic risk factors and maternal depressive symptoms may be due in part to the lack of social resources that are available to lower SES mothers

and the higher life stress they encounter, compared to their higher SES counterparts (Evans, Boxhill, & Pinkava, 2008; Goyal, Gay, & Lee, 2010).

Mothers with higher demographic risk factors not only are at higher risk of developing depressive symptoms, these risk factors also can exacerbate the effects of maternal depressive symptoms on parenting behaviors and mother-child interaction. In one meta-analysis, Lovejoy et al. (2000) found that maternal depression had a moderate effect on positive parenting behaviors for mothers from economically disadvantaged background, whereas the effect was zero for nondisadvantaged mothers. Moreover, NICHD ECCRN (1999) revealed that income-to-needs ratio interacted with maternal depression groups in that maternal sensitivity over time was more strongly related to income-to-needs ratio among chronically depressed mothers than never depressed mothers in the first 3 years postpartum.

In the present study, it was examined whether the contextual factor, SES, moderates the prediction of dyadic synchrony from maternal depressive symptoms through responsiveness. The results of multiple group analyses revealed that the mediation pathway varied by SES, controlling for partner status, social support, parenting stress, and ethnicity. Specifically, SES moderated the path from depressive symptoms intercept to maternal responsiveness. The paths from maternal responsiveness and depressive symptoms intercept to dyadic synchrony were equivalent across low, average, and high SES groups. Although the results indicated moderation effect of SES, the findings are inconsistent with previous studies with regard to the strength of the effect for different SES groups. The results suggested that depressive symptom at 6 months has a slightly stronger negative effect on maternal responsiveness at 36 months for mothers

with average SES background, which was quite unexpected. Consistent with our hypotheses, for high SES mothers, the negative effect of depressive symptoms on responsiveness was weaker (than for average SES mothers). One unexpected finding was that the strength of the effect from depressive symptoms intercept to maternal responsiveness was the same for both low and high SES mothers. This finding was contrary to our hypotheses in that we had postulated that the growth parameters of depressive symptoms would have a stronger association with responsiveness for low SES mothers than for average or high SES mothers.

Although the strength of the effect was the same for both low and high SES mothers, the variance of responsiveness that was predicted by depressive symptoms intercept was quite different. Depressive symptoms at 6 months explained only 5.9% of the variance in maternal responsiveness at 36 months for low SES mothers, whereas it accounted for 17.1% of the variance for high SES mothers and 21.7% of the variance for average SES mothers. Both significant and nonsignificant effects of the covariates on depressive symptoms intercept for different SES groups were also found. The 4 covariates (i.e., partner status, social support, European American, and parenting stress) all significantly predicted 6-month depressive symptoms in average SES mothers. However, having a partner or not did not significantly account for initial level of depressive symptom in low SES mothers. For high SES mothers, being European American did not significantly predict maternal depressive symptoms at 6 months. On the other hand, maternal responsiveness explained the most variance in dyadic synchrony among low (47%) and average SES mothers (39.5%) than in high SES mothers (8%). The results may suggest that mothers' responsiveness toward the children play a greater role

in facilitating the development of synchronous interaction in mother-child dyads from low and average SES families.

The moderation findings in the present study were inconsistent with previous research by Lovejoy et al. (2000) and NICHD ECCRN (1999) with regard to the strength of the effect of depressive symptoms for the low SES group. However, the present study is different from the above two studies in several ways. First, the composite score of income-to-needs ratio and maternal education was used as an indicator of SES in the present study, whereas the above two studies used solely income and/or Hollingshead score. Second, NICHD ECCRN (1999) examined the trajectory of maternal sensitivity from 6 to 36 months and whether it varied as a function of depression group and income. They categorized mothers into chronically, sometimes, and never depressed groups by using the clinical cutoff score of CES-D, whereas the raw scores of CES-D from 6 to 24 months were used to investigate the trajectory of depressive symptoms in this study.

It is plausible that, for low SES mothers, SES also has unique effect on responsiveness, given that SES also has been related to maternal parenting behaviors in previous research (e.g., Bradley & Corwyn, 2003; Hoff, Laursen, & Tardif, 2002; McLoyd, 1998). In addition, in testing the mediation hypothesis, the effect of SES on depressive symptoms was not considered either, given the association of lower SES and greater occurrence of depressive symptoms that was previously found in the literature. Moreover, previous studies also have documented factors such as social support and maternal life stress as affecting maternal responsiveness (e.g., Bradley et al., 2001; Evans, Boxhill, & Pinkava, 2008; Hashima & Amato, 1994). Therefore, whether the weaker association between depressive symptoms and maternal responsiveness among low SES

moms was due to the unexamined possible unique effects of partner status, social support, ethnicity, and parenting stress on maternal responsiveness is unclear in this study.

In the literature, researchers have also suggested cumulative risk factors and the associations with child outcomes and parenting behaviors (Popp, Spinrad, & Smith, 2008; Rutter, 1979). The accumulation of risks such as low social status, marital discord, maternal mental disorder, large family size, disadvantaged minority status, single parenthood, and stressful life events increases the likelihood of experiencing negative outcomes (Rutter, 1979; Sameroff, 2000). For instance, cumulative demographic risk has been found to be related to lower maternal responsivity concurrently and longitudinally (Popp, Spinrad, & Smith, 2008). Therefore, it might also be the cumulative risk associated with being in lower SES families that influences lower SES mothers' responsiveness toward the children, rather than the sole negative impact of maternal depressive symptoms.

On the other hand, it also is possible that the association between depressive symptoms intercept and responsiveness was stronger for average SES mothers because the sample was less diverse with the majority of the mothers in the average SES group. In our analyses, 72% of the mothers were categorized in average SES group, whereas only 13% and 15% of the mothers were in low and high SES groups, respectively.

Moderating Role of Child Temperament

Previous studies have indicated that children's temperament may interact with parenting behaviors in predicting parent-child interaction and child outcomes (Crockenberg & Smith, 1982; Thomas, Chess, & Birch, 1968; Ziv & Cassidy, 2002). In addition, it has also been suggested that the impact of parental responsiveness may vary

as a function of child characteristics (Ziv & Cassidy, 2002). Similarly, Belsky (1997) in his differential susceptibility hypothesis also posited that children with difficult temperament are most affected by rearing influences. For example, it has been found in previous study that, for difficult children, maternal responsiveness predicted greater child cooperation with the mother (Kochanska, Aksan, & Carlson, 2005). With more responsive mothers, difficult children were more cooperative months later, whereas difficult children with unresponsive mothers were found to be uncooperative (Kochanska, Aksan, & Carlson, 2005). These evidences are consistent with a model in which child characteristics moderates the effects of maternal behaviors on mother-child interaction.

The final goal of this study was to examine explicitly whether the child factor, temperament, moderates the mediation pathway in predicting dyadic synchrony. The results of multiple group analysis indicated that the link from depressive symptoms intercept to dyadic synchrony through maternal responsiveness varied by child temperament. However, contrary to our hypothesis, child temperament did not moderate the path from maternal responsiveness to dyadic synchrony. Rather, child temperament moderated the impact of depressive symptoms on maternal responsiveness. As could be expected, for mothers with temperamentally easy children, the negative effect of earlier depressive symptoms on later maternal responsiveness was weaker. In contrast, for mothers with temperamentally average and difficult children, the impact of depressive symptoms on maternal responsiveness was stronger. In addition to struggling with symptoms such as negative affect, sadness, and lack of energy due to depression, infants who are fussy and demanding seem to exacerbate depressed mothers' already impaired ability to be sensitive and responsive to the child's needs. As a result, depressed mothers

tend to be more disengaged or intrusive toward the difficult child, which considerable research shows to affect children's developmental outcomes (e.g., Cummings & Davies, 1994; Downey & Coyne, 1990). It appears that only when the children are perceived as easygoing can the negative effect of depressive symptoms on responsiveness be lessened. Even with a temperamentally average child, the negative impact of depressive symptoms on mother's caregiving behavior is still inevitable in this research.

