Data Supplement for Meaney, Perinatal Maternal Depressive Symptoms as an Issue for Population Health. Am J Psychiatry (doi: 10.1176/appi.ajp.2018.17091031)

Annotated Bibliography: Maternal Depressive Symptoms and Child Developmental Outcomes

Search terms: child; child development; depression; development; maternal; maternal depression

Source: Ovid Medline 1996-present

The papers described below examined associations between maternal symptoms of depression, analyzed as a continuous variable across the sample or as graded effects, such as multi-level symptom trajectories, and child neurodevelopmental outcomes.

Davies PT, Windle M: Gender specific pathways between maternal depressive symptoms, family discord, and adolescent adjustment. Devel Psychol 1997; 33:657–668.
Maternal depressive symptoms, family discord, and adolescent psychological adjustment were examined in longitudinal study (n= 443) mothers and adolescent offspring. Maternal depressive symptoms were assessed (CES-D) at 3 time points and analyzed as a continuous measure in regression models. Maternal depressive symptoms were associated with reported stressful life events for offspring, marital discord, low family intimacy and parenting impairments. Maternal depressive symptoms were significantly associated with adolescent reports of depressive symptoms, conduct problems, and academic difficulties for girls, but not for boys. Mediational analyses revealed that family discord accounted for the influence of maternal depressive symptoms on social and emotional adjustment in girls.

Early Child Care Research Network (1999). Chronicity of maternal depressive symptoms, maternal sensitivity, and child functioning at 36 months. Devel Psychol 1999; 35: 1297–1310.
Women (N = 1,215) and infants were followed from birth with maternal reports of depressive symptoms (CES-D) obtained at multiple postnatal time points. 1,6, 15, 24, and 36 months. Mothers were classified as never (Mean CES-D = 5.2), sometimes (Mean CES-D = 12.8) or chronically (Mean CES-D = 24.8) reporting symptoms of depression. There was a graded effect of maternal depressive symptoms on maternal sensitivity that was moderated by socio-economic status (Figure 2). There were graded effects of maternal depressive symptoms on school readiness and cognitive skills associated with academic achievement. These effects were mediated or moderated by maternal sensitivity.

Sugawara M, Kitamura T, Toda MA, Shima S: Longitudinal relationship between maternal depression and infant temperament in a Japanese population. J Clin Psychol 1999; 55: 869–880.
The study reports associations between maternal symptoms of depression, assessed using the Zung Self-Rating Depression Scale (SDS) and infant temperament assessed at 6 and 18 months postnatal with maternal ratings using the Revised Infant Temperament Questionnaire (RITQ) and the Japanese version of the Toddler Temperament Scale (TTS) in a prospective study of maternal depression in pregnancy and the postpartum period in women (n= 1329) attending an antenatal clinic in Kawasaki, Japan. SDS scores (number and severity of symptoms) were associated with multiple temperament outcomes.

Brennan PA, Hammen C, Andersen MJ, Bor W, Najman JM, Williams GM. Chronicity, severity, and timing of maternal depressive symptoms: Relationships with child outcomes at age5. Devel Psychol 2000; 36: 759-766.
The relationships between severity and chronicity of maternal depressive symptoms and child outcomes were examined in an Australian cohort of mothers – child dyads (n= 4953). Mothers provided self-reports of depressive symptoms on the seven depression items of the Delusions-Symptoms-States Inventory during pregnancy, immediately postpartum, and at 6 months and 5 years. Severity of depressive symptoms was established a continuous measure that reflected the maximum number of depressive symptoms (0 to 7). Mothers reported on behavior using the Child Behavior Checklist and children completed a receptive vocabulary test at 5 years of age. The severity of maternal depressive symptoms was significantly associated with both child behavioral problem scores and their receptive vocabulary scores, such that an increasing number of depressive symptoms was associated with increasingly negative outcomes. The interaction of severity and chronicity of maternal depressive symptoms was significantly related to higher levels of child behavior problems.

