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Relationship of Maternal Psychological Distress Class to Later Mother-Infant Interaction, Home Environment, and Infant Development in Preterm Infants

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Abstract

Latent class analyses can be used early in the postpartum period to identify mothers of preterm infants experiencing similar patterns of psychological distress symptoms, but whether these classes of mothers also differ in parental responses to their infants or in their infants' development is largely unknown. In this longitudinal multisite repeated measures study, we evaluated the usefulness of three psychological distress classes (low distress, high depressive and anxiety symptoms, and extreme distress) in predicting mother-infant interactions, quality of home environment, and infant development in 229 mother-preterm infant pairs. Mothers completed psychological distress questionnaires at study entry; parent-infant interaction was recorded at two and six months of age corrected for prematurity; and infant developmental data were collected 12 months corrected age. Mothers in the extreme distress class engaged in more developmental stimulation at two months ($\beta = 0.99$, $p < 0.01$) and at six months ($\beta = 1.38$, $p < 0.01$) than mothers in the other classes and had better quality of home environment at two months ($\beta = 2.52$, $p = 0.03$). When not controlling for neurological insult, infants of mothers in the extreme distress class had poorer cognitive ($\beta = -10.28$, $p = 0.01$) and motor ($\beta = -15.12$, $p < 0.01$) development scores at 12 months corrected age than infants of mothers in the other distress classes, but after controlling for infant neurological insult, there were no differences in cognitive, motor and language development based on maternal psychological distress class.

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Keywords

mental health; depression; anxiety; infant development; maternal-infant interaction

The majority of clinical studies on psychological distress in mothers of preterm infants are focused on one or two symptoms, usually depressive symptoms or anxiety (Kong et al., 2013; McCabe et al., 2012; Miles, Holditch-Davis, Schwartz, & Scher, 2007; O'Hara & McCabe, 2013; Rogers, Kidokoro, Wallendorf, & Inder, 2013). Although this approach has led to important advances in understanding of effects of postpartum depressive symptoms in mother-child dyads, mothers of preterm infants often experience high levels of depressive, anxiety, stress and post-traumatic stress symptoms, which are consistently found to be correlated (Holditch-Davis et al., 2009; 2015; Singer et al., 1999).

Recognizing that mothers of preterm infants experience an array of psychological distress symptoms, researchers have recently identified psychological distress classes of mothers of preterm infants, based on sub-groups who show similar symptom patterns in the early postpartum period (Holditch-Davis et al., 2015). The goal of this study was to expand on this emerging literature by evaluating the usefulness of these psychological distress classes in predicting mother-infant interactions, quality of home environment and short-term infant developmental outcomes.

Distress Classes in Mothers of Preterm Infants

In a group of African-American mothers of preterm infants during hospitalization in the NICU (Holditch-Davis et al., 2009), researchers identified four latent classes of distress, based on patterns of six types of psychological distress symptoms (depressive symptoms, state anxiety, post-traumatic stress, infant appearance and behavior stress, stress related to alteration in parental role in the NICU, daily hassles). The four distress classes varied from low distress to extreme distress, with the extreme distress class displaying the highest means on all six measures of psychological distress symptoms. Then, in an ethnically diverse group of mothers of preterm infants, five psychological distress classes were identified (Holditch-Davis et al.,, 2015). Both studies had a low distress class, an extreme distress class, and two intermediate classes–one high on NICU-related distress and one high on anxiety and depressive symptoms. The fifth class had moderate scores on all measures and appeared to be intermediate, between the low and high distress classes.

In both studies, researchers were able to use the psychological distress classes to predict maternal psychological distress levels for 1–2 years. Mothers in the extreme distress classes and, to a lesser degree, the high depressive and anxiety symptom class remained at risk of significant distress for a year after the infants reached full-term age. These mothers also reported less positive perceptions of their infants.

Harmful Effects of Maternal Distress

The detrimental effects of maternal psychological distress on infants and children include impaired maternal-infant interactions (Beck, 1995; Field, 2010; Field et al., 1996), which

can result in infants' behavioral dysregulation and impaired language, cognitive, and motor development (Field, 2010; Grace, Evindar, & Stewart, 2003; Lovejoy, Graczyk, O'Hare, & Neuman, 2000; Stein et al., 2014). The effects of distress on early mother-preterm infant interactions, such as verbalizations, sensitivity, and touch, are of particular concern because these behaviors are related to cognitive and language development (Cusson, 2003; Evans et al., 2012; Holditch-Davis, Schwartz, Black, & Scher, 2007; McManus & Poehlmann, 2012; Stein et al., 2014).

However, most of the studies on maternal distress have been retrospective in nature, limiting prediction of mother-infant interaction and infant outcomes based on the mothers' psychological distress profile in the early postpartum. Clinicians are therefore unable to identify at-risk mothers early in the postpartum period. The aim of the present study was to identify whether sub-groups of mothers of preterm infants with similar profiles of psychological distress during neonatal hospitalization in the NICU would differ on mother-infant interactions and the quality of the stimulation of the home environment at two and six months corrected for prematurity, and whether infant development would differ at one year corrected age.

Method

This was a secondary analysis of a longitudinal, repeated-measures, experimental study testing the effects of two maternally administered interventions for preterm infants (Holditch-Davis et al., 2014; White-Traut, Wink, Minehart, & Holditch-Davis, 2012). In the parent study, the interventions had no significant effect on maternal psychological distress or infant development. The current analysis focused on the effects of classes of mothers, defined at study enrollment using profiles of distress measures taken before the intervention. The effect of the intervention was included in all analytical models to eliminate any possible confounding of intervention effects with the results presented in this report.

Participants

We included 229 mothers of preterm infants weighing ≤ 1750 grams at birth (gestational age, mean 27.1 weeks and SD 2.9) who were no longer considered critically ill (i.e., not on the ventilator or continuous positive airway pressure, not in immediate danger of needing these treatments, without an umbilical artery catheter, and able to be held outside the incubator). Exclusion criteria included mothers who did not have custody of the infants, whose infants had congenital neurological problems (e.g., congenital hydrocephalus), who had symptoms of substance exposure, who would have difficulty participating in the study (age ≤ 15; history of psychosis or bipolar disease; current major depression diagnosis; ongoing critical illness or HIV), or for whom follow-up for 12 months was unlikely. All other infants were eligible, including those with substance exposure without symptoms and neurological insults.

Mothers and infants were recruited from the NICUs at two hospitals in North Carolina and two hospitals in Illinois. The North Carolina hospitals served populations that were diverse in socioeconomic status and location, and the Illinois hospitals served inner-city, poor populations. Randomization to treatment groups was stratified by recruitment hospital.

Mothers from the Illinois hospitals were more likely than the North Carolina mothers to be young, unmarried, Black or Hispanic, poorly educated, and on welfare (Holditch-Davis et al., 2015).

