Antepartum and postpartum exposure to maternal depression: different effects on different adolescent outcomes

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Background: Postpartum depression (PPD) is considered a major public health problem that conveys risk to mothers and offspring. Yet PPD typically occurs in the context of a lifelong episodic illness, and its putative effects might derive from the child’s exposure to other episodes, in pregnancy or later childhood. The aim of the study is to test two hypotheses: (1) that the effects of PPD on adolescent outcomes are partly explained by antepartum depression (APD) and (2) that the effects of APD and PPD are both explained by later exposure to the mother’s depression. Method: A random sample of 178 antenatal patients was drawn from two general medical practices in South London; 171 gave birth to live infants, and 150 (88%) were assessed at 3 months post partum, with 121 of their offspring (81%) assessed for emotional disorders (ED), disruptive behaviour disorders (DBD) and IQ, at 11 and 16 years of age. Results: When APD and subsequent episodes of depression were taken into account, PPD had a significant effect on adolescent IQ, especially for boys, but did not predict psychopathology. ED and DBD in adolescence were predicted by the extent of exposure to maternal depression after 3 months post partum; a significant effect of APD on ED in girls was accounted for by later exposure to the mother’s illness. Mothers’ symptoms of anxiety, smoking and alcohol use in pregnancy did not predict adolescent outcomes, once maternal depression was taken into account. Conclusions: Some effects attributed to mothers’ mental health problems in pregnancy or post partum may be mediated by cumulative exposure to maternal illness, probably reflecting genetic influence and gene–environment correlation. However, PPD has a direct effect on cognition. Clinicians should endeavour to identify women with depression in pregnancy (31% of this sample) and help them to manage their lifelong illness. Keywords: Postpartum depression, antepartum depression, maternal anxiety, adolescent psychopathology, IQ, disruptive behaviour, perinatal, emotional disorder. Abbreviations: SLCDS: South London Child Development Study; PPD: postpartum depression; APD: antepartum depression; MDD: major depressive disorder; CIS: Clinical Interview Schedule; SADS-L: Schedule for Affect Disorders and Schizophrenia, Lifetime Version; CAPA: Child and Adolescent Psychiatric Assessment; ED: emotional disorders; DBD: disruptive behaviour disorders.

Postpartum depression (PPD) is a well-known risk factor for children’s development, with particular problems noted in brain function (Dawson, Frey, Pangiotides, Osterling, & Head, 1997), attention (e.g., Hart, Field, del Valle, & Pelaez-Noguera, 1998), cognitive ability (Galler, Harrison, Ramsey, Forde, & Butler, 2000; Hay & Kumar, 1995; Murray, 1992), and emotional functioning (e.g., Halligan, Murray, Martins, & Cooper, 2006). Some effects may attenuate over time; for example, in one longitudinal sample, infants of depressed mothers showed early problems in sensorimotor intelligence (Murray, 1992), but did not show later problems on IQ tests (Murray, Hipwell, Hooper, Stein, & Cooper, 1996). However, problems in emotional functioning persisted into adolescence (Halligan et al., 2006).

Why might PPD put infants at risk? Observational studies have shown that, compared to well women, depressed women express more negative emotion (Campbell, Cohn, Flanagan, Popper, & Meyers, 1992), and respond less sensitively to infants’ signals, being more preoccupied with their own concerns (Murray, Kempton, Woolgar, & Hooper, 1993). These changes in mother–infant interaction may have specific effects on cognitive development (Hay, 1997), which is known to be facilitated by mothers’ responsiveness (e.g., Bornstein & Tamis-Lamonda, 1997) and disrupted by early privation (e.g., O’Connor, Rutter, Beckett, Keaveney, Krepner, & The ERA Team, 2000). Mothers suffering from PPD are less likely to breastfeed; breastfeeding conveys nutritional advantage and promotes behavioural synchrony between infant and mother (Lavelli & Poli, 1998; Lucas, Morley, Cole, Lister, & Leeson Payne, 1992).