Brennan PA, Hammen C: Severity, chronicity and timing of maternal depression and risk for adolescent offspring diagnosis in a community sample. Arch Gen Psychiatry 2003; 60:253-258.
A follow-up study of Brennan et al 2000 with mothers (n= 816) from the same Australian study with self-reports of depressive symptoms on the seven depression items of the Delusions-Symptoms-States Inventory and clinical diagnosis (Structured Clinical Interview for DSM-IV; SCID) to ascertain lifetime or current depressive symptoms and severity (severe, moderate, mild/subsyndromal). The presence of psychopathology in the offspring was determined using the Schedule for Affective Disorders and Schizophrenia for School-Aged Children – Revised for DSM IV; K-SADS-E). The results showed that severe to moderate depression for 1-2 months prior or mild, subsyndomral depression for 12 months or longer significantly increased the risk for depression in the offspring.

Cummings EM, Keller PS, Davies PT. Towards a family process model of maternal and paternal depressive symptoms: exploring multiple relations with child and family functioning. J Child Psychol & Psychiatr 2005; 46:479–489.
A community sample of 235 families in which the Centers for Epidemiologic Studies Depression Scale (CES-D) was used as a self-report measure of depressive symptomatology in mothers and fathers. Mean scores were 8.38 (SD= 7.57) for men and 8.97 (SD= 7.97) 13.7% of men and

16.7% of women scoring above the clinical cut-off of 16 or above, generally consistent with the distribution of depressive symptoms across the population. Mothers, fathers, and teachers completed the Child Behavior Checklist to assess children's emotional and behavioral problems as well as the Asocial, Prosocial and Peer Exclusion Scales of the Child Behavior Scale. The results were analyzed using parental depressive symptoms as a continuous variable and showed that maternal and paternal depressive symptoms were significantly associated with poor child adjustment, including internalizing problems, externalizing problems, exclusion by peers, and prosocial behavior (paternal dysphoria only). Parental depressive symptoms were also related to marital conflict, marital attachment, parental warmth, and psychological control in parenting.

Campbell SB, Matestic P, von Stauffenberg V, Mohan R, Kirchner T: Trajectories of Maternal Depressive Symptoms, Maternal Sensitivity, and Children's Functioning at School Entry. Devel Psychol 2007; 43: 1202–1215.

Mothers and children (n= 1261) from the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development, with mothers completing the CES-D (cut-off = 16) at 7 time points between 1 and 84 months post-partum. The authors modeled trajectories of maternal depressive symptoms and identified 6 trajectories: high–chronic (2.5%; CES-D scores stably >28.1 over the entire period), moderate–increasing (6.2%; CES-D scores rising from 15.0 to 26.5), high– decreasing (5.6%; CES-D scores gradually falling from 25.9 at 1 month to 13.1, intermittent depression (3.6%; with highly variable CES-D scores ranging from 8.4 to 29.6), moderate–stable (36.4%%; CES-D= 12.5 at 1 month decreasing to 9.2 by 84 months), and low–stable (45.6%; CES-D= 6.0 at 1 month decreasing to 4.2 by 6 months). Child outcomes were assess using 1) maternal reports using the Child Behavior Checklist (CBCL); 2) first-grade teacher reports using a Teacher Report Form; 3) maternal and teacher reports with the Social Skills Rating System; 4) observations of child behavior in school in their first-grade classrooms by trained observers to rate children's self-reliance and positive affect; 5) the Woodcock–Johnson Psycho-Educational Battery-Revised as an assessment of cognitive aptitude and achievement in first grade. There were significantly fewer maternally-reported internalizing and externalizing problems in child of mothers in the Low-Stable group compared to all other groups. Scores in the Moderate-Stable group were, in turn, lower than High groups, reflecting a graded effect of depressive symptoms. The same pattern was observed for reports of social skills. Cognitive achievement was significantly better in the children of Low-Stable and Moderate-Stable groups.

Campbell SB, Morgan-Lopez AA, Cox MJ, McLoyd VC: A latent class analysis of maternal depressive symptoms over 12 years and offspring adjustment in adolescence. J Abnormal Psychol 2009; 118; 479–493.