Psychological Distress Classes

Three psychological distress classes were used in the current study: 1) Low to moderate psychological distress, 2) High depressive and anxiety symptoms, and 3) Extreme distress. In the parent study, five psychological distress classes had been identified: low distress, high NICU-related distress, high anxiety and depressive symptoms, intermediate scores on all measures, and extreme distress (Holditch-Davis et al., 2015). The original low, moderate and high NICU-related distress classes had a predicted trajectory of most symptom scores that did not differ after 2 months corrected age over the first year after term and were condensed into a single low to moderate class. The reduced number of psychological distress classes also reduced the degrees of freedom for statistical models, allowing more power for the current analysis, which dealt with unequal sizes of distress classes.

The mothers in the low to moderate distress class (n = 184) averaged moderate or lower scores on all measures. The mothers in the high depressive and anxiety symptom class (n = 20) had elevated scores on depressive and anxiety symptoms, and the mothers in the extreme distress class (n = 25) had extremely elevated scores on all measures. Further detail on symptom scores by distress classes is provided in Table 1. Characteristics of the three distress classes are presented in Table 2.

Measures

Independent variable: Psychological distress classes—The three psychological distress classes were used as independent variables: Low to moderate psychological distress, high depressive and anxiety symptoms, and extreme distress. These distress classes had been defined in the parent study using latent class analysis of scores on five self-reported maternal psychological distress measures administered at study baseline during neonatal hospitalization: maternal depressive symptoms, situational anxiety, post-traumatic stress, NICU-related stress, and parental role alteration stress. These measures had significant correlations (p < .01) ranging from 0.42 (NICU-related stress and anxiety symptoms) to 0.69 (depressive and anxiety symptoms; Holditch-Davis et al., 2015). The measures have good reliability and validity.

Psychological distress measures: The Center for Epidemiologic Studies Depression Scale (CESD) was used to measure maternal depressive symptoms (Radloff, 1977). Scores range from 0 to 60. Cronbach alpha in this sample was 0.90.

State-Trait Anxiety Inventory (STAI, state sub-scale) was used to measure maternal situational anxiety symptoms (Spielberger, 1983). Scores range from 20 to 80. Cronbach alpha in this study was 0.93 at enrollment. For both CESD and STAI, higher scores indicate more symptomatology.

The Perinatal Post-Traumatic Stress Symptom Questionnaire (PPQ) was used to measure post-traumatic stress symptoms related to preterm birth and the NICU experience (DeMier,

Hynan, Harris, & Manniello, 1996). Scores range from 0 to 14. A score of six or greater indicates elevated post-traumatic stress symptoms. Cronbach alpha in this sample was 0.79 at enrollment.

The Parental Stress Scale: NICU (PSS: NICU) was used to measure stress related to alterations in parental role during neonatal hospitalization, the appearance and behavior of the child, and NICU sights and sounds (Miles, Funk, & Carlson, 1993). Higher scores indicate more stress. Cronbach alpha for the two subscales used in this report was 0.91 at enrollment for the infant appearance and behavior subscale and 0.90 for the parental role alteration subscale.

Outcome variables—We explored three outcome variables in this study: mother-infant interaction, quality of the home environment, and infant development.

Mother-infant interactions: During home visits at two and six months, a 45-minute video recording of mother-infant interactions was obtained when the infant was awake. Mothers received instructions to care for their children as they would usually do and were told that the goal was to record mother-infant interactive behaviors in the home. Research assistants who were masked to group membership in the parent study coded videos with a validated coding system (Holditch-Davis, Bartlett, & Belyea, 2000; Holditch-Davis et al., 2009; Holditch-Davis, Roberts, & Sandelowski, 1999). Maternal and child interactive behaviors (e.g., location, looking, touching) were coded for every 10 seconds of the video. Throughout the study, inter-rater reliability was checked every other month by having two scorers score the same video. The kappa for agreement on individual behaviors ranged from of 0.68 to 0.90. Specific definitions of all maternal and infant interactive behaviors are described in Table 3.

Each of the maternal and infant interactive behaviors was measured as a percentage of the total observation time. For example, mother interact (caregiving, talking to, touching, gesturing toward, or playing with the child) plus mother uninvolved (not interacting with or looking at the child) plus passive observation (looking at the child but not interacting) totaled 100%. These interactive behaviors have been related to infant development and maturity or affected by maternal depression (Field et al., 1996; Harrison, 1990; Holditch-Davis, Brandon, & Schwartz, 2003; Holditch-Davis, Cox, Miles, & Belyea, 2003; Holditch-Davis et al., 2007; Smith, Landry, & Swank, 2000).

Quality of the home environment: The HOME inventory (0–3 version) was used to measure the social-emotional and stimulation characteristics of the home environment related to child developmental status (Caldwell & Bradley, 1980). Scores range from 0 to 45; higher scores indicating better, more stimulatory, environments. The HOME has been correlated with mother-infant interactive behaviors (Holditch-Davis, Tesh, Goldman, Miles, & D'Auria, 2000; Tesh & Holditch-Davis, 1997). For this study, research assistants were trained to score the HOME with 90% inter-rater reliability. The HOME total score was analyzed, and the maternal involvement subscale was used in the maternal dimensions. The HOME total score had Cronbach alphas of 0.84 at two months and 0.83 at six months. The

maternal involvement subscale had Cronbach alphas of 0.70 at two months and 0.70 at six months.

Interactive dimensions: Six maternal behaviors from the videotaped observation and two sub-scales from the HOME were grouped into two maternal dimensions: Positive involvement and developmental stimulation. Eight infant behaviors were grouped into three child dimensions: Social, developmental maturity, and irritability (Table 3). To calculate dimension scores, the 2- and 6-month data for each behavior was combined to determine an overall mean and standard deviation then used to calculate a Z-score for each behavior of each participant. The Z-scores for each variable in each dimension were summed at each age, and these standardized dimension scores were used in all analyses. This procedure maintained the age-related differences in the dimension scores. As would be expected, interactive dimension scores changed with infant age (Holditch-Davis et al., 2007), so only maternal dimensions of interaction were tested as mediators of child development because child dimensions directly reflected the outcome variable of developmental status. The Cronbach alphas for the dimensions ranged from .91 for child irritability and to .58 for child developmental maturity; the lower alpha is justified by the limited developmental maturity behaviors shown by young babies (Table 3).

Infant development: The Bayley Scales of Infant and Toddler Development (BSID-III) were used to measure development at 12 months after term (Bayley, 2003). This scale was administered by an examiner who was naive to infants' group status in the parent study and who had advanced training in infant developmental assessment. The BSID-III is a standardized, norm-referenced measure. A child's performance is compared with normative data from children of the same age. The BSID-III is the gold standard of infant and toddler assessment tools and has shown good validity and acceptable reliability (Bayley, 2003).