Although the path from maternal responsiveness to dyadic synchrony was equivalent across easy, average, and difficult temperament groups, the percentage of explained variance in dyadic synchrony was different across groups. For mothers of difficult children, responsiveness accounted for almost half of the variance in dyadic synchrony, indicating the important maternal behavior in facilitating synchronous interaction with a difficult or irritable child. For temperamentally easy children, maternal responsiveness only explained approximately one-fourth of the variance in synchrony, suggesting that easygoing children may play a greater role in maintaining the synchronous interaction. With respect to maternal responsiveness, depressive symptoms accounted for about one-fourth of the variance in responsiveness among mothers of average and difficult children, whereas only 6.5% of the variance was explained by depressive symptoms among mothers of temperamentally easy children. The results once again suggest that psychological functioning contributes to the quality of parenting behaviors, which is especially the case for mothers with children of average and difficult temperament.

Taken together, the results indicated that it was the effect of depressive symptoms on responsiveness, rather than the effect of maternal responsiveness on synchrony, that

varied as a function of child temperament. It is unclear why our findings differed from our hypothesis of the specific link. One possibility is that child temperament may still interact with maternal responsiveness in predicting child outcomes, such as externalizing behavior problems (Belsky, Hsieh, & Crinc, 1998), but not in predicting mother-child synchronous interaction. Nevertheless, the findings are consistent with previous studies that report an interaction between maternal depressive symptoms and child temperament in the association with parenting behavior. For example, Black et al. (2007) found that maternal depressive symptoms were negatively related to maternal stimulation measured by HOME for mothers who perceived their children as irritable, whereas it was not significantly related for mothers with easy temperament children.

Given the finding of the interaction effect between maternal depressive symptoms and child temperament, it is noteworthy that previous research reports that difficulty child temperament is a significant predictor of postpartum depression, in addition to its association with maternal interaction style (e.g., Beck, 2001; Milgrom, Westley, & Gemmill, 2004; Murray et al, 1996). Due to the use of multiple group analyses for testing moderation effect in the overall mediation model, it is important to acknowledge that the main effects of child temperament on depressive symptoms and responsiveness were not tested in the present study. On the other hand, it has also been argued that maternal report of child temperament actually reflects parent characteristics in that maternal psychological functioning affects mothers' perception of child temperament (Wachs, 2006). For instance, depressed mothers tend to rate their children as more difficult/irritable than do nondepressed mothers (e.g., McGrath, Records, & Rice, 2008; Wachs, 2006). However, the present study revealed that the correlations between child

temperament and depressive symptoms over time were small in magnitude.

Implications

The results also have important implications for clinical practice and preventive interventions, particularly with mothers at risk for depression. Because maternal depression affected interactional synchrony only by impairing mothers' responsiveness to their children, it is possible that teaching mothers to be more responsive, even when faced with depression, could prevent many of the negative consequences children tend to experience when mothers are depressed. This could be especially true for mothers whose infants have difficult temperaments.

Limitation and Future Directions

There are several limitations that should be acknowledged despite the significant findings. First, although the NICHD SECCYD was a nationally representative dataset at the time of data collection, the sample does not reflect the diversity that currently exists in the US. The majority of the participants in this study were middle-class, European Americans. Moreover, the sample was not specifically designed for the examination of dyadic synchrony. Therefore, due to the methodological limitation of secondary data analysis, we were not able to capture the relative balance of interaction (i.e., reciprocity, one of the three indicators of dyadic synchrony) in real time. Rather, we created a composite score from the individual mother and child behavior ratings during laboratory interaction. Hence, the factor loading of reciprocity was relatively small, compared to the other two indicators.

Additionally, due to the constraint of examining dyadic synchrony at 54 months and responsiveness at 36 months, we were only able to fit a linear model to investigate

the trajectory of depressive symptoms across three time points. Because no significant variability was found in the slope, the linear growth of depressive symptoms was not predictive of maternal behavior and mother-child interaction. It is plausible that the trajectory of maternal depressive symptoms over time was nonlinear in nature, rather than linear. Future study should also examine linear, quadratic, and cubic change of depressive symptoms over a longer period of time and investigate whether growth of depressive symptoms contributes to the prediction of later responsiveness and dyadic synchrony in middle childhood or adolescence. Moreover, studies could also examine how change in depressive symptoms is related to change in maternal responsiveness and change in mother-child interaction.

Further, the present study used maternal rating of child temperament, rather than observer report or laboratory assessments. It is possible that the degree of maternal depressive symptoms may have affected mothers' perception of their children as easy or difficult. As a result, the ratings of temperament might be biased and the associations found in multiple group analyses might be inflated. In addition, child temperament was measured at an early age (i.e., 6 months). Although the NICHD dataset has another maternal rating of child temperament at 54 months, due to the design of the study targeting on antecedents of dyadic synchrony at 54 months, we were not able to include the 54-month temperament rating in the analyses.

Although the present study examined maternal, child, and contextual antecedents of dyadic synchrony, maternal depressive symptoms and responsiveness were tested as the main predictors of synchrony, whereas family SES and child temperament were treated as moderators. Given that maternal responsiveness predicted only about half of

the variance in dyadic synchrony, it is possible that both child and contextual factors, and additional maternal factors, might have additive effects on the prediction of mother-child dyadic synchrony, For instance, children's greater expressive language ability has been found to be associated with higher levels of dyadic synchrony (Rocissano & Yatchmink, 1983; Skuban et al., 2006). It has been suggested that children with higher expressive language ability are more likely to be actively involved in the dyadic interaction, and mothers may enjoy interacting with more verbal children (Skuban et al., 2006). In addition, children's emotionality has also been related to dyadic interaction (Skuban et al., 2006). Children who are less socially fearful and less prone to anger tend to have higher compliance during mother-child interaction (Lehman, Steier, Guidash, & Wanna, 2002). Mothers, in turn, may be more responsive toward the easygoing children than more irritable or negative children. Several demographic factors also have been suggested to be related to parent-child interaction. This study is consistent with others that suggest SES, especially, may provide a unique contribution to the prediction of synchrony. Mothers from low SES families tend to engage in less verbal interaction and stimulation, whereas mothers in high SES families tend to be more responsive and provide more stimulation (Seifer, Sameroff, Anagnostopolou, & Elias, 1992). The greater verbal communication and responsiveness associated with being in high SES families may, therefore, facilitate children's acquisition of language and the development of synchronous interaction between mother-child dyad.

The measure of SES used in this study may have contributed to the unexpected pattern of findings regarding how SES moderated the path from depressive symptoms to responsiveness. Given that data were collected in or near universities, it is possible that a

number of low SES families were highly educated graduate students. If this were the case, the income-to-needs ratio could have inaccurately reflected SES for many families.

Another possibility is that there were trivial differences in income-to-needs ratio across the three SES grouping. To examine this possibility, a series of ANOVAs was conducted in which the SES grouping variable served as the between-subjects factor and income-to-needs ratio served as the dependent variable. These analyses revealed that families in the three groups differed significantly on income-to-needs ratio at all time points. Specifically, at 1 month, 6 months, 15 months, 24 months, 36 months, and 54 months, families in the high SES group had significantly higher income-to-needs ratios than families in the average- and lower-SES groups, and families in the average-SES group had higher income-to-needs ratios than families in the lower-income group at all time points. For instance, at 36 months, the mean income-to-needs ratios for the three groups were .85, 2.86, and 8.44, respectively for low-, average-, and high-SES groups. Thus, it is unlikely that the cause of the unusual pattern of findings for SES groups resulted from trivial differences in resources across the three groups.

A more likely explanation for the unusual pattern of findings regarding SES is that income-to-needs ratios changed over time for many families. A comparison of the between-SES-group variance with the within-SES-group variance in income-to-needs ratios at each age showed that only at 36 months was the between-group variance larger than the within-group variance. In addition, the correlations among the income-to-needs measures across time ranged from .53 to .83, indicating considerable change across time. Correlations among income-to-needs ratio at 36 months and income-to-needs ratios at other ages ranged from .65 to .83. This suggests that family resources changed over time

and that income-to-needs ratio at 36 month was not necessarily reflective of family circumstances at other times. It may be that the history of family circumstances over the child's life influenced mother-child interaction more than did circumstances when children were 36 months old.