The body of evidence on PPD has had a significant effect on policy and practice (e.g., National Institute for Health and Clinical Excellence (NICE), 2007). Less attention has been paid to the impact of maternal psychopathology during pregnancy or at later points in a child’s life, despite the fact that major depressive disorder (MDD) is a lifelong, episodic illness. The aim of the present paper is to test two hypotheses: (1) that the putative effects of PPD are partly explained by antepartum depression (APD) and (2) that any effects of perinatal depression (PPD

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or APD) are explained by the child’s later exposure to the mother’s lifelong illness.

These two hypotheses are tested, with appropriate controls, with respect to three major domains of psychological functioning that have been found to be affected by maternal depression: emotional disorders (ED), including depression (e.g., Halligan et al., 2006), disruptive behaviour disorders (DBD), including antisocial behaviours (e.g., Kim-Cohen, Moffitt, Taylor, Pawlby, & Caspi, 2005); and cognitive ability (e.g., Hay & Kumar, 1995).

Hypothesis 1: Effects of PPD may be explained by APD

With respect to the first hypothesis, several studies have provided evidence for effects of foetal exposure to mothers’ stress and anxiety (e.g., Talge et al., 2007). For example, there is considerable evidence for links between anxiety in pregnancy and behavioural and emotional problems in childhood (O’Connor, Heron, Golding, Beveridge, & Glover, 2002), as well as symptoms of ADHD in later childhood and adolescence (Van den Bergh & Marcoen, 2004; Van den Bergh et al., 2005a, 2005b, 2006). Depression is comorbid with anxiety (Moffitt et al., 2007), and so women experiencing anxiety symptoms in pregnancy may also be suffering from antepartum depression (APD), which in turn is a significant predictor of PPD. Thus it is important to evaluate any effects of exposure to PPD with reference to foetal exposure to maternal depression and anxiety.

A focus on the mother’s mental health in pregnancy draws attention to other sources of influence on the foetus. Firstly, there may be teratogenic effects. A pregnant woman with mental illness may be more likely to expose the foetus to alcohol, nicotine, and both legal (prescribed psychotropic medication) and illegal drugs, which will affect birth weight and subsequent outcomes (e.g., Raine, 2002). Secondly, hormonal change in the pregnant woman associated with her illness – e.g., elevated secretion of cortisol – is associated with elevated cortisol levels in her offspring. Antepartum exposure to cortisol may disrupt the functioning of the HPA axis in the foetus, rendering that child more susceptible to later depression (O’Keane, 2006).

To our knowledge, no existing study has contrasted the effects of clinically diagnosed APD and PPD on long-term outcomes for the adolescent offspring of depressed women, while controlling for anxiety in pregnancy, other intrauterine factors and later episodes of mental illness. We now seek to determine whether apparent effects of PPD are actually explained by exposure to maternal depression in utero, controlling for several features of the intrauterine environment that might influence foetal development (anxiety symptoms, smoking, and drinking of alcohol in pregnancy) as well as the infant’s birth weight, which might mediate later outcomes.

In testing the first hypothesis, we also examined whether any effects of APD and PPD are moderated by the infant’s sex. Analysis of sex differences illuminates the processes whereby risk factors operate to influence children’s development (Rutter, Caspi, & Moffitt, 2003). The two sexes may be differentially sensitive to early experiences in the womb and during the first months post partum. During foetal development, differences in neuroendocrine development (e.g., the antenatal testosterone surge in boys) may moderate the impact of maternal hormones and teratogenic substances on the foetus (van Goozen, 2005). After birth, sex differences in maturational rate, the postnatal testosterone surge and differential treatment by mothers may influence infants’ reactions to PPD (Hay, 2007). Thus sex may moderate any effects of antenatal or early postnatal experience, and thus needs to be controlled for when testing the first hypothesis.