Covariates—Parity, study site (North Carolina or Illinois), parent study intervention group, maternal education, and infant neurological insults were used as covariates. Parity, maternal education, and infant neurological insults have been found to be significant correlates of mother-premature infant interactions (Holditch-Davis et al., 2007). Infant medical problems that could result in neurological insults was determined from the medical record and scored on the Neurobiologic Risk Scale (NBRS), which measures potential insults to the brain through direct injury or inadequate blood flow, nutrients, or oxygenation (Brazy, Goldstein, Oehler, Gustafson, & Thompson, 1993). Seven types of neurological insults are scored for severity on a 4-point scale, with higher scores indicating more severe insults. Inter-rater reliability for NRBS has been reported as 97% (Brazy et al., 1993). Cronbach alpha in the current sample was 0.71.

Procedures

The institutional review boards of all study sites approved the study. Mothers signed informed consents for their infants' and their own participation. Mothers answered self-report psychological distress symptoms measures and maternal and infant characteristic questionnaires at enrollment in the hospital, and at 2 and 6 months corrected age, at-home mother-infant interaction was recorded. During the home visits, a research assistant scored

the HOME after the videotaped interaction, using information about the home environment obtained during the video recording. At 12 months corrected age at the neonatal follow-up clinic, the infant development measure BSID-III was completed.

Data Analyses

We conducted data analysis using SAS software, version 9.3. First, we used bivariate analysis (ANOVA) to explore the relationship between the latent class variable and all the outcome variables: mother-infant interactive dimensions and quality of the home environment at 2 and 6 months after term, and infant development at 12 months after term. Second, general linear models (GLM) were built to assess the relationship between each of the outcome variables and latent class variable after adjusting for all possible confounders.

The possible confounders included in the models were parity, study site, maternal education, region, infant neurological insult and parent study intervention. Parity and study site were found to significantly differ between distress classes (Holditch-Davis et al., 2015). Maternal education and infant neurological insults are often correlated with mother-infant interactions (Holditch-Davis et al., 2007). Parent study intervention group was included to control for any possible confounding effect, although the interventions had no significant effect on distress classes (Holditch-Davis et al., 2015). We kept significant covariates in the final reduced model to control for the confounding effects.

The final models were reduced by a stepwise backwards elimination process using the 0.05 level of significance. In this manuscript, both the initial and final models are presented, so the effects of the covariates on study outcomes can be demonstrated.

Results

Mother-Infant Interaction

In the bivariate models, maternal dimensions of maternal-infant interaction differed significantly by psychological distress class (Table 4). None of the child dimensions differed by distress class and, therefore, were not included in the final analysis.

In the initial GLM model, using the low to moderate distress class as the referent group, mothers in the extreme distress classes engaged in more developmental stimulation with the infants than mothers in the low distress classes at two ($\beta = 0.99$, $p < 0.01$) and six ($\beta = 1.38$, $p < 0.01$) months corrected age (Table 5). This significant difference was maintained in the final model after we controlled for maternal education and infant neurological insult. Mothers with higher education ($\beta = 0.12$, $p = 0.02$) and living in Illinois ($\beta = -0.91$, $p < 0.01$) were more likely to engage in interactions that stimulated development at two months, but not at six months corrected age. Detailed GLM model results are presented in Table 6. At six months corrected age, none of the variables in the final model had a significant effect on developmental stimulation.

Mothers in the extreme distress classes engaged in more positive involvement at 6 months corrected age than did mothers in the low to moderate distress class ($\beta = 2.22$, $p = 0.05$) when not controlling for maternal education (Table 5). In the final GLM model, we did not

find a statistical difference among the distress classes in positive involvement. Mothers with higher education were more likely than less-educated mothers to engage in more positive involvement interactions at two ($\beta = 0.58$, $p < 0.01$) and six months ($\beta = 0.37$, $p = 0.04$) corrected age. Mothers living in Illinois were less likely than mothers in North Carolina to engage in positive involvement at two months corrected age ($\beta = -2.03$, $p < 0.01$); this effect was not significant at 6 months. For both developmental stimulation and positive involvement, when maternal education was introduced in the model, parity was no longer significant (Table 6).

Quality of the Home Environment

At 2 months corrected age, we found a positive significant difference between the extreme distress and the comparison classes on the quality of home environment ($\beta = 2.52$, $p = 0.03$). Distress class differences were not identified at 6 months corrected age in either the initial or final GLM models (Table 5). Study site and maternal education were consistently significant predictors of quality of the home environment, but parity was significant only at two months corrected age. Mothers with higher education and living in North Carolina were more likely than mothers with low education and living in Illinois to have a better home environment for infant development at both 2 and 6 months corrected age (Table 6).

Infant Development

In the initial GLM model (Table 4), we found that infants of mothers in the extreme distress class had significantly lower cognitive ($\beta = -10.28$, $p = 0.01$) and motor ($\beta = -15.12$, $p < 0.01$) development scores at 12 months corrected age than infants of mothers in the other distress classes. In the final model, after controlling for infant neurological insults (NBRS total), there were no differences in cognitive, motor and language development between distress classes (Table 7). Infants who experienced fewer neurological insults during hospitalization were more likely than infants with more neurological insults to have better developmental outcomes.

Discussion

Mothers' psychological distress has been known to affect the mother-preterm infant relationship. Mothers with depressive or anxiety symptoms have reported more negative perceptions of their children than healthy mothers (Singer et al., 2007; Voegtline et al., 2010). Mothers with high levels of psychological distress have been consistently reported as being less sensitive parents, providing less cognitive and interactive stimulation to their infants (Feeley, Gottlieb, & Zelkowitz, 2005; Korja et al., 2008). In the current study, however, mothers in the extreme psychological distress class displayed more positive involvement and cognitive stimulation, which is congruent with our previous report that greater maternal stress due to the NICU environment was related to more positive involvement (Holditch-Davis et al., 2007).

Feldman (2007) argued that mothers have a key role in coordinating reciprocal responsiveness in mother-infant interactions. Thus, our findings could be explained by maternal compensatory behavior in which mothers provided more interaction to compensate

for the lack of interactive behaviors from a sick or at-risk infant (Holditch-Davis, Cox, et al., 2003; Singer et al., 1996). Another potential explanation is that mothers with severe emotional distress (e.g., chronically depressed) may have been receiving more family support and developed better adaptive skills to engage with their infants (Gross, Shaw, Burwell, & Nagin, 2009; Rutter, 1990.