Finally, control variables were included only as predictors of initial levels of depressive symptoms. Given the significant associations between depressive symptoms and the control variables and the well-documented negative effects associated with demographic risk factors, it is possible that factors such as social support, parenting stress, partner status, ethnicity, and gender might also have significant effects on maternal behaviors and mother-child interaction. Further studies should also include these factors in the analyses and examine how the protective and risk factors add to the prediction.

Conclusion

The present study contributes to our understanding of the factors that facilitate the development of dyadic synchrony between mother and child, which has been found to predict children's later adjustment outcomes. Based upon previous literature, this study examined the maternal, child, and contextual factors and their longitudinal relations with dyadic synchrony. Instead of investigating the predictors of change in maternal depressive symptoms, which has been done most frequently in the depression trajectory literature, this study employed latent growth curve modeling to examine the trajectory of depressive symptoms over time as a predictor of maternal behaviors and mother-child interaction. However, the results showed that there was no between-individual variability in linear change of maternal depressive symptoms from 6 to 24 months. As a result, the linear slope was not predictive of either responsiveness or synchrony. However, analyses

were consistent with previous studies in showing that mothers with higher levels of depressive symptoms in infancy had lower levels of interactional synchrony with their children in early childhood. This is the first study to document that the depression – synchrony link is mediated by maternal responsiveness, however. Mothers who exhibited higher levels of depressive symptoms at 6 months tended to be less responsive toward their children at 36 months. Lower levels of maternal responsiveness at 36 months, in turn, predicted less synchronous mother-child synchronous interaction at 54 months.

The findings also supported our hypotheses and Belsky's (1984) ecological process model in that child and contextual factors added to the prediction of parent-child interaction. The negative effect of depressive symptoms on responsiveness was the strongest for average SES mothers. In line with previous research, the negative effect of depressive symptoms was weaker in high SES mothers. However, one unexpected finding was that the effect of depressive symptoms was the same for both low and high SES mothers. However, the variance in responsiveness that was explained by depressive symptoms was much lower for low SES mothers than for high SES mothers. Possibly, it is the cumulative effects of all the possible risk factors associated with being in lower SES families (e.g., life stress, lower income, social support, ethnicity), rather than depression alone, that contribute to lower SES mothers' ability to be responsive toward their children. The findings also revealed that lower and average SES mothers seemed to play a greater role in maintaining the synchronous interaction than did high SES mothers, given the higher variance of dyadic synchrony that was explained by maternal responsiveness in low and average SES mothers.

On the other hand, child temperament also changed the magnitude of the effects

from maternal depressive symptoms. Interacting with easygoing children, the negative consequence of depressive symptoms on mothers' sensitive or contingent behavior appeared to be weaker while the effects were stronger for mothers with temperamentally difficult and even average children. It seemed that for mothers of average and difficult children, responsiveness was determined more by the level of depressive symptoms. However, that doesn't seem to be the case for mothers with temperamentally easy children. The results also suggested that mothers play a greater role in facilitating synchronous interaction with a difficult child than with an average or easygoing child. The findings of the present study add to the dyadic synchrony literature by providing support for the ecological perspective in examining the possible maternal, child, and contextual factors that contribute to the development of mother-child dyadic synchrony.

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Appendix 1: Additional Tables and Figures

Table 1
Unstandardized Path Coefficients from Multiple Group Analyses of the Mediation Model by SES Groups, χ^2 (199) = 351.56, $p < .001$; CFI = .946; TLI = .942; RMSEA = .041, 90% CI = .034, .048; SRMR = .062. ~ $p < .10$ ** $p < .01$ *** $p < .001$

	SES groups		
	Low	Average	High
	n = 181	*n* = 981	*n* = 201
Depression Intercept → Responsiveness	-.02**	-.04***	-.02**
Responsiveness → Synchrony	1.30***	1.30***	1.30***
Depression Intercept → Synchrony	.008	.008	.008
Covariates→ Depression Intercept			
Partner status	1.26	-2.19***	-2.95~
Social support	-3.18***	-3.02***	-3.68***
Parenting stress	.31***	.23***	.14***
White	-2.10~	-1.79**	1.62

Table 2
Standardized Path Coefficients from Multiple Group Analyses of the Mediation Model by SES Groups, χ^2 (199) = 351.56, $p < .001$; CFI = .946; TLI = .942; RMSEA = .041, 90% CI = .034, .048; SRMR = .062. ~ $p < .10$ ** $p < .01$ *** $p < .001$

	SES groups		
	Low	Average	High
	n = 181	*n* = 981	*n* = 201
Depression Intercept → Responsiveness	-.24**	-.47***	-.41**
Responsiveness → Synchrony	.70***	.65***	.30***
Depression Intercept → Synchrony	.05	.05	.04
Covariates→ Depression Intercept			
Partner status	.09	-.12***	-.11~
Social support	-.41***	-.35***	-.53***
Parenting stress	.49***	.37***	.31***
White	-.15~	-.11**	.11~

Table 3
Unstandardized Path Coefficients from Multiple Group Analyses of the Mediation Model by Child Temperament, χ^2 (198) = 384.73, $p < .001$; CFI = .939; TLI = .933; RMSEA = .047; SRMR = .072. ~ $p < .10$ ** $p < .01$ *** $p < .001$

	Temperament groups		
	Easy	Average	Difficult
	n = 198	*n* = 901	*n* = 180
Depression Intercept → Responsiveness	-.02*	-.05***	-.05***
Responsiveness → Synchrony	1.18***	1.18***	1.18***
Depression Intercept → Synchrony	.009	.009	.009
Covariates→ Depression Intercept			
Partner status	-.71	-2.78***	-3.01*
Social support	-4.52***	-2.79***	-3.04***
Parenting stress	.13**	.23***	.28***
White	-.60	-1.74**	-1.34

Table 4
Standardized Path Coefficients from Multiple Group Analyses of the Mediation Model by Child Temperament, χ^2 (198) = 384.73, $p < .001$; CFI = .939; TLI = .933; RMSEA = .047; SRMR = .072. ~ $p < .10$ ** $p < .01$ *** $p < .001$

	Temperament groups		
	Easy	Average	Difficult
	n = 198	*n* = 901	*n* = 180
Depression Intercept → Responsiveness	-.26*	-.52***	-.49***
Responsiveness → Synchrony	.49***	.62***	.73***
Depression Intercept → Synchrony	.06	.06	.06
Covariates→ Depression Intercept			
Partner status	-.04	-.16***	-.17*
Social support	-.55***	-.33***	-.34***
Parenting stress	.20**	.37***	.42***
White	-.03	-.11**	-.09

Figure 1
Standardized Parameter Estimates of the Final Fitted Latent Growth Curve Model (Model 7) with Maternal Responsiveness Mediating the Link between the Intercept of Maternal Depressive Symptoms and Mother-Child Dyadic Synchrony, Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American, χ^2 (59) = 238.38, $p < .001$; CFI = .944; TLI = .932; RMSEA = .047, $p > .05$; SRMR = .052. Dashed lines indicate nonsignificant paths that are fixed to zero. *** $p < .001$