A further analysis (see Campbell et al., 2007) of data from the NICHD Study of Early Child Care and Youth Development using latent class analysis to model patterns of maternal depressive symptoms from infant age 1 month to the transition to adolescence (age 12) in relation to adolescent adjustment at age 15. Maternal reports of depression were obtained using the Center for Epidemiological Studies Depression Scale (CES-D; cut-off = 16) when children were 1, 6, 15, 24, 36, and 54 months and at each assessment from first through sixth grade (i.e., at ages 7 through 12), for a total of 10 assessments. The authors identified five latent classes of symptoms in women (n= 1357) while also taking into account sociodemographic measures: Non-Depressed

(48.5%; %; CES-D scores = 7 to 5 at later time points); stable subclinical (30.8%; CES-D scores = 12.5 to 9.5); early-decreasing (5.1%; CES-D scores = 24.1 to 9.8); moderately elevated (10.9%; CES-D scores = 13.0 to 20.0); chronic (4.7%; CES-D scores = 23.3 to 29.3). Outcome measures were derived from adolescent self-reports obtained at the age 15 laboratory visit and included: 1) the Children's Depression Inventory; 2) a Loneliness and Social Dissatisfaction Questionnaire; 3) the Youth Self-Report Form; and 4; a self-report on risky behaviors. Adolescents with mothers in the chronic depression class and the stable subclinical class reported significantly higher levels of depressive symptoms at age 15 than did children of never-depressed mothers. The difference between the offspring of the stable subclinical and never depressed mothers was stronger in girls than boys. Likewise, children of mothers in the elevated class and the stable subclinical class reported significantly higher levels of loneliness at age 15 than did children of never-depressed mothers. Compared to adolescents of mothers in the non-depressed class, adolescents with mothers in the elevated depression, the chronic depression and the stable subclinical classes reported higher internalizing and externalizing symptoms and engaged in more risk behavior at age 15.

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. Devel & Psychopathol 2009; 21: 139–156.

The sample was comprised of mothers and male offspring (n= 289) from predominantly low-income families enrolled in the Allegheny County Women, Infants and Children program (Pittsburgh PA) Metropolitan area studied repeatedly between 1.5 and 12 years, with teacher reports (Teacher Report Form; TRF) of externalizing and internalizing symptoms between 10 and 13 years as well as offspring self-reports using the Youth Self-Report questionnaire and completing the Self-Reported Delinquency (SRD) questionnaire at ages 11 and 12. Trajectories of depressive symptoms among mothers were modelled from ages 1.5 to 10 years, yielding 4 groups based on Beck Depression Inventory scores (score of 17-20 = borderline clinical depression) at 8 time points from 1.5 to 10 years post-partum: Group 1 (Low; 25.2%; mean BDI = 2.0); Group 2 (moderate low; 45.7%; mean BDI = 6.3); Group 3 (Moderate High; 21.8%; mean BDI = 11.8); Group 4 (High Chronic; 7.3%; mean BDI = 20.6). Offspring-reported delinquency in the moderate high group, where scores associated with a mild mood disturbance, was significantly higher than in the low and moderate low groups. Likewise, teachers rated significantly higher externalizing, but not internalizing, symptoms boys of mothers in the moderate high group than boys of mothers in the low and moderate low groups. The externalizing scores among boys in the moderate high group were similar to the mean of a sample of "clinic-referred boys" reflecting the strength of the outcome.

Gump BB, Reihman J, Stewart P, et al: Trajectories of maternal depressive symptoms over her child's life span: Relation to adrenocortical, cardiovascular, and emotional functioning in children. Devel & Psychopathol 2009; 21: 207–225.

Maternal depressive symptoms were assessed in a community sample using the Center for Epidemiological Studies Depression Scale; CES-D) at 3 months, 6 months, 1 year, 2 years, 4.25 years, 6 years, 7 years, 8 years, and 10 post-partum. Mean CES-D scores ranged from 8.7 to 10.5 with 17.5% showing scores above the clinical CES-D cut-off (16) consistent with findings from normal US populations. At 9.5 years of age, children's (n= 176) depressive symptoms as well as basal and stress-induced cardiovascular and cortisol levels were measured. The authors used

multilevel modeling that analyzed maternal depressive symptom trajectories in relation to adrenocortical and cardiovascular responses to acute stress in the offspring. The analyses defined maternal depressive symptom trajectories for children with elevated cardiovascular and cortisol reactivity to acute stress and elevated depressive symptoms. Children of mothers with chronically elevated depressive symptoms (i.e, CES-D scores between 10 and 11, but well below the cut-off) associated with lower initial cortisol, greater stress-induced cardiac output and stroke volume as well as lower vascular resistance and significantly more depressive symptoms in the offspring at 9.5 years of age.

Gartstein MA, Bridgett DJ, Rothbart MK, et al: A latent growth examination of fear development in infancy: Contributions of maternal depression and the risk for toddler anxiety. Devel Psychol 2010; 46: 651–668.