Future researchers should replicate these procedures and should explore interventions for mothers with extreme distress to encourage more positive involvement and cognitive stimulation behaviors with their infants and determine whether these interactive behaviors result in better long-term maternal and infant outcomes. An alternative analytic approach would be to look at symptom-specific profiles (e.g., concentration difficulty, depressed mood, insomnia) instead of sum-score profiles (e.g., CESD total score). A symptom-specific approach may reveal which symptoms of extreme distress processes are related to functional impairment. Latent transition analysis, an extension of latent class analysis, also could be used to explore whether mothers in the extreme distress class are more responsive to social support and/or interventions, which would explain their parent-infant interactive responses in this study.

Psychological distress classes were related to infant development in expected ways at one year corrected age: infants of mothers in the extreme distress class showed lower cognitive and motor development than infants of mothers in the other distress classes. However, these differences were explained by infant neurological insults (NBRS total) rather than psychological distress class. In another study with mothers of preterm infants, depressive symptoms were correlated with lower child cognitive function at 16 months postpartum (McManus & Poehlmann, 2012). However, effect sizes were generally small, and not all studies have shown significant associations (Barker, Jaffee, Uher, & Maughan, 2011; Evans et al., 2012; Stein et al., 2014; Tse, Rich-Edwards, Rifas-Shiman, Gillman, & Oken, 2010). How and when maternal psychological distress affects offspring is not completely understood (Kingston, Tough, & Whitfield, 2012; Stein et al., 2014), and the associations between maternal distress and infant development may differ over time in infancy and childhood. Yet our findings of neurological insult as the persistent predictor of development are consistent with other studies showing that illness severity as measured by longer mechanical ventilation was related to poorer child development and less positive mother-infant interactions (Holditch-Davis et al., 2007; Vohr et al., 2003).

In this study, maternal education was not related to infant developmental outcomes, as has been found previously (Gordon, Lindsay Chase-Lansdale, & Brooks-Gunn, 2004; Holditch-Davis et al., 2007), although maternal education and study state (Illinois vs. North Carolina) were significant covariates of the relationship between psychological distress classes and mother-infant interactions and quality of the home environment. For example, mothers with higher education were more likely to engage in more developmental stimulation, more positive involvement and provide more stimulation in the home environment to promote infant development. However, these covariates seem to have greater effects at two months corrected age than at six months. In previous studies, maternal education has a strong effect on maternal competence (Feeley et al., 2005; Holditch-Davis, Miles, Burchinal, & Goldman,

2011); greater competence and maternal education were associated with higher quality caregiving (Holditch-Davis et al., 2011).

Explaining the effect of study site is complex, because site differences encompass the broader social context in which the families were embedded. However, the demographic heterogeneity of samples in the sites may be driving this finding, rather than the geographic location per se. Ethnic and socioeconomic status difference might be confounded by study site. The North Carolina site served populations that were diverse in socioeconomic status and location, whereas the Illinois site served inner-city and poor populations (Holditch-Davis et al., 2015). Inner-city poverty has been associated with increased psychological distress (Giurgescu et al., 2013; Holditch-Davis et al., 2015; Poehlmann, Schwichtenberg, Bolt, & Dilworth-Bart, 2009). Additional research is needed to determine how maternal psychological distress is related to ethnic group and geographic location.

Generalizability of this study has some limitations. First, mothers in this study participated in two maternally administered interventions for preterm infants (Holditch-Davis et al., 2014, 2015; White-Traut et al., 2012), although the interventions had no significant effect on maternal psychological distress or infant development (Holditch-Davis et al., 2015) and distress classes were defined using data collected before interventions began, and intervention group was included in the analysis to control for any possible confounding. Second, the relatively small group sizes in the high depressive and anxiety symptom class and in the extreme distress class may have limited our ability to identify further significant statistical interactions. Third, study site differences may have been confounded by external factors, although the multi-site design increased the potential generalizability of the findings. Fourth, we only followed the mothers until the infant was one year corrected age, and distress classes may have effects for more than two years after term (Holditch-Davis et al., 2009). Additional longitudinal research is needed to determine whether maternal psychological distress classes defined at early postpartum can be used to reliably predict mothers' responses to their infants, maternal provision of a stimulating home environment, and infant outcomes beyond one year.

This is the first analysis of the relationship between psychological distress classes and mother-infant interaction, quality of the home environment, and infant development in preterm infants over the first year after term. Further exploration of ways to predict maternal and infant outcomes related to mothers' psychological distress is needed.

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References

Barker ED, Jaffee SR, Uher R, Maughan B. The contribution of prenatal and postnatal maternal anxiety and depression to child maladjustment. Depression and Anxiety. 2011; 28:696–702. DOI: 10.1002/da.20856 [PubMed: 21769997]

Bayley, N. Bayley Scales of infant and toddler development. San Antonio, TX: The Psychological Association; 2003.

Beck CT. The effects of postpartum depression on maternal-infant interaction: a meta-analysis. Nursing Research. 1995; 44:298–304. [PubMed: 7567486]

Brazy JE, Goldstein RF, Oehler JM, Gustafson KE, Thompson RJ. Nursery neurobiologic risk score: levels of risk and relationships with nonmedical factors. Journal of Developmental & Behavioral Pediatrics. 1993; 14:375–380. [PubMed: 8126229]

Caldwell, B., Bradley, R. Home Observation for Measurement of the Environment. Little Rock, AR: University of Arkansas at Little Rock; 1980.

Cusson RM. Factors influencing language development in preterm infants. Journal of Obstetric, Gynecologic, & Neonatal Nursing. 2003; 32:402–409. DOI: 10.1177/0884217503253530

DeMier RL, Hynan MT, Harris HB, Manniello RL. Perinatal stressors as predictors of symptoms of posttraumatic stress in mothers of infants at high risk. Journal of Perinatology. 1996; 16:276–280. [PubMed: 8866297]

Evans J, Melotti R, Heron J, Ramchandani P, Wiles N, Murray L, Stein A. The timing of maternal depressive symptoms and child cognitive development: A longitudinal study. Journal of Child Psychology and Psychiatry. 2012; 53:632–640. DOI: 10.1111/j.1469-7610.2011.02513.x [PubMed: 22211468]

Feeley N, Gottlieb L, Zelkowitz P. Infant, mother, and contextual predictors of mother-very low birth weight infant interaction at 9 months of age. Journal of Developmental & Behavioral Pediatrics. 2005; 26:24–33. 0196-206X/00/2601-0024. [PubMed: 15718880]

Feldman R. Parent-infant synchrony and the construction of shared timing; physiological precursors, developmental outcomes, and risk conditions. Journal of Child Psychology and Psychiatry. 2007; 48:329–354. DOI: 10.1111/j.1469-7610.2006.01701.x [PubMed: 17355401]

Field T. Postpartum depression effects on early interactions, parenting, and safety practices: a review. Infant Behavior and Development. 2010; 33:1–6. DOI: 10.1016/j.infbeh.2009.10.005 [PubMed: 19962196]