Hypothesis 2: Effects of PPD and APD may be explained by later exposure to maternal depression

Our second hypothesis states that some apparent effects of PPD and/or APD can be explained by later exposure to the mother’s affective illness. In any test for early experience effects, it is important to control for characteristics of children’s subsequent environments and the conditions under which they are later tested (e.g., Rutter, 1972). This is particularly important in examining outcomes of perinatal illness. PPD does not occur in isolation: four out of five women who experience PPD have subsequent episodes of depression (Halligan et al., 2006), and so repeated exposure rather than early exposure to maternal depression may explain its effects on children (Campbell & Cohn, 1997). Thus it is particularly important to determine, in long-term follow-up studies, whether any apparent effects of PPD and indeed APD are explained by later exposure to maternal depression.

Children of depressed mothers are at genetic as well as environmental risk for mental health problems. The well-known comorbidity of depression with other disorders implies that the child of a depressed mother is genetically at risk for other disorders, not just depression. In an ideal design, one would test for the effects of exposure to the mother’s illness while controlling for genetic sources of influence. We are not able to supply direct evidence for genetic influence on the SLCDS sample. However, we tested whether apparent effects of APD or PPD were explained by pre-existing characteristics of the mother, present before the index pregnancy. Thus, for each domain of functioning (ED, DBD and IQ), we controlled for the mother’s own problems in each domain: her history of depression prior to this pregnancy, her juvenile conduct symptoms and her own IQ, respectively. The mother’s earlier problems in each domain will have been
influenced by her genetic inheritance as well as her experiences, and so provide some indications of traits that could potentially be passed on to the child through genetic transmission.

To summarise, the following analyses test whether effects of PPD on children’s outcomes in three domains of functioning can be explained (1) by APD and (2) later exposure to the mother’s episodic illness. These two hypotheses were tested while controlling for the child’s sex, other antenatal and postnatal influences, and the mother’s pre-existing problems in each domain.

**Method**

**The families**

APD and PPD were assessed in 150 women, 88% of a random sample (N = 171) of antenatal patients from two general practices in South London who gave birth to live infants. Based on the 2001/2002 data collected throughout England, the deprivation scores of the two South London communities from which the random sample was drawn ranked on the 6th and 11th percentiles, where a lower rank indicates greater deprivation. For 121 families (81% of those assessed post partum), complete information was available concerning the mother’s clinical diagnoses in pregnancy and post partum, adolescent outcomes, and characteristics of the intrauterine and postnatal environment. There was no significant difference in post partum caseness between these 121 mothers and the 29 mothers where complete information was not available.

Characteristics of the sample at age 16 are summarised in Table 1. Compared to national norms, the sample had a higher proportion of working-class families and families from ethnic minorities (Office for National Statistics, 2006).

All phases of the study were approved by the Ethics Committee of the Institute of Psychiatry, Kings College, London. After complete description of all procedures, written informed consent was obtained from mothers and their adolescent offspring.

**Procedure**

**Pregnancy and the first postnatal year.** Two GPs, one from each practice, interviewed the mothers, who were not their patients, twice during pregnancy, between 14 and 20 weeks and at 36 weeks, and twice during the first postnatal year, at 3 and at 12 months. Mothers also completed questionnaires at 8 months.

**Fourth, 11th and 16th birthdays.** Families were visited at home at 4, 11 and 16 years post partum. At each time point mothers provided socio-demographic information, both current and retrospective to the last visit, to interviewers who were unaware of the information collected at previous visits. The children were given age-appropriate IQ tests at 11 and 16. Parents (in most cases, the biological mother) and children were interviewed at 11 and 16 by different researchers.

**Measures**

**Maternal disorder.** At both points in pregnancy and at 3 and 12 months post partum, an assessment was made of the women’s current mental state, using the Clinical Interview Schedule (CIS) to generate ICD-9 diagnoses of depression and anxiety (Goldberg, Cooper, Eastwood, Kedward, & Shepherd, 1970). The overall agreement of the reported symptoms on the CIS from the tape-recorded interviews, given as a weighted kappa coefficient, was .80. Mothers completed the Leeds Anxiety Scale (Snith, Bridge, & Hamilton, 1971) at two points in pregnancy. The Leeds scale scores at each time point were averaged to provide a composite measure of symptoms of anxiety in pregnancy.