A community-based US study of mother-infant pairs. In study 1 (n= 158) the Beck Depression Inventory was used to assess symptoms of maternal depression when infants were 4-months of age together with repeated assessments of fear using the Infant Behavior Questionnaire—Revised (IBQ-R), a parent-report measure of infant temperament, at 4, 6, 8, 10, and 12 months and latent growth curve analysis defined developmental trajectories in fearfulness. Maternal BDI scores (M= 8.8; SD= 7.1) reveal that the majority of subjects fell well below the clinical range for depressive conditions. Maternal depressive symptoms, but not maternal fear, accounted for significant variance in changes in infant fearfulness from 4 to 12 months of age: higher maternal depressive symptoms when infants were 4 months of age predicted steeper increases in infant fearfulness. Maternal depressive symptoms did not account for initial levels of infant fearfulness at 4 months of age. Study 2 with mother-infant pairs (n= 134) replicated these findings using depressive symptom scores from the Parental Stress Inventory and a laboratory-based (Lab-TAB) measure (Scary Masks) of infant fear. The authors conclude that more frequent and severe symptoms of maternal depression, even at largely subclinical levels, contribute significantly to increases in infant fear over the course of infant development.

Goodman SH, Rouse MH, Long Q, ji S, Brand SR: Deconstructing antenatal depression: what is it that matters for neonatal behavioral functioning? Infant Ment Htlh J 2011; 32:339–361.

This prospective study examined the variability within clinical characteristics of antenatal maternal depression for associations with newborn infant behavior using the Neonatal Behavioral Assessment Scale (NBAS). Participants (n= 81) were 81 pregnant women at risk for perinatal depression. Assessment of depression symptoms was performed using the Beck Depression Inventory-II with added clinical assessment using the SCID for DSM-IV to determine the presence of a major depressive episode. There were no differences in development scales between infants whose mothers met diagnostic criteria for major depression and those who had clinically significant levels of depression symptom severity but failed to meet diagnostic criteria, compared with a no depression group. A higher overall level of depression symptoms over the course of pregnancy was a significant predictor of a wide range of poorer newborn functioning. The authors conclude that the most significant and consistent role in predicting NBAS scores was played by dose, or the overall severity of symptom level over the course of pregnancy.

Barker ED, Jaffee SR, Uher R, Maughan B: The contribution of prenatal and postnatal maternal anxiety and depression to child maladjustment. Dep & Anx 2011; 28: 696–702.
The authors examined 3,298 mother–offspring pairs drawn from the Avon Longitudinal Study of Parents and Children (ALSPAC), a population-based study designed to investigate the effects of a wide range of influences on the health and development of children. Symptoms of depression and anxiety were assessed at multiple pre- and post-natal time points using the Edinburgh Postnatal Depression Scale and the Crown Crisp index, respectively, and analyzed as continuous variables. Maternal symptoms of depression and anxiety were highly correlated at both pre- and post-natal time points. DSM-IV psychiatric child disorders were assessed at ages 7–8 years using the Development and Well-Being Assessment. The results revealed that pre- and post-natal maternal symptoms of depression revealed more general associations with child functioning than did prenatal maternal anxiety, with an increase in child externalizing difficulties and a small decrease in verbal IQ. Maternal pre- and post-natal symptoms of anxiety were associated only with child internalizing difficulties, although with a greater effect size.

Lupien SJ, Parent S, Evans AC, et al: Larger amygdala but no change in hippocampal volume in 10-year-old children exposed to maternal depressive symptomatology since birth. Proc Natl Acad Sci USA 2011; 108: 14324–14329.
Mothers participating in the Quebec Longitudinal Study of Child Development were assessed for maternal depressive symptoms using a shortened version of the CES-D at 5, 17, 30, 42, 60, 84, and 156 months post-partum. Children from the longitudinal sample who were (n=17) or were not (n= 21) continuously exposed to symptoms of maternal depression since birth were scanned using magnetic resonance imaging at 10 years of age. There were significantly larger left and right amygdala volumes in children of mothers with high levels of depressive symptoms (comparable to mild depression) compared with controls. The authors then used maternal depressive symptoms as continuous variable and report a significant positive association between the mean depression score of the mother over the first 7 y ears post-partum mean amygdala volume (Fig. 3) in the offspring.