Field T, Estroff DB, Yando R, del Valle C, Malphurs J, Hart S. “Depressed” mothers’ perceptions of infant vulnerability are related to later development. Child Psychiatry and Human Development. 1996; 27:43–53. [PubMed: 8810115]

Giurgescu C, Kavanaugh K, Norr KF, Dancy BL, Twigg N, McFarlin BL, … White-Traut RC. Stressors, resources, and stress responses in pregnant African American women: a mixed-methods pilot study. Journal of Perinatal and Neonatal Nursing. 2013; 27:81–96. DOI: 10.1097/JPN.0b013e31828363c3 [PubMed: 23360946]

Gordon RA, Lindsay Chase-Lansdale P, Brooks-Gunn J. Extended households and the life course of young mothers: understanding the associations using a sample of mothers with premature, low birth weight babies. Child Development. 2004; 75:1013–1038. DOI: 10.1111/j.1467-8624.2004.00723.x [PubMed: 15260862]

Grace SL, Evindar A, Stewart DE. The effect of postpartum depression on child cognitive development and behavior: a review and critical analysis of the literature. Archives of Women’s Mental Health. 2003; 6:263–274. DOI: 10.1007/s00737-003-0024-6

Gross HE, Shaw DS, Burwell RA, Nagin DS. Transactional processes in child disruptive behavior and maternal depression: A longitudinal study from early childhood to adolescence. Development and Psychopathology. 2009; 21:139–156. DOI: 10.1017/S0954579409000091 [PubMed: 19144227]

Harrison MJ. A comparison of parental interactions with term and preterm infants. Research in Nursing & Health. 1990; 13:173–179. [PubMed: 2343157]

Holditch-Davis D, Bartlett TR, Belyea M. Developmental problems and interactions between mothers and prematurely born children. Journal of Pediatric Nursing. 2000a; 15(3):157–167. DOI: 10.1053/jn.200.6021 [PubMed: 10897553]

Holditch-Davis D, Brandon DH, Schwartz T. Development of behaviors in preterm infants: Relation to sleeping and waking. Nursing Research. 2003; 52(5):307–317. [PubMed: 14501545]

Holditch-Davis D, Cox MF, Miles MS, Belyea M. Mother-infant interactions of medically fragile infants and non-chronically ill premature infants. Research in Nursing & Health. 2003; 26:300–311. DOI: 10.1002/nur.10095 [PubMed: 12884418]

Holditch-Davis D, Miles MS, Burchinal MR, Goldman BD. Maternal role attainment with medically fragile infants: Part 2. relationship to the quality of parenting. Research in Nursing & Health. 2011; 34:35–48. DOI: 10.1002/nur.20418 [PubMed: 21243657]

Holditch-Davis D, Miles M, Weaver M, Black B, Beeber L, Thoyre S, Engelke S. Patterns of distress in African-American mothers of preterm infants. Journal of Developmental and Behavioral Pediatrics. 2009; 30:193–205. DOI: 10.1097/DBP.0b013e3181a7ee53 [PubMed: 19412125]

Holditch-Davis D, Roberts D, Sandelowski M. Early parental interactions with and perceptions of multiple birth infants. Journal of Advanced Nursing. 1999; 30:200–210. DOI: 10.1046/j.1365-2648.1999.01065.x [PubMed: 10403997]

Holditch-Davis D, Santos H, Levy J, White-Traut R, O'Shea TM, Geraldo V, David R. Patterns of psychological distress in mothers of preterm infants. Infant Behavior and Development. 2015; 41:154–163. DOI: 10.1016/j.infbeh.2015.10.004 [PubMed: 26495909]

Holditch-Davis D, Schwartz T, Black B, Scher M. Correlates of mother-premature infant interactions. Research in Nursing & Health. 2007; 30:333–346. DOI: 10.1002/nur.20190 [PubMed: 17514707]

Holditch-Davis D, Tesh E, Goldman B, Miles M, D'Auria J. Use of the HOME Inventory with medically fragile infants. Childrens Health Care. 2000b; 29:257–278. DOI: 10.1207/S15326888CHC2904_3

Holditch-Davis D, White-Traut RC, Levy JA, O'Shea TM, Geraldo V, David RJ. Maternally administered interventions for preterm infants in the NICU: Effects on maternal psychological distress and mother-infant relationship. Infant Behavior & Development. 2014; 37:695–710. DOI: 10.1016/j.infbeh.2014.08.005 [PubMed: 25247740]

Kingston D, Tough S, Whitfield H. Prenatal and postpartum maternal psychological distress and infant development: a systematic review. Child Psychiatry & Human Development. 2012; 43:683–714. DOI: 10.1007/s10578-012-0291-4 [PubMed: 22407278]

Kong LP, Cui Y, Qiu YF, Han SP, Yu ZB, Guo XR. Anxiety and depression in parents of sick neonates: A hospital-based study. Journal of Clinical Nursing. 2013; 22:1163–1172. DOI: 10.1111/jocn.12090 [PubMed: 23480505]

Korja R, Savonlahti E, Ahlqvist-Björkroth S, Stolt S, Haataja L, Lapinleimu H. … PIPARI study group. Maternal depression is associated with mother-infant interaction in preterm infants. Acta Paediatrica. 2008; 97:724–730. DOI: 10.1111/j.1651-2227.2008.00733.x [PubMed: 18373715]

Lovejoy MC, Graczyk PA, O'Hare E, Neuman G. Maternal depression and parenting behavior: a meta-analytic review. Clinical Psychology Review. 2000; 20:561–592. DOI: 10.1016/S0272-7358(98)00100-7 [PubMed: 10860167]

McCabe K, Blucker R, Gillaspy JA, Cherry A, Mignogna M, Roddenberry A, … Gillaspy SR. Reliability of the postpartum depression screening scale in the neonatal intensive care unit. Nursing Research. 2012; 61:441–445. DOI: 10.1097/NNR.0b013e318268d06c [PubMed: 22960585]

McManus BM, Poehlmann J. Parent-child interaction, maternal depressive symptoms and preterm infant cognitive function. Infant Behavior & Development. 2012; 35:489–498. DOI: 10.1016/j.infbeh.2012.04.005 [PubMed: 22721747]

Miles MS, Funk SG, Carlson J. Parental stressor scale: neonatal intensive care unit. Nursing Research. 1993; 42:148–152. [PubMed: 8506163]

Miles MS, Holditch-Davis D, Schwartz TA, Scher M. Depressive symptoms in mothers of prematurely born infants. Journal of Developmental & Behavioral Pediatrics. 2007; 28:36–44. DOI: 10.1097/01.DBP.0000257517.52459.7a [PubMed: 17353730]