At 4, 11 and 16 years post partum, mothers were interviewed about their current mental states and experience of symptoms retrospective to the last assessment point, using the Schedule of Affective Disorders and Schizophrenia (SADS-L; Spitzer, Endicott, & Robins, 1978). Diagnoses were made in consultation with the lead psychiatrist on the team, using Research Diagnostic Criteria (RDC) criteria.

APD was defined by the combined ICD diagnoses from the second and third trimester interviews; if the woman had met ICD criteria for depression at either time, she was judged to have experienced APD. PPD was defined by the ICD diagnosis of depression at 3 months post partum.

The current and ‘retrospective to last visit’ data were used to assess the occurrence of maternal depression over four subsequent developmental time periods, based on the interviews conducted at 1, 4, 11 and 16 years post partum. A variable measuring the extent of the infant’s later exposure to maternal depression was created by adding together the number of time periods from the 12-month assessment onwards (ranging from 0 to 4) during which the infant was exposed to maternal depression.

To control for the mother’s previous history of depressive illness, it was necessary to construct a variable indicating some evidence for her mental health problems prior to the index child’s conception. During the first antenatal interview, mothers were asked about any treatment of mental health problems prior to this pregnancy. At the 4-year assessment, mothers were given the SADS-L and asked retrospectively about the presence of clinically significant disorder prior to the pregnancy, according to RDC criteria. A dichotomous variable indicating any evidence of prior depression was constructed from mothers’ retrospective reports of depression, using RDC, and their reports at the first interview in pregnancy of having been prescribed antidepressant medication before the birth of the index child.

**Measures of the intrauterine environment.** During the interviews between 14 and 20 and at 36 weeks of pregnancy, mothers reported the number of cigarettes they had smoked. Only 2 women without a diagnosis of depression met ICD-9 criteria for an anxiety disorder. Therefore, the Leeds Scale was used to provide a continuous measure of the extent of antenatal anxiety, which is used as a covariate in subsequent analyses.
smoked per day and units of alcohol drunk per week. Composite measures of foetal exposure to nicotine and alcohol were constructed by averaging the scores reported at each interview. The infant’s birth weight, which might mediate the effects of antenatal risk factors on later outcomes, was ascertained at the post partum visit.

Breastfeeding. In the absence of detailed observation of infant development and mother–infant interaction in the months following childbirth, we controlled for one salient aspect of the early postnatal environment, the experience of being breastfed, which has been found to be associated with maternal depression and children’s outcomes, and thus is a potential mediator of the effects of PPD. Duration of breastfeeding (in weeks) was ascertained by questionnaire at 8 months post partum. Those women still breastfeeding were given a duration score of 32 weeks.

The mother’s intellectual ability. During the home visit at age 4 years, mothers were given four subscales of the Wechsler Adult Intelligence Scale, which provide an estimate of general IQ (WAIS; Wechsler, 1981). Women who had not been assessed at 4 years were tested at later time points.

The mother’s symptoms of juvenile conduct disorder. At the 16-year visit, we obtained mothers’ retrospective reports of their own conduct symptoms before the age of 15, using the antisocial personality disorder section of the SADS-L. All women were asked about juvenile conduct symptoms, whether or not they screened in as possible cases of antisocial personality disorder. A 10-item scale was constructed, summing women’s reports of truancy, expulsion from school, rule-breaking, stealing, lying, running away, vandalism, underage alcohol use, underage sex and juvenile arrest (Cronbach’s $\alpha = .75$).

Adolescent disorder. At 11 and 16, parents and children were interviewed separately about the child’s symptoms of disorder, using the Child and Adolescent Psychiatric Assessment (Angold et al., 1995). The CAPA is a psychiatric interview that elicits information about symptoms contributing to a wide range of DSM-IV diagnoses. A three-month ‘primary period’ is used to ensure more accurate recall (Angold et al., 1996).