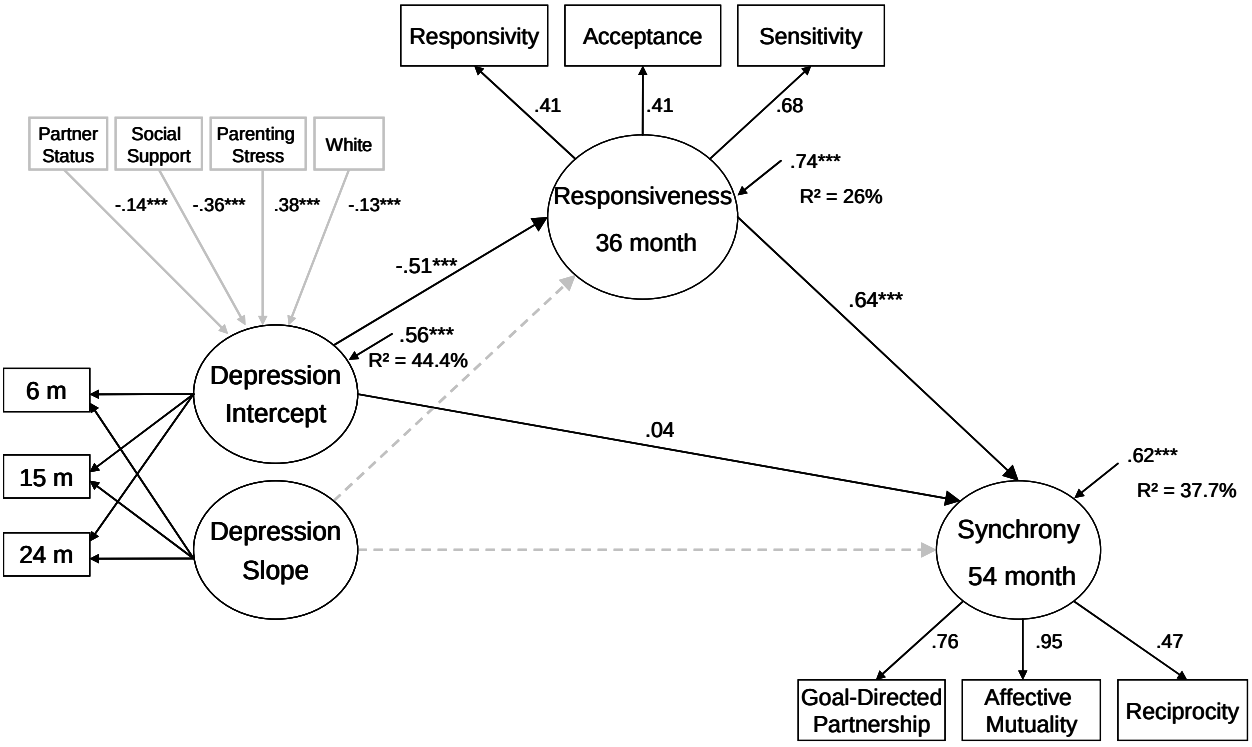


Figure 2
Standardized Parameter Estimates of the Structural Equation Modeling (SEM) with Maternal Responsiveness Mediating the Link between Maternal Depressive Symptoms and Mother-Child Dyadic Synchrony, Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American. *** $p < .001$

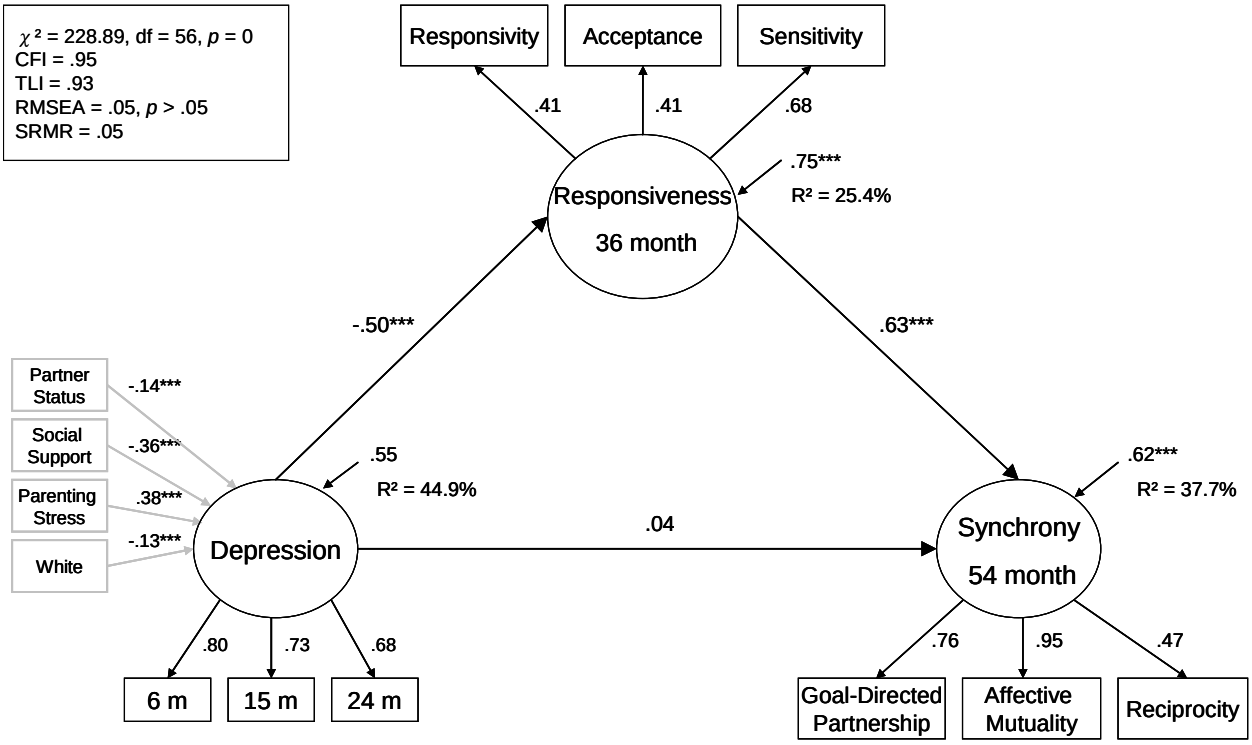


Figure 3
Standardized Parameter Estimates of the Final Fitted Mediation Model (Model 5) for Low SES Mothers, Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (n = 181). Model fit indices: χ^2 (199) = 351.56, p < .001; CFI = .946; TLI = .942; RMSEA = .041, 90% CI = .034, .048; SRMR = .062. Dashed lines indicate nonsignificant paths that are fixed to zero. ~ p < .10 ** p < .01 *** p < .001

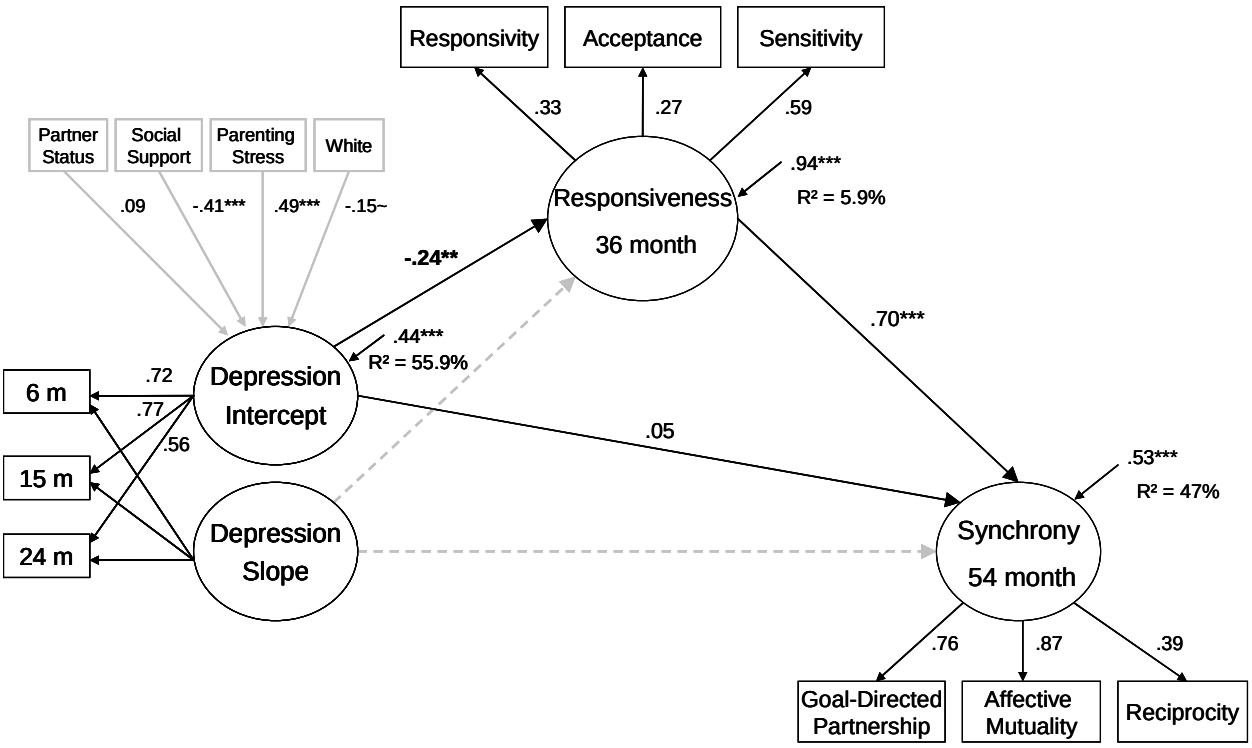


Figure 4
Standardized Parameter Estimates of the Final Fitted Mediation Model (Model5) for Average SES Mothers, Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (n = 981). Model fit indices: χ^2 (199) = 351.56, p < .001; CFI = .946; TLI = .942; RMSEA = .041, 90% CI = .034, .048; SRMR = .062. Dashed lines indicate nonsignificant paths that are fixed to zero. ** p < .01 *** p < .001