O'Hara MW, McCabe JE. Postpartum depression: current status and future directions. Annual Review of Clinical Psychology. 2013; 9:379–407. DOI: 10.1146/annurev-clinpsy-050212-185612

Poehlmann J, Schwichtenberg AJ, Bolt D, Dilworth-Bart J. Predictors of depressive symptom trajectories in mothers of preterm or low birth weight infants. Journal of Family Psychology. 2009; 23:690–704. DOI: 10.1037/a0016117 [PubMed: 19803605]

Radloff LS. The CES-D scale: A self-report depression scale for research in the general population. Applied Psychological Measurement. 1977; 1:385–401. DOI: 10.1177/014662167700100306

Rogers CE, Kidokoro H, Wallendorf M, Inder TE. Identifying mothers of very preterm infants at-risk for postpartum depression and anxiety before discharge. Journal of Perinatology. 2013; 33:171–176. DOI: 10.1038/jp.2012.75 [PubMed: 22678144]

Rutter M. Commentary: Some focus and process considerations regarding effects of parental depression on children. Developmental Psychology. 1990; 26:60–67. DOI: 10.1037/h0092669

Singer LT, Davillier M, Preuss L, Szekely L, Hawkins S, Yamashita T, Baley J. Feeding interactions in infants with very low birth weight and bronchopulmonary dysplasia. Journal of Developmental & Behavioral Pediatrics. 1996; 17:69–76. [PubMed: 8727839]

Singer LT, Fulton S, Kirchner HL, Eisengart S, Lewis B, Short E, … Baley JE. Parenting very low birth weight children at school age: maternal stress and coping. Journal of Pediatrics. 2007; 151:463–469. DOI: 10.1016/j.jpeds.2007.04.012 [PubMed: 17961686]

Singer LT, Salvator A, Guo S, Collin M, Lilien L, Baley J. Maternal psychological distress and parenting stress after the birth of a very low-birth-weight infant. JAMA. 1999; 281:799–805. [PubMed: 10071000]

Smith KE, Landry SH, Swank PR. The influence of early patterns of positive parenting on children's preschool outcomes. Early Education and Development. 2000; 11:147–169. DOI: 10.1207/s15566935eed1102_2

Spielberger, C. Manual for the State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists Press; 1983.

Stein A, Pearson RM, Goodman SH, Rapa E, Rahman A, McCallum M, … Pariante CM. Effects of perinatal mental disorders on the fetus and child. Lancet. 2014; 384(9956):1800–1819. DOI: 10.1016/S0140-6736(14)61277-0 [PubMed: 25455250]

Tesh EM, Holditch-Davis D. HOME inventory and NCATS: Relation to mother and child behaviors during naturalistic observations. Research in Nursing & Health. 1997; 20:295–307. DOI: 10.1002/(SICI)1098-240X(199708)20:4<295::AID-NUR3>3.0.CO;2-B [PubMed: 9256876]

Tse AC, Rich-Edwards JW, Rifas-Shiman SL, Gillman MW, Oken E. Association of maternal prenatal depressive symptoms with child cognition at age 3 years. Paediatric and Perinatal Epidemiology. 2010; 24:232–240. DOI: 10.1111/j.1365-3016.2010.01113.x [PubMed: 20415752]

Voegtline KM, Stifter CA, Vernon-Feagans L, Cox M, Blair C, Burchinal P, … Willoughby M. Late-preterm birth, maternal symptomatology, and infant negativity. Infant Behavior & Development. 2010; 33:545–554. DOI: 10.1016/j.infbeh.2010.07.006 [PubMed: 20732715]

Vohr BR, Allan WC, Westerveld M, Schneider KC, Katz KH, Makuch RW, Ment LR. School-age outcomes of very low birth weight infants in the indomethacin intraventricular hemorrhage prevention trial. Pediatrics. 2003; 111:e340–346. [PubMed: 12671149]

White-Traut R, Wink T, Minehart T, Holditch-Davis D. Frequency of premature infant engagement and disengagement behaviors during two maternally administered interventions. Newborn and Infant Nursing Reviews. 2012; 12:124–131. DOI: 10.1053/j.nainr.2012.06.005 [PubMed: 22984346]

Table 1

Scores of Three Distress Classes of Mothers of Preterm Infants on Five Psychological Distress Measures

	Low- Moderate Distress (*n* = 187)		High Depression/Anxiety (*n* = 20)		Extreme Distress (*n* = 25)	
	Mean	***(SD)***	**Mean**	***(SD)***	**Mean**	***(SD)***
Depressive Symptoms	12.4	(8.0)	31.8	(6.5)	36.6	(7.4)
State Anxiety	37.0	(10.8)	54.3	(6.2)	59.4	(10.2)
Post-Traumatic Stress	3.7	(2.8)	7.7	(1.8)	9.3	(1.9)
Infant Appearance Stress	35.3	(17.9)	30.4	(7.5)	63.0	(10.7)
Parental Role Stress	28.9	(12.8)	29.8	(9.0)	46.1	(4.9)

Note. SD, standard deviation.

Res Nurs Health. Author manuscript; available in PMC 2017 July 27.

Table 2

Characteristics of Mothers and Preterm Infants in Three Maternal Psychological Distress Classes

	Low- Moderate Distress (*n* = 187)		High Depression/Anxiety (*n* = 20)		Extreme Distress (*n* = 25)		
	n	***%***	***n***	***%***	***n***	***%***	***p***
Race: Non-Hispanic White	31	16.8	4	20.0	11	44.0	0.07
Non-Hispanic Black	131	71.2	15	75.0	13	52.0	
Hispanic	18	9.8	1	5.0	1	4.0	
Other	4	2.2	0	0.0	0	0.0	
Married	60	32.8	6	33.3	9	32.0	0.99
First-Time Mothers	98	55.4	8	42.1	16	66.7	0.27
Study Site: Illinois	91	80.5	12	70.6	7	50.0	0.03
North Carolina	22	19.5	5	29.4	7	50.0	
Study Intervention Group							
ATTV	62	33.7	5	25.0	8	32.0	0.62
KC	63	34.2	5	25.0	8	32.0	
Control	59	32.1	10	50.0	9	36.0	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	
Maternal Age	27.0	6.0	26.6	6.3	27.8	7.1	0.78
Maternal Education: Years	13.5	2.2	12.0	1.6	13.9	2.6	0.01
Neurological Insults[a]	3.7	3.6	3.7	3.8	7.6	4.8	< 0.01

Note. ATTV = auditory-tactile-visual-vestibular intervention; KC = kangaroo care.

[a]Neurobiologic Risk Scale NBRS (Brazy et al., 1993).