Sharp H, Pickles A, Meaney MJ, Marshall K, Tibu F, Hill J: Frequency of infant stroking reported by mothers moderates the effect of prenatal depression on infant behavioural and physiological outcomes. PLOS ONE 2012; 7: e4544.
A sample (n= 271) was selected from mothers and infants participating in the Wirral Child Health & Development Study stratified on the basis of reported inter-partner psychological abuse (high vs Low) with assessments at 5, 9 and 29 weeks post-partum. Maternal depressive symptoms were assessed using the Edinburgh Postnatal Depression Scale (low vs high abuse strata were 6.7 ± 4.0 vs 9.9 ± 4.8) with values comparable to a normal population. Mothers reported how often they stroked their babies at 5 and 9 weeks. At 29-weeks vagal tone to a stressor (physiological adaptability) and maternal-reported negative emotionality were assessed. There was a significant interaction between prenatal depression (examined as a continuous variable; see Figs 1 and 2) and maternal stroking in the prediction of vagal reactivity to a stressor ($p = .01$), and maternal reports of infant anger proneness ($p = .007$) and fear ($p = .043$). Increasing maternal depression was associated with decreasing physiological adaptability, and with increasing negative emotionality, only amount mothers who reported low infant stroking. The results are consistent with reports showing that the influence of maternal depressive symptoms across the population are mediated by effects on parental care.

Barker ED, Kirkham N, Ng J, Jensen SKG. Prenatal maternal depression symptoms and nutrition, and child cognitive function. Br J Psychiatry 2013; 203: 417–421.
Maternal symptoms of depression were assessed (at 32 weeks of gestation and at 8 weeks, 8 months, 21 months and 33 months post-partum) using the Edinburgh Postnatal Depression Scale (EPDS). The model included latent depressive symptom scores created for the pre-and post-natal periods, with higher values indicating a greater number of depressive symptoms.
Analysis of the data from mother–offspring pairs (n= 6979) participating in the Avon Longitudinal Study of Parents and Children (ALSPAC) in the UK revealed that higher prenatal depressive symptoms were related to lower levels of healthy nutrition and higher levels of unhealthy nutrition, each of which in turn was prospectively associated with reduced cognitive function assessed using the performance and verbal IQ assessments of the Wechsler Intelligence Scale for Children (WISC-III).

Cents RAM, Diamantopoulou S, Hudziak JJ et al: Trajectories of maternal depressive symptoms predict child problem behaviour: The Generation R Study. Psychol Med 2013; 43: 13-25.
Mother–child dyads (n=4167) participated in the population-based, prospective Generation Rotterdam cohort study. Maternal depressive symptoms were assessed with the Brief Symptom Inventory during pregnancy and at 2, 6 and 36 months postpartum. Childhood behavioral problems were assessed with the Child Behaviour Checklist completed by both parents. Trajectories of maternal depressive symptoms were derived and revealed four trajectories: 'no symptoms' (34 %), 'low symptoms' (54 %), 'moderate symptoms' (11%) and 'high symptoms' (1.5 %). Child problem behaviour varied as a function of maternal symptom trajectory with a graded association with both internalizing and externalizing behavioral problems (see Table 3), with significant differences between even the 'No' vs 'Low' symptom groups. Trajectories of maternal depressive symptoms accounted for 33% of the explained variance in measures of childhood problems.

Herba CM, Tremblay RE, Boivin M, et al: Maternal Depressive Symptoms and Children's Emotional Problems: Can Early Child Care Help Children of Depressed Mothers? JAMA Psychiatry 2013; 70:830-838.
Participants were enrolled in the Québec Longitudinal Study of Child Development, a representative sample of 2120 infants (Québec, Canada) and followed yearly at ages 5, 17, 30, 42, 54, and 60 months. Québec Longitudinal Study of Child Development participants (n = 1759) assessed repeatedly between ages 5 and 60 months. High-level trajectories of socio-emotional problems between ages 17 and 60 months. Maternal depressive symptoms were assessed at 5, 17, 42, and 60 months using the Center for Epidemiologic Studies Depression Scale. Child care type moderated the association between maternal depressive symptoms and child socio-emotional problems; children of mothers with elevated symptoms levels who received group-based child care had lower odds ratios for socio-emotional problems than those who remained in maternal care or those who were cared for by a relative or babysitter.