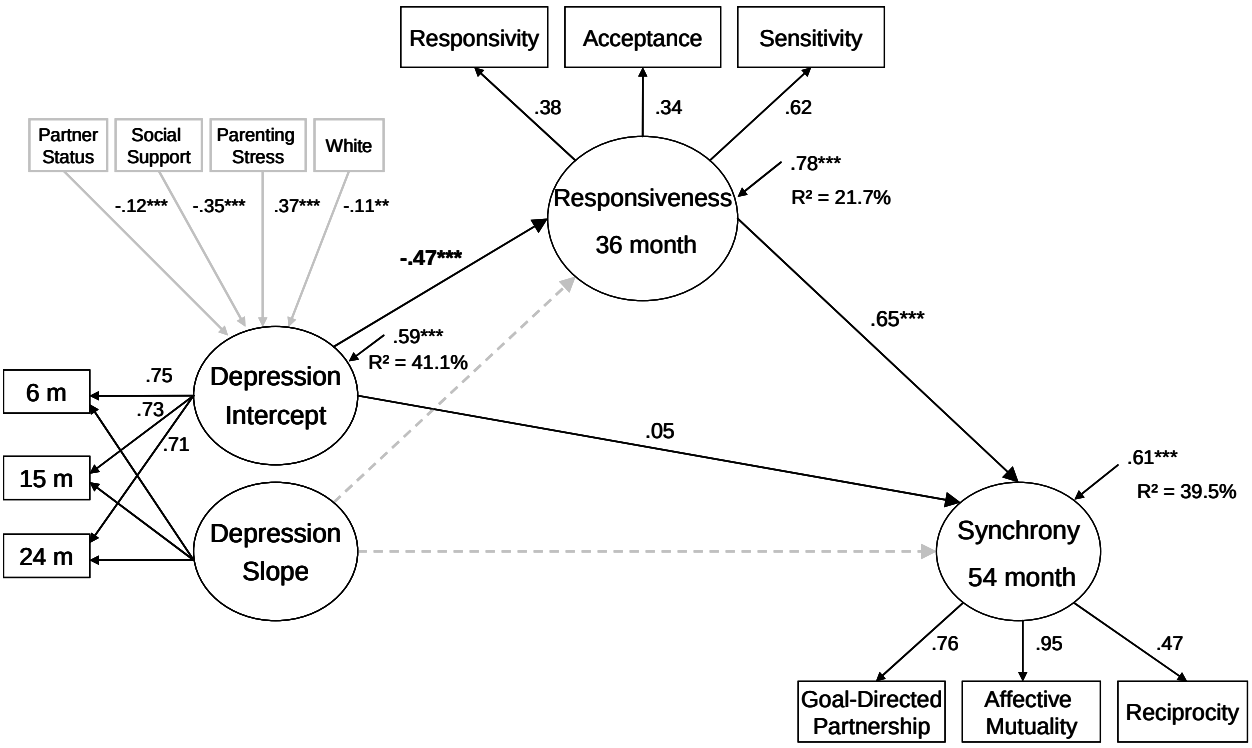


Figure 5
Standardized Parameter Estimates of the Final Fitted Mediation Model (Model5) for High SES Mothers, Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (n = 201). Model fit indices: χ^2 (199) = 351.56, p < .001; CFI = .946; TLI = .942; RMSEA = .041, 90% CI = .034, .048; SRMR = .062. Dashed lines indicate nonsignificant paths that are fixed to zero. ~ p < .10 ** p < .01 *** p < .001

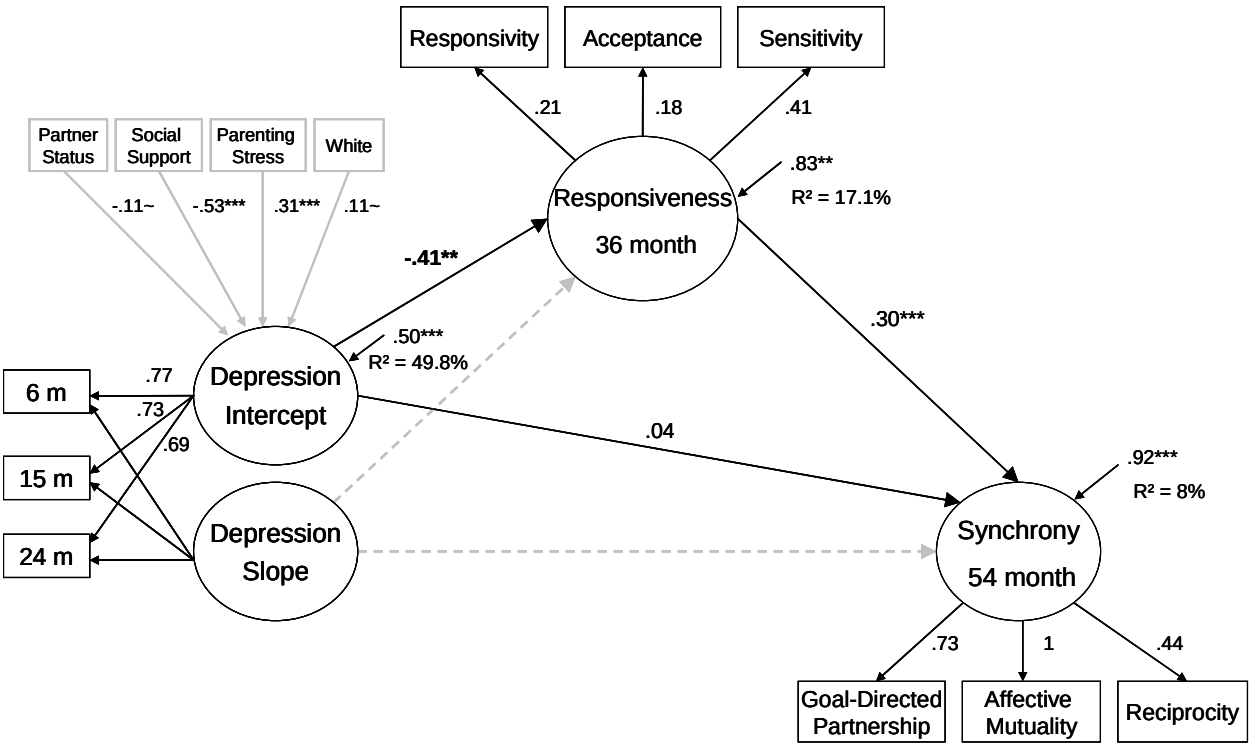


Figure 6
Standardized Parameter Estimates of the Final Fitted Mediation Model (Model5) for Mothers of Children with Easy Temperament, Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (n = 654). Model fit indices: χ^2 (198) = 384.73, p < .001; CFI = .939; TLI = .933; RMSEA = .047, 90% CI = .040, .054; SRMR = .072. Dashed lines indicate nonsignificant paths that are fixed to zero. * p < .05 ** p < .01 *** p < .001