Table 3

Definitions and Internal Consistency of Mother-Infant Interactive Dimensions Identified in Videotaped Observations

Dimension	Component Behaviors[a]	Alpha
Positive Involvement	Mother Positive: The mother is directing positive affect towards the child, such as smiling, praising, or affectionate touching Mother Touch: The mother touches the infant, pats, caresses, or hits Uninvolved with Child[b]: The mother is not interacting with or looking at the child Play with Child: The mother engages in joint play with the infant HOME Subscale V	0.78
Developmental Stimulation	Mother Talk: The mother talks to the infant Mother Teach: The mother instructs the child, such as by naming an object or showing him or her how to perform any activity	0.69
Child Social	Child Positive: The infant is expressing positive affect, such as by smiling or hugging Child Look: The infant looks at the mother Child Gesture: The child makes a gesture, such as showing or taking a toy, shaking his head, or smiling	0.68
Developmental Maturity	Vocalize and Talk: The infant makes a non-fussy sound or say words Play with Objects: The child is playing with an object but not with a person Locomote and Walk: The baby changes his or her location, such as by belly creeping or scooting or walking	0.58 [c]
Child Irritability	Child Negative: The infant is fussing, crying, or grimacing Child Fuss as % of Together: The infant is fussing, crying, or grimacing while together with the mother, but not receiving a feeding, bath, or diaper change	0.91

Note. Dimension totals are means of Z-scores for the component behaviors.

[a] Behaviors scored as percentage of total recording time, except for variables with divisors in titles and Play with Objects, which was measured as percentage of time that child was not playing with the mother.

[b] Reverse-scored when combined with the other variables in the dimension.

[c] The lower alpha is explained by the limited developmental maturity behaviors of young babies.

Table 4

Bivariate Analysis of Differences by Distress Class in Maternal Dimensions of Mother-Infant Interaction and Home Environment at 2 and 6 Months and Infant Development at 12 Months Corrected Age

		Low- Moderate Distress(*n* = 187)	High Depression/Anxiety (*n* = 20)	Extreme Distress (*n* = 25)	*p* (ANOVA)
2 months	Positive involvement	2.27	−0.85	−0.07	0.01
	Developmental stimulation	0.96	−0.34	−0.35	< 0.01
	Home Environment	38.0	32.5	33.2	< 0.01
6 months	Positive involvement	1.80	−0.97	−0.35	0.11
	Developmental stimulation	1.70	−0.42	0.04	< 0.01
	Home Environment	38.94	34.64	36.34	0.05
12 months	Cognitive development	87.65	100.00	98.23	0.03
	Motor development	76.82	89.33	91.18	< 0.01
	Language development	88.12	87.33	90.85	0.58

Res Nurs Health. Author manuscript; available in PMC 2017 July 27.

Table 5

Comparison of Mothers in Psychological Distress Classes on Positive Involvement, Developmental Stimulation, and Home Environment at 2 and 6 Months and Infant Development at 12 Months Corrected Age

		Bivariate Model (ANOVA)				Initial GLM Model[a]				Final GLM Model[b]			
		Extreme Distress	High Dep/Anx	Low- Mod	*p*	Extreme v. Low-Mod		High Depr/Anx v. Low- Mod		Extreme v. Low-Mod		High Depr/Anx v. Low- Mod	
						Beta	*p*	Beta	*p*	Beta	*p*	Beta	*p*
2 months	Positive involvement	2.27	−0.85	−0.07	.10	1.59	.17	−0.27	.82	1.48	.21	0.31	.79
	Developmental stimulation	0.96	−0.34	−0.35	.003	0.99	.009	0.24	.53	0.93	.02	0.36	.35
	Home Environment	38.0	32.5	33.2	.003	2.98	.01	0.11	.93	2.52	.03	1.53	.17
6 months	Positive involvement	1.80	−0.97	−0.35	.11	2.22	.05	−0.69	.55	1.86	.12	−0.27	.81
	Developmental stimulation	1.70	−0.42	0.04	.001	1.38	.004	−0.23	.63	1.41	.04	−0.12	.80
	Home Environment	38.94	34.64	36.34	.05	1.59	.21	−0.82	.54	1.92	.12	−0.03	.97
12 months	Cognitive development	87.65	100.00	98.23	.03	−10.28	.01	0.58	.90	−3.01	.45	1.47	.74
	Motor development	76.82	89.33	91.18	.006	−15.12	.001	−2.84	.58	−6.36	.09	−0.61	.88
	Language development	88.12	87.33	90.85	.58	−4.53	.22	−2.19	.61	0.33	.92	−1.80	.64

Note. Depr/Anxiety = depressive and anxiety symptoms class; Lo- Mod Distress = low to moderate distress class. The low to moderate distress class was used as reference group. Control group was used as reference group for parent study interventions.

[a]Initial model included psychological distress classes, first-time mother, study setting, and parent study treatments.

[b]The full model added education and neurological insult.

Table 6

Comparison of Maternal Psychological Distress Classes on Mother-Infant Interactive Dimensions and Home Environment at 2 and 6 Months Corrected Age

	Positive Involvement at 2 Months						**Positive Involvement at 6 Months**					
	Initial Model			**Final Model**			**Initial Model**			**Final Model**		
Variable	**Beta**	***SE***	t_{162}	**Beta**	***SE***	t_{156}	**Beta**	***SE***	t_{140}	**Beta**	***SE***	t_{136}
Intercept	0.36	0.84	0.44	−7.31	2.47	−2.96**	−1.24	0.96	−1.30	−6.41	2.8	−2.29*
Extreme Distress	1.59	1.16	1.38	1.48	1.18	1.25	2.22	1.13	1.96*	1.86	1.19	1.56
High Depr/Anx	−0.27	1.21	−0.23	0.31	1.18	0.27	−0.69	1.18	−0.59	−0.28	1.19	−0.23
First Time Mother	1.44	0.69	2.07*	0.66	0.70	0.93	1.28	0.72	1.78	0.90	0.73	1.23
Study Site	−2.86	0.69	−4.10**	−2.03	0.72	−2.80**	0.08	0.73	0.12	0.65	0.82	0.79
Treatment ATTV	0.15	0.86	0.18	0.04	0.84	0.05	0.50	0.88	0.57	0.52	0.88	0.59
Treatment KC	0.45	0.83	0.55	0.67	0.80	0.83	−0.23	0.84	−0.28	−0.04	0.86	−0.06
Education	--	--	--	0.58	0.17	3.47**	--		--	0.37	0.18	2.07*
Neurological Insults	--	--	--	−0.03	0.09	−0.32	--		--	−0.01	0.10	−0.16
	Developmental Stimulation at 2 Months						Developmental Stimulation at 6 Months					
	Initial Model			Final Model			Initial Model			Final Model		
Variable	Beta	*SE*	t_{154}	Beta	*SE*	t_{148}	Beta	*SE*	t_{134}	Beta	*SE*	t_{130}
Intercept	−0.08	0.27	−0.30	−1.74	0.84	−2.06	0.13	0.39	0.35	−1.89	1.18	−1.60
Extreme Distress	0.99	0.37	2.64**	0.93	0.40	2.32*	1.38	0.47	2.91**	1.41	0.49	2.83*
High Depr/Anx	0.24	0.39	0.62	0.36	0.40	0.92	−0.23	0.48	−0.48	−0.12	0.48	−0.25
First Time Mother	0.47	0.23	2.03*	0.26	0.24	1.09	0.66	0.30	2.21*	0.58	0.30	1.92
Study Site	−1.05	0.23	−4.52**	−0.91	0.25	−3.65**	−0.89	0.30	−2.91**	−0.59	0.34	−1.75
Treatment ATTV	0.07	0.28	0.27	0.10	0.29	0.36	0.17	0.36	0.46	0.19	0.36	0.60
Treatment KC	0.09	0.27	0.34	0.12	0.27	0.44	0.01	0.34	0.01	0.15	0.36	0.44
Education	--	--	--	0.12	0.05	2.24*	--	--	--	0.13	0.07	1.75
Neurological Insult	--	--	--	−0.01	0.03	−0.18	--	--	--	0.01	0.04	0.23