Skotheim S, Braarud HC, Høie K, et al: Subclinical levels of maternal depression and infantsensitivity to social contingency. Infant Behav & Devel 2013; 36: 419– 426.
The authors report an analysis of three-month-olds (n= 39) interacting with a mother who was assessed using the Edinburgh Postnatal Depression Scale (EPDS) and categorized as either non-

depressed (mean symptoms = 3.3) or sub-clinically depressed (mean symptoms = 8.3). Infants of sub-clinically depressed mothers showed a high gaze focus at their mother independently of whether the interaction with the mother was contingent or not, while infants of non-depressed mothers showed a preference for looking at their mother only when the interaction was contingent. Infants of the sub-clinically depressed mothers showed no differentiation in affective expression between the contingent and non-contingent interactions; infants of non-depressed mothers expressed more positive than negative affect when the interaction with the mother was contingent. There was a significant relation between the infant preference for looking at their mother and the amount of positive affect in the contingent interactions, but this was only in the infants of the non-depressed mothers.

Van Batenburg-Eddes T, Brion, MJ, Henrichs J: Parental depressive and anxiety symptoms during pregnancy and attention problems in children: a crosscohort consistency study. J Child Psychol Psychiatry 2013; 54: 591–600.

The analyses of associations between perinatal, parental symptoms of depression or anxiety with child cognitive-emotional problems (CBCL) was performed in two longitudinal cohort studies (Generation Rotterdam, n = 2,280 and Avon Longitudinal Study of Parents and Children, ALSPAC; n = 3,442). Symptoms of depression and anxiety. Generation R: Symptoms of parental depression and anxiety were assessed with the Brief Symptom Inventory in Gen R and the EPDS (depression) and Crown-Crisp index (anxiety) in ALSPAC. Regressions were used to assess the association between parental symptoms of depression or anxiety and child problems using symptom levels as continuous variables. Child problems were measured in Gen R at age 3 with the Child Behavior Checklist, and in ALSPAC at age 4 with the Strengths and Difficulties Questionnaire. Maternal and, to a lesser extent, paternal symptoms of depression and maternal symptoms of anxiety were associated with attentional and emotional problems across the cohorts.

Pina-Camacho L, Jensen SK, Gaysina D, Barker ED: Maternal depression symptoms, unhealthy diet and child emotional–behavioural dysregulation. Psychol Med 2015; 45: 1851–1860.

The authors used path analysis to examine the associations of maternal depression symptoms and unhealthy diet with child dysregulation in 7814 mother–child pairs drawn from The Avon Longitudinal Study of Parents and Children (ALSPAC) is a prospective study of pregnant women. Maternal depression symptoms were measured using the Edinburgh Postnatal Depression Scale (EPDS) at prenatal (18 and 32 weeks of gestation) and post-natal (8 weeks, 8 months, 2 years and 3 years) time points. Latent depression scores were created for the prenatal and postnatal periods and used as a continuous variable. Higher prenatal maternal depression symptoms were prospectively associated with higher unhealthy diet, both during pregnancy and the postnatal period, which, in turn, was associated with higher child dysregulation up to the age of 7 years. In addition, during pregnancy, higher maternal depression symptoms and unhealthy diet were each independently associated with higher child dysregulation up to the age of 7 years. These results were robust to other prenatal, perinatal and postnatal confounders (such as parity and birth complications, poverty, maternal education, etc.).

Qiu A, Anh TT, Li Y, et al: Prenatal maternal depression alters amygdala functional connectivity in 6-month-old infants. Transl Psychiatry 2015; 5:e508.
This study examined mothers and children (n= 24) from the Growing Up in Singapore Towards healthy Outcomes (GUSTO) with maternal self-reported symptoms of depression using the EPDS at mid-gestation with both structural magnetic resonance imaging (MRI) and resting state functional MRI (fMRI) performed at 6 months of age. Linear regression was used to identify the amygdala functional networks and to examine the associations between prenatal maternal depressive symptoms, analyzed as a continuous variable, and amygdala functional connectivity. The results showed that at 6 months of age, after controlling for postnatal maternal depressive symptoms, infants born to mothers with higher prenatal maternal depressive symptoms showed greater functional connectivity of the amygdala with the left temporal cortex and insula, as well as the bilateral anterior cingulate, medial orbitofrontal and ventromedial prefrontal cortices, which are largely consistent with patterns of connectivity observed in adolescents and adults with major depressive disorder.