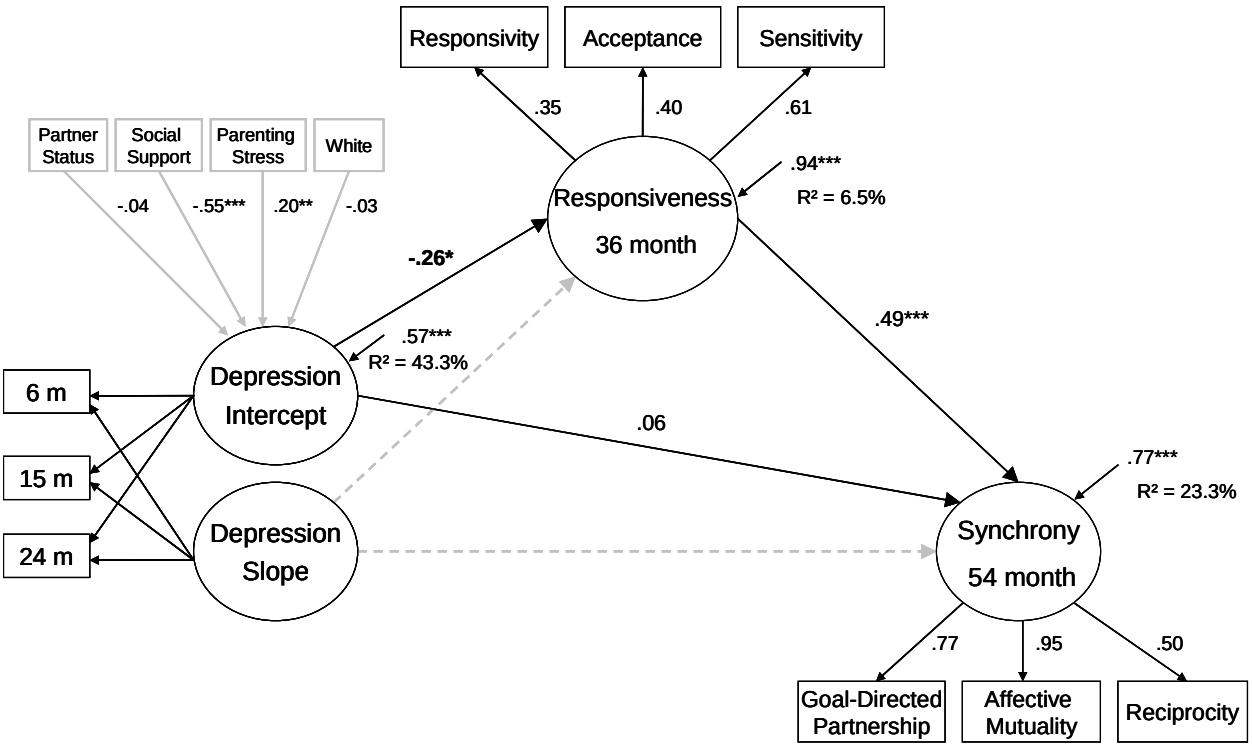


Figure 7
Standardized Parameter Estimates of the Final Fitted Mediation Model (Model5) for Mothers of Children with Average Temperament, Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (n = 625). Model fit indices: χ^2 (198) = 384.73, p < .001; CFI = .939; TLI = .933; RMSEA = .047, 90% CI = .040, .054; SRMR = .072. Dashed lines indicate nonsignificant paths that are fixed to zero. ** p < .01 *** p < .001

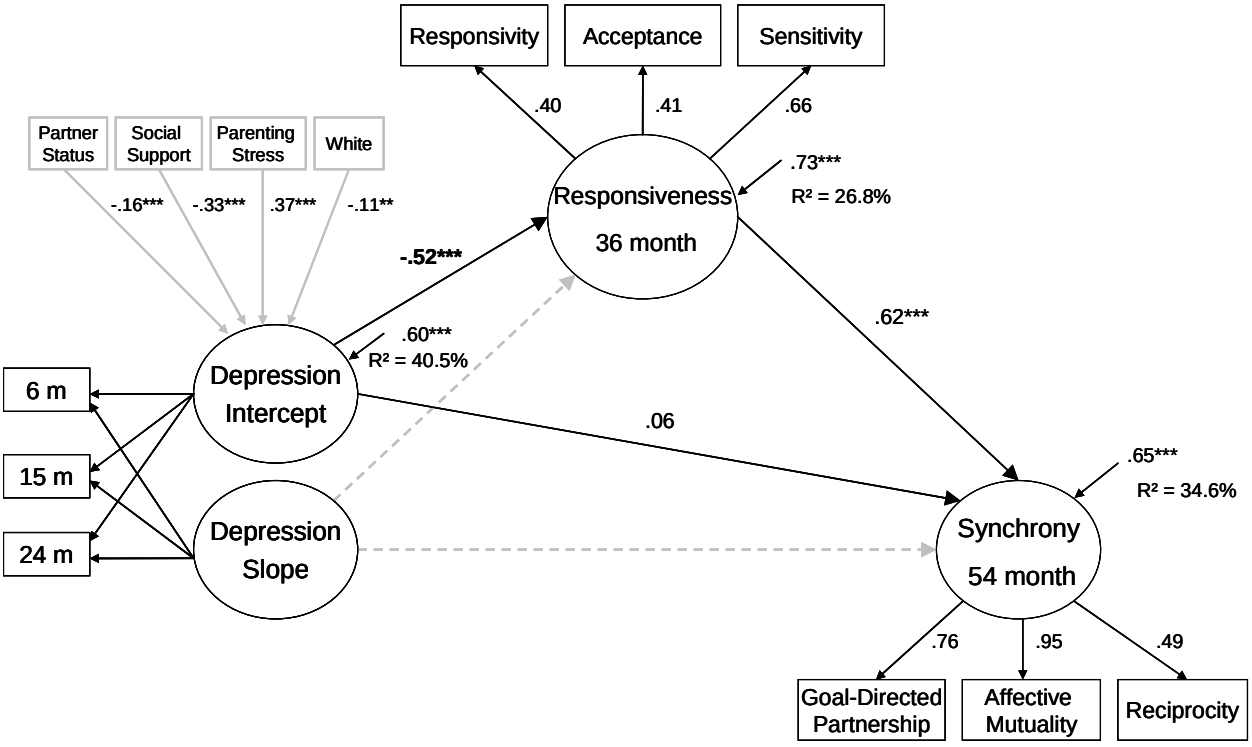
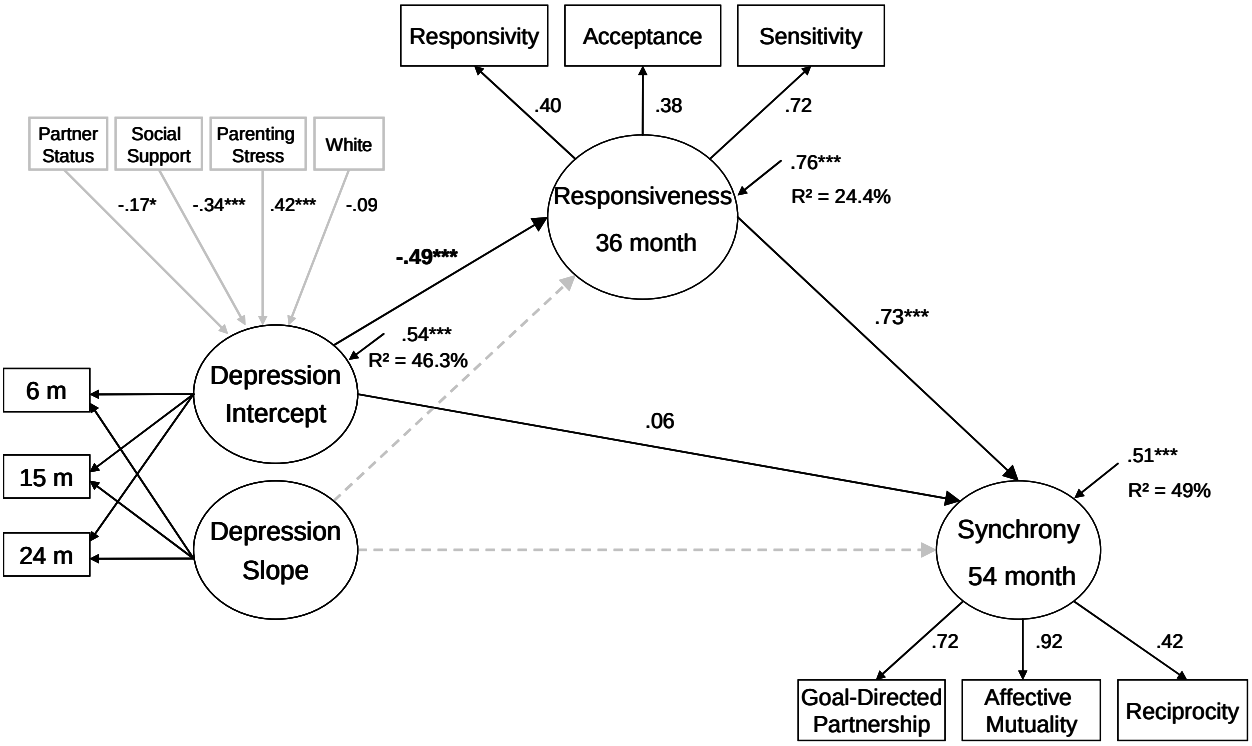