	Positive Involvement at 2 Months						Positive Involvement at 6 Months					
	Initial Model			Final Model			Initial Model			Final Model		
Variable	**Beta**	***SE***	t_{162}	**Beta**	***SE***	t_{156}	**Beta**	***SE***	t_{140}	**Beta**	***SE***	t_{136}
	Quality of Home Environment at 2 Months						Quality of Home Environment at 6 Months					
	Initial Model			Final Model			Initial Model			Final Model		
Variable	Beta	*SE*	t_{147}	Beta	*SE*	t_{142}	Beta	*SE*	t_{132}	Beta	*SE*	t_{128}
Intercept	34.10	0.96	35.45**	18.74	2.45	7.65**	37.44	1.12	33.42**	23.52	3.09	7.59**
Extreme Distress	2.98	1.23	2.42**	2.52	1.16	2.17*	1.59	1.27	1.25	1.92	1.26	1.53
High Depr/Anx	0.10	1.25	0.08	1.53	1.12	1.37	−0.82	1.37	−0.60	−0.03	1.28	−0.03
First-Time Mother	2.83	0.75	3.77**	1.61	0.68	2.35*	1.68	0.82	2.04*	1.11	0.78	1.43
Study Site	−5.32	0.76	−6.96**	−3.89	0.72	−5.37**	−3.77	0.85	−4.40**	−1.86	0.89	−2.08*
Treatment ATTV	0.70	0.94	0.75	0.62	0.84	0.75	0.81	1.0	0.80	0.89	0.94	0.95
Treatment KC	1.52	0.89	1.70	1.75	0.79	2.20	−0.28	0.97	−0.30	0.74	0.93	0.79
Education	--	--	--	1.14	0.16	6.89**	--	--	--	0.96	0.19	4.87**
Neurological Insult	--	--	--	−0.06	0.09	−0.70	--	--	--	−0.09	0.11	−0.80

Note. The low to moderate distress class was used as reference group for the maternal psychological distress classes. Intervention control group was used as reference group for parent study interventions. *SE*=standard error; Depr/Anxiety = depressive and anxiety symptoms; ATTV = auditory-tactile-visual-vestibular intervention; KC = kangaroo care.

* $p < 0.05$

** $p < 0.01$

Table 7

Role of Maternal Distress Classes and Other Variables in Infant Development at 12 Months Corrected Age

	Cognitive Development					
	Initial Model			**Final Model**		
Variable	**Beta**	***SE***	t_{148}	**Beta**	***SE***	t_{143}
Intercept	94.41	3.22	29.31**	104.65	8.82	11.85**
Extreme Distress	−10.28	4.27	−2.40*	−3.01	4.06	−0.74
High Depr/Anx	0.58	4.97	0.12	1.47	4.48	0.33
First-Time Mother	4.56	2.69	1.70	3.01	2.50	1.20
Study Site	4.41	2.72	1.62	2.73	2.64	1.03
Treatment ATTV	−0.66	3.27	−0.20	−0.12	2.95	−0.04
Treatment KC	−0.77	3.19	−0.24	−0.28	2.91	−0.10
Education	--	--	--	−0.19	0.58	−0.22
Neurological Insult	--	--	--	−2.02	0.33	−5.96**
	Motor Development					
	Initial Model			Final Model		
Variable	Beta	*SE*	t_{148}	Beta	*SE*	t_{143}
Intercept	87.79	3.4	25.75**	100.75	8.37	12.03**
Extreme Distress	−15.12	4.53	−3.34**	−6.36	3.83	12.03
High Depr/Anx	−2.84	5.26	−0.54	−0.61	4.22	−0.15
First-Time Mother	6.82	2.85	2.39*	4.53	2.36	1.92
Study Site	2.61	2.89	0.90	−0.73	2.49	−0.29
Treatment ATTV	−2.79	3.48	−0.80	−1.46	2.79	−0.53
Treatment KC	−0.82	3.38	−0.24	−0.90	2.74	−0.33
Education	--	--	--	−0.01	0.55	−0.01
Neurological Insult	--	--	--	−3.04	0.32	−9.51**
Variable	Language Development					

	Cognitive Development					
	Initial Model			**Final Model**		
Variable	**Beta**	***SE***	t_{148}	**Beta**	***SE***	t_{143}
	Initial Model			Final Model		
	Beta	*SE*	t_{146}	Beta	*SE*	t_{141}
Intercept	92.95	2.83	32.81**	106.23	7.82	13.58**
Extreme Distress	−4.53	3.76	−1.21	0.35	3.59	0.10
High Depr/Anx	−2.19	4.37	0.50	−1.80	3.97	−0.45
First-Time Mother	3.75	2.38	1.58	2.51	2.22	1.13
Study Site	−6.21	2.41	−2.57*	−8.20	2.35	−3.48**
Treatment ATTV	−0.87	2.91	−0.30	−0.50	2.64	−0.19
Treatment KC	−2.35	2.81	−0.84	−1.90	2.57	−0.74
Education	--	--	--	−0.43	0.51	−0.85
Neurological Insult	--	--	--	−1.66	0.30	−5.49**

Note. The low to moderate distress class was used as reference group for the maternal psychological distress classes. Intervention control group was used as reference group for parent study interventions. *SE*= standard error; Depr/Anxiety = depressive and anxiety symptoms; ATTV = auditory-tactile-visual-vestibular intervention; KC = kangaroo care.

* $p < 0.05$

** $p < 0.01$