At 11 and 16 years, DSM-IV diagnoses and symptom scales were generated by computer algorithms, based on ‘combined reports’, where a symptom is regarded as being present if either parent or child reports it. Diagnoses were made with reference to the functional impairment or incapacities section of the CAPA, which relates the symptoms to the adolescent’s ability to function at a developmentally appropriate level in relationships with family, peers, and teachers, and in activities at school, home and in the community. Diagnoses made using CAPA algorithms show acceptable levels of test–retest reliability (Angold & Costello, 2000).

Adolescent IQ. Age-appropriate IQ measures were administered at 11 (Wechsler Intelligence Scale for Children, WISC-IIIUK; Wechsler, 1992) and 16 (Wechsler Abbreviated Scale of Intelligence, WASI; Wechsler, 1999). The Full Scale IQ scores at 11 were highly correlated with Full Scale IQ scores at 16, $r (116) = .91, p < .001$.

Data analysis
To obtain adequate cell sizes with which to test for the effects of timing of maternal depression on adolescent disorder, we combined information across the two assessment points in early and middle adolescence, including all cases of ED and DBD where DSM-IV criteria were met on the basis of parents’ and adolescents’ combined reports at 11 and/or 16 years of age. We similarly used the best estimate of each adolescent’s

Table 1 Characteristics of the sample at 16 years post partum ($N = 121$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
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<tbody>
<tr>
<td>Mother’s age at birth</td>
<td>$M = 26.2$, $SD = 5.0$ (range, 16 to 43)</td>
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<tr>
<td>Marital status at birth</td>
<td>64% married, 29% cohabiting, 7% single</td>
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<td>Social class</td>
<td>88% working class</td>
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<tr>
<td>Maternal education</td>
<td>72% basic qualifications, 14% further education</td>
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<tr>
<td>Marital status at age 16</td>
<td>59% married (87% to biological father)</td>
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<td>13% cohabiting (33% to biological father)</td>
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<td>28% single-parent household</td>
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<td>54% two biological parents</td>
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<td>39% biological mother</td>
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<td>5% biological father</td>
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<td>2% no biological parent (other relative, $N = 1$)</td>
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<td></td>
<td>independently, $N = 1$ (under supervision of Social Services, $N = 1$)</td>
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<td>Child’s sex</td>
<td>55% female</td>
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<td>Child’s birth order</td>
<td>47% firstborn</td>
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<tr>
<td>Child’s ethnicity</td>
<td>72% white British, 6% white, non-British, 22% other (Caribbean, African, East Asian, mixed)</td>
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<tr>
<td>Child’s age at assessment</td>
<td>$M = 16.3$ years, $SD = 2.8$ (range, 16 to 17.3)</td>
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<td>Child’s educational attainment</td>
<td>48% – 5 or more GCSEs A* to C</td>
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<tr>
<td></td>
<td>32% – no GCSEs A* to C</td>
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1Ns vary slightly (117–121) because of missing data on some variables.
true IQ by taking the mean across the 11 and 16 year IQ scores.

Within each domain of functioning, we first tested Hypothesis 1, that apparent effects of PPD would be explained by foetal exposure to APD, and examined whether the effect of either experience was moderated by offspring sex. If significant effects of PPD and/or APD were found, subsequent models controlled for other features of the antenatal and postnatal environments. We next tested Hypothesis 2, determining whether any effect of perinatal illness (either APD or PPD) might be explained by the extent of later exposure to maternal depression; we then controlled for the mother’s problems in the relevant domain of functioning that predated this pregnancy.

Results

Descriptive analyses

Maternal depression over time. Virtually all episodes of APD and PPD occurred in the context of recurrent depressive illness. Thirty-eight women (31.4%) met ICD-9 criteria for depression in pregnancy; 26 women (21.5%) met ICD-9 criteria for depression at 3 months post partum. Of the 38 women who were depressed in pregnancy, 16 (42.1%) were depressed post partum, and 17 others (44.7%) became depressed at a later point in the child’s life. Only five of the 38 women with APD had no further episodes.