Figure 8
Standardized Parameter Estimates of the Final Fitted Mediation Model (Model5) for Mothers of Children with Difficult Temperament, Controlling for Partner Status, Social Support, Parenting Stress, and Child Ethnicity as European American (n = 625). Model fit indices: χ^2 (198) = 384.73, p < .001; CFI = .939; TLI = .933; RMSEA = .047, 90% CI = .040, .054; SRMR = .072. Dashed lines indicate nonsignificant paths that are fixed to zero. * p < .05 *** p < .001



Appendix 2: Measures

Maternal Depressive Symptoms (6, 15, 24 Months)

MY FEELINGS

ID NUMBER REL

0	0	0	0	0	0	0
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9

The 20 statements below describe how people sometimes feel about themselves. Please answer all questions. THERE ARE NO RIGHT OR WRONG ANSWERS. Give your honest opinions and feelings. Please fill in the box that indicates how often you have felt this way during the past week.

1 - Rarely or none of the time (less than once a week)
2 - Some or all of the time (1-2 days a week)
3 - Occasionally or a moderate amount of time (3-4 days a week)
4 - Most or all of the time (5-7 days a week)

1 - Less than once a week
2 - 1 -2 days a week
3 - 3- 4 days a week
4 - 5-7 days a week

1.	I was bothered by things that usually don't bother me.	1 2 3 4
2.	I felt that everything I did was an effort.	1 2 3 4
3.	I felt I was just as good as other people.	1 2 3 4
4.	I had trouble keeping my mind on what I was doing.	1 2 3 4
5.	I felt sad.	1 2 3 4
6.	I felt fearful.	1 2 3 4
7.	I felt lonely.	1 2 3 4
8.	I had crying spells.	1 2 3 4
9.	I talked less than usual.	1 2 3 4
10.	My sleep was restless.	1 2 3 4
11.	I enjoyed life.	1 2 3 4
12.	I felt that I could not shake off the blues even with the help of my family/friends.	1 2 3 4
13.	I thought my life had been a failure.	1 2 3 4
14.	I was happy.	1 2 3 4
15.	I could not get "going".	1 2 3 4
16.	I felt hopeful about the future.	1 2 3 4
17.	People were unfriendly to me.	1 2 3 4
18.	I did not feel like eating; my appetite was poor.	1 2 3 4
19.	I felt depressed.	1 2 3 4
20.	I felt that people dislike me.	1 2 3 4

Maternal Responsiveness (36 Months): Responsivity & Acceptance

36-MONTH EARLY CHILDHOOD HOME INVENTORY SCORE SHEET

Fill in the box beside each item if the behavior is observed during the visit or if the parent reports that the conditions or events are characteristic of the home environment.
(OB) = scored by observation only

Responsivity

1. Parent holds child close 10-15 minutes per day.
2. Mother converses with child 2 or more times during visit. (OB)
3. Mother answers child's questions or requests verbally. (OB)
4. Mother usually responds verbally to child's speech. (OB)
5. Mother praises child's qualities twice during visit. (OB)
6. Mother caresses, kisses, or cuddles child during visit.
7. Mother helps child demonstrate some achievement during visit. (OB).

Acceptance

1. Mother does not scold or derogate or yell at child more than once during the visit. (OB)
2. Mother does not use physical restraint during visit. (OB)
3. Mother neither slaps nor spanks child during visit. (OB)
4. No more than one instance of physical punishment occurred during the past week.

Maternal Responsiveness (36 Months): Sensitivity

MOTHER/CHILD INTERACTION 36 MONTHS

Coder ID		Month		Day		Year	
0	0	0	0	0	0	9	1
1	1	1	1	1	1		2
2	2		2	2	2		3
3	3		3	3	3		
4	4		4		4		
5	5		5		5		
6	6		6		6		
7	7		7		7		
8	8		8		8		
9	9		9		9		

CHILD ID NUMBER

						REL
0	0	0	0	0	0	0
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9

1 = Very Low
2 = Low
3 = Moderately Low
4 = Moderate
5 = Moderately High
6 = High
7 = Very High

Mother Ratings

1.	Supportive Presence	1	2	3	4	5	6	7
2.	Respect for Child Autonomy	1	2	3	4	5	6	7
3.	Stimulation of cognitive development	1	2	3	4	5	6	7
4.	Hostility	1	2	3	4	5	6	7
5.	Confidence	1	2	3	4	5	6	7

Child Ratings

6.	Enthusiasm	1	2	3	4	5	6	7
7.	Negativity	1	2	3	4	5	6	7
8.	Persistence	1	2	3	4	5	6	7
9.	Affection towards Mother	1	2	3	4	5	6	7
10.	Felt Security	1	2	3	4	5	6	7

11. Problems/Complications _____ 0 NO 1 YES

_____

_____

Dyadic Synchrony (54 Months): Goal-directed Partnership, Affective Mutuality, & Reciprocity

54-MONTH LAB VISIT STRUCTURED INTERACTION QUALITATIVE RATING SCALES

CHILD ID NUMBER

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

Coder ID		Month		Day		Year	
0	0	0	0	0	0	9	6
1	1	1	1	1	1		7
2	2		2	2	2		8
3	3		3	3	3		
4	4		4		4		
5	5		5		5		
6	6		6		6		
7	7		7		7		
8	8		8		8		
9	9		9		9		

1=Very Low 5=Moderately High
2=Low 6=High
3=Moderately Low 7=Very High
4=Moderate

Mother Ratings

1.	Supportive Presence	1	2	3	4	5	6	7
2.	Respect for Autonomy	1	2	3	4	5	6	7
3.	Stimulation of Cognitive Development	1	2	3	4	5	6	7
4.	Quality of Assistance	1	2	3	4	5	6	7
5.	Hostility	1	2	3	4	5	6	7
6.	Confidence	1	2	3	4	5	6	7

Child Ratings

7.	Agency	1	2	3	4	5	6	7
8.	Negativity	1	2	3	4	5	6	7
9.	Persistence	1	2	3	4	5	6	7
10.	Experience of Session	1	2	3	4	5	6	7
11.	Goal Directed Partnership	1	2	3	4	5	6	7
12.	Felt Security	1	2	3	4	5	6	7
Coder's Confidence		1	2	3	4			
Problems/Complications		0 NO 1 YES						

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Child Temperament (6 Months)

MY BABY

ID NUMBER | REL

0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

The purpose of these questions is to determine the general pattern of your baby's reactions to the world. For each question, please fill in the response indicating how often you think the statement is true for your baby. Although some of the statements seem to be similar, they are not the same, and we would appreciate your response to each question. If your baby has changed with respect to any of the questions, fill in the response that best describes the recently established pattern. If a question asks about a situation that your baby has not experienced, you may fill in CA, for "Can't Answer". There are no good, bad, right or wrong answers, only descriptions of what your baby does.

USING THE SCALE SHOWN BELOW, PLEASE FILL IN THE SPACE THAT TELLS HOW OFTEN YOUR BABY'S BEHAVIOR HAS BEEN LIKE THE BEHAVIOR DESCRIBED IN EACH STATEMENT.

IF YOUR BABY HAS NOT EXPERIENCED A SITUATION, FILL IN CA (for Can't Answer).