Sandman CA, Buss C, Head K, Davis EP: Fetal exposure to maternal depressive symptoms is associated with cortical thickness in late childhood. Biol Psychiatry 2015; 77:324-334.
A prospective, longitudinal study of maternal depressive symptoms reported using the CES-D scale at 19, 25 and 31 weeks of gestation was followed by acquisition of a structural MRI scan in 81 children scanned between 6 and 9 years of age (mean = 86.1 ± 9.9 months). The mean maternal CES-D score was ~6.0 (± 4.1), well below the cut-off of 16 for probable depression (only 2 subjects scored above the DES-D cut-off in this sample). Child behavioral problems were assessed using maternal report with the Child Behavior Checklist (CBCL). Prenatal maternal depressive symptoms were analyzed as a continuous variable and revealed a significant association between cortical thickness in children primarily in the right frontal lobes prenatal maternal depressive symptoms. The strongest association was at mid- gestation; exposure to increased levels of maternal depressive symptoms at 25 weeks of gestation was associated with cortical thinning in 19% of the whole cortex and 24% of the frontal lobes, primarily in the right superior, medial orbital and frontal pole regions of the prefrontal cortex. The association between prenatal maternal depressive symptoms and child externalizing behavior was significantly mediated by cortical thinning in right prefrontal regions.

Lebel C, Walton M, Letourneau N, Giesbrecht GF, Kaplan BJ, Dewey D: Prepartum and postpartum maternal depressive symptoms are related to children's brain structure in preschool. Biol Psychiatry 2016; 80: 859-868.
Women and children (n= 52) were recruited from an ongoing, prospective study (The Alberta Pregnancy Outcomes and Nutrition (APrON) cohort study. Mothers provided Edinburgh Postnatal Depression Scale (EPDS) scores during each trimester of pregnancy and at 3 months postpartum and children underwent neuroimaging between ages 2.6 to 5.1 years. The mean EPDS scores at each time fell within the low range with only 3 of 52 women scoring above the clinical cut-off (means ranged from 4.4 to 4.8). Nevertheless, EPDS scores in the 2nd trimester negatively correlated with cortical thickness in right inferior frontal and middle temporal regions; correlations survived correction for postpartum EPDS. Postpartum EPDS scores negatively correlated with right superior frontal cortical thickness and with diffusivity in white matter after correcting for prenatal EPDS. Prenatal maternal depressive symptoms across the normal range

were correlated with cortical thickness, while postnatal symptoms were associated with cortical white matter.

Yan N, Dix T: Mothers' depressive symptoms and children's cognitive and social development. Devel Psychol 2016; 52:1291–1298.
Participants were mothers and children of 1,364 families from the NICHD Study of Early Child Care. At 6, 15, and 24 months, mothers rated 20 depressive symptoms using the Center for Epidemiologic Studies Depression Scale (CES–D). The mean depression score from 6 to 24 months was 9.21 (SD= 7.2) with 15.3% mothers above the clinical cutoff, reflecting a distribution of depressive symptoms in a normal population. Early At 36 months, mothers and caregivers completed the Child Behavior Checklist (CBCL) at 2-3 and 4.5 years. Mastery motivation was assessed by observing children's persistence and enthusiasm in a laboratory task. Maternal sensitivity at 36 and 54 months was coded from mother – child interactions. Teachers evaluated cognitive functioning using the Academic Rating Scale. Structural equation modeling was used to assess the relations of maternal depressive symptoms as a continuous variable, maternal sensitivity, children's withdrawal, and children's mastery motivation to first-grade cognitive functioning. The results suggest that maternal depressive symptoms during infancy reduce maternal sensitivity which, in turn, predicts poor first-grade cognitive functioning because of reduced mastery motivation and increased withdrawal thus affecting the learning context. These relations were independent of mothers' cognitive stimulation.

Koutra K; Roumeliotaki T; Kyriklaki A; Kampouri M; Sarri K; Vassilaki M; Bitsios P; Kogevinas M; Chatzi L. Maternal depression and personality traits in association with child neuropsychological and behavioral development in preschool years: Mother-child cohort (Rhea Study) in Crete, Greece. J Affect Dis 2017; 217:89-98.
A population-based, prospective study of associations between maternal symptoms of depression, anxiety and personality traits on multiple domains of child neuropsychological and behavioral development at age 4 years. Maternal depressive symptoms were assessed both pre- and post-natally using the Edinburgh Postnatal Depression Scale (EPDS); personality characteristics were assessed at 28–32 weeks of gestation using the Eysenck Personality Questionnaire; anxiety was assessed using the State-Trait Anxiety Inventory (STAI). Increased postnatal depressive symptoms were associated with child's perceptual performance. Per unit increases in maternal depressive symptoms during pregnancy and postpartum, as well as anxiety and neuroticism scores were associated with ADHD scores as well as behavioral problems (Strengths & Difficulties Questionnaire).

Soe NN, Wen DJ, Poh JS, Chong YS, Broekman BF, Chen H, Shek LP, Tan KH, Gluckman PD, Fortier MV, Meaney MJ, Qiu A: (2017) Perinatal maternal depressive symptoms alter amygdala functional connectivity in girls. Human Brain Map 2017
We investigated the relationships between pre- and early post-natal maternal depressive symptoms, their changes with frontal electroencephalogram (EEG) activity and functional connectivity in 6- and 18-month olds, as well as externalizing and internalizing behaviors in 24-month olds (n = 258). Neither prenatal nor postnatal maternal depressive symptoms independently predicted frontal EEG activity or functional connectivity in 6- and 18-month infants. However, increasing maternal depressive symptoms from the prenatal to postnatal period predicted greater right frontal activity and relative right frontal asymmetry amongst 6-month

infants, but these finding were not observed amongst 18-month infants after adjustment for post-conceptual age on the EEG visit day. Subsequently increasing maternal depressive symptoms from the prenatal to postnatal period predicted lower right frontal connectivity within 18-month infants but not among 6-month infants after controlling for post-conceptual age on the EEG visit day. These findings were observed only in females, but not in males. Both prenatal and early postnatal maternal depressive symptoms independently predicted children's externalizing and internalizing behaviors at 24 months of age. This suggests that the altered frontal functional connectivity in infants born to mothers whose depressive symptomatology increases in the early postnatal period compared to that during pregnancy, and may reflect a neural basis for the postnatal familial transmission of phenotypes associated with mood disorders, particularly in girls.

van der Waerden J, Bernard JY, De Agostini M, et al: Persistent maternal depressive symptoms trajectories influence children's IQ: The EDEN mother-child cohort. Dep & Anx 2017; 34:105-117.

The authors analyzed the French EDEN mother-child birth (n= 1039) cohort study to assess perinatal trajectories of maternal symptoms of depression (CES-D and EPDS) in association with child cognitive development (Wechsler Preschool and Primary Scale of Intelligence Third Edition (WPPSI-III) at ages 5 to 6. Five trajectories of maternal symptoms of depression were distinguished: no symptoms (62.2%), persistent intermediate-level depressive symptoms (24.7%), persistent high depressive symptoms (4.7%), high symptoms in pregnancy only (3.6%), and high postnatal symptoms only (4.8%). Overall, compared to offspring of mothers with no symptoms, there was a statistically significant association between maternal depression during pregnancy, persistent intermediate or high-level symptoms and child IQ measures.

Wen DJ, Poh JS, Ni SN, et al: Influences of prenatal and postnatal maternal depression on amygdala volume and microstructure in young children. Transl Psychiatry 2017; 7: e1103.

This study examined mothers and children (n= 235) from the Growing Up in Singapore Towards healthy Outcomes (GUSTO) with maternal self-reported symptoms of depression using the EPDS at mid-gestation (mean = 7.8 ± 4.7) and 3 months postpartum mean = 6.5± 45.1), with the Beck Depression Inventory-II used at 1, 2, 3 and 4.5 years postpartum (mean scores for the BDI ranged from 6.3 ± 8.2 to 7.6 ± 7.5). Structural magnetic resonance imaging and diffusion tensor imaging were performed with 4.5-year-old children to extract the volume and fractional anisotropy (FA) values of the amygdala, with maternal depressive symptoms analyzed as a continuous variable in regression analyses. The results showed that higher levels of prenatal maternal depressive symptoms were associated with larger right amygdala volume in girls, but not in boys. Increased postnatal maternal depressive symptoms were associated with higher right amygdala FA in the overall sample and girls, but not in boys. The findings reveal a differential association between prenatal and postnatal maternal depressive symptoms on the volume and microstructure of the right amygdala.