Almost never	Rarely	Usually does not	Usually does	Frequently	Almost always	Can't Answer
1	2	3	4	5	6	CA

1.	My baby accepts right away any change in place or position of feeding or person giving it.	Almost never	1	2	3	4	5	6	Almost always CA
2.	My baby sits still while watching TV or other nearby activity.	Almost never	1	2	3	4	5	6	Almost always CA
3.	My baby accepts nail cutting without protest.	Almost never	1	2	3	4	5	6	Almost always CA
4.	My baby takes feedings quietly with mild expression of likes and dislikes.	Almost never	1	2	3	4	5	6	Almost always CA
5.	My baby is fussy (frowns, cries) on waking up or going to sleep.	Almost never	1	2	3	4	5	6	Almost always CA
6.	My baby lies quietly in the bath.	Almost never	1	2	3	4	5	6	Almost always CA
7.	My baby accepts his/her bath any time of the day without resisting it.	Almost never	1	2	3	4	5	6	Almost always CA
8.	My baby vigorously resists additional food or milk when full (spits out, clamps mouth closed, bats at spoon, etc.)	Almost never	1	2	3	4	5	6	Almost always CA
9.	My baby moves about much (kicks, grabs, squirms) during diapering and dressing.	Almost never	1	2	3	4	5	6	Almost always CA

Almost never	Rarely	Usually does not	Usually does	Frequently	Almost always	Can't Answer
1	2	3	4	5	6	CA

10.	My baby is shy (turns away or clings to mother) on meeting another child for the first time.	Almost never	1	2	3	4	5	6	Almost always	CA
11.	My baby makes happy sounds (coos, smiles, laughs) when being diapered or dressed.	Almost never	1	2	3	4	5	6	Almost always	CA
12.	My baby resists changes in feeding schedule (1 hour or more) even after two tries.	Almost never	1	2	3	4	5	6	Almost always	CA
13.	My baby sits still (little squirming) while traveling in car seat or stroller.	Almost never	1	2	3	4	5	6	Almost always	CA
14.	My baby reacts mildly (just blinks or startles briefly) to bright light such as flash bulb or letting sunlight in by pulling up shade.	Almost never	1	2	3	4	5	6	Almost always	CA
15.	My baby is pleasant (smiles, laughs) when first arriving in unfamiliar places (friend's house, store).	Almost never	1	2	3	4	5	6	Almost always	CA
16.	My baby accepts new foods right away, swallowing them promptly.	Almost never	1	2	3	4	5	6	Almost always	CA
17.	My baby accepts regular procedures (hair brushing, face washing, etc.) at any time without protest.	Almost never	1	2	3	4	5	6	Almost always	CA
18.	My baby moves much (squirms, bounces, kicks) while lying awake in crib.	Almost never	1	2	3	4	5	6	Almost always	CA
19.	My baby reacts strongly to foods, whether positively (smacks lips, laughs, squeals) or negatively (cries).	Almost never	1	2	3	4	5	6	Almost always	CA
20.	My baby is pleasant (coos, smiles, etc.) during procedures like hair brushing or face washing.	Almost never	1	2	3	4	5	6	Almost always	CA
21.	My baby's initial reaction to seeing doctor is acceptance (smiles, coos).	Almost never	1	2	3	4	5	6	Almost always	CA
22.	My baby plays actively with parents-much movement of arms, legs, body.	Almost never	1	2	3	4	5	6	Almost always	CA
23.	My baby objects to being bathed in a different place or by a different person even after 2 or 3 tries.	Almost never	1	2	3	4	5	6	Almost always	CA
24.	My baby greets a new toy with a loud voice and much expression of feeling (whether positive or negative).	Almost never	1	2	3	4	5	6	Almost always	CA

ID # |_|_|_|_|_|_| |_|

Almost never	Rarely	Usually does not	Usually does	Frequently	Almost always	Can't Answer
1	2	3	4	5	6	CA

25.	My baby moves about much during feedings (squirms, kicks, grabs).	Almost never	1	2	3	4	5	6	Almost always	CA
26.	My baby cries when left to play alone.	Almost never	1	2	3	4	5	6	Almost always	CA
27.	My baby's initial reaction to a new babysitter is rejection (crying, clinging to mother, etc.).	Almost never	1	2	3	4	5	6	Almost always	CA
28.	My baby adjusts within 10 min. to new surroundings (home, store, play area)	Almost never	1	2	3	4	5	6	Almost always	CA
29.	My baby displays much feeling (vigorous laugh or cry) during diapering or dressing.	Almost never	1	2	3	4	5	6	Almost always	CA
30.	My baby lies still when asleep and wakes up in the same place.	Almost never	1	2	3	4	5	6	Almost always	CA
31.	My baby's first reaction to any new procedure (first haircut, new medicine, etc.) is objection.	Almost never	1	2	3	4	5	6	Almost always	CA
32.	My baby is content (smiles, coos) during interruptions of milk or solid feeding.	Almost never	1	2	3	4	5	6	Almost always	CA
33.	My baby adjusts easily and sleeps well within 1 or 2 days with changes of time or place.	Almost never	1	2	3	4	5	6	Almost always	CA
34.	My baby shows much bodily movements (kicks, waves arms) when crying.	Almost never	1	2	3	4	5	6	Almost always	CA
35.	For the first few minutes in a new place or situation (new store or home) my baby is fretful.	Almost never	1	2	3	4	5	6	Almost always	CA
36.	My baby reacts strongly to strangers: laughing or crying.	Almost never	1	2	3	4	5	6	Almost always	CA
37.	My baby continues to react to a loud noise (hammering, barking dog, etc.) heard several times in the same day.	Almost never	1	2	3	4	5	6	Almost always	CA
38.	My baby actively grasps or touches objects within his/her reach (hair, spoon, glasses, etc.).	Almost never	1	2	3	4	5	6	Almost always	CA
39.	My baby cries for less than one minute when given an injection.	Almost never	1	2	3	4	5	6	Almost always	CA
40.	My baby is still wary or frightened of strangers after 15 minutes.	Almost never	1	2	3	4	5	6	Almost always	CA
41.	My baby's initial reaction at home to approach by strangers is acceptance.	Almost never	1	2	3	4	5	6	Almost always	CA

Almost never	Rarely	Usually does not	Usually does	Frequently	Almost always	Can't Answer
1	2	3	4	5	6	CA

42.	My baby reacts mildly (quiet smiles or no response) to meeting familiar people.	Almost never	1	2	3	4	5	6	Almost always	CA
43.	My baby lies still and moves little while playing with toys.	Almost never	1	2	3	4	5	6	Almost always	CA
44.	My baby is fussy or moody throughout a cold or an intestinal virus.	Almost never	1	2	3	4	5	6	Almost always	CA
45.	My baby requires introduction of a new food on 3 or more occasions before he/she will accept (swallow) it.	Almost never	1	2	3	4	5	6	Almost always	CA
46.	My baby lies still during procedures like hair brushing or nail cutting.	Almost never	1	2	3	4	5	6	Almost always	CA
47.	My baby plays quietly and calmly (little vocalization or other noise) with toys.	Almost never	1	2	3	4	5	6	Almost always	CA
48.	My baby accepts within a few minutes a change in place of bath or person giving it.	Almost never	1	2	3	4	5	6	Almost always	CA
49.	My baby remains pleasant or calm with minor injuries (bumps, pinches).	Almost never	1	2	3	4	5	6	Almost always	CA
50.	My baby moves much (kicking, waving arms and bouncing) and for several minutes or more when playing by self.	Almost never	1	2	3	4	5	6	Almost always	CA
51.	My baby's initial reaction is withdrawal (turns head, spits out) when consistency, flavor, or temperature of solid foods is changed.	Almost never	1	2	3	4	5	6	Almost always	CA
52.	My baby is calm in the bath. Like or dislike is mildly expressed (smiles/frowns).	Almost never	1	2	3	4	5	6	Almost always	CA
53.	My baby accepts changes in solid food feedings (type, amount, timing) within 1 or 2 tries.	Almost never	1	2	3	4	5	6	Almost always	CA
54.	My baby appears bothered (cries, squirms) when first put down in a different sleeping place.	Almost never	1	2	3	4	5	6	Almost always	CA
55.	My baby is fussy or cries during the physical examination by the doctor.	Almost never	1	2	3	4	5	6	Almost always	CA

56. My baby's temperament (style of behaving) is:

a about average
b more difficult than average
c easier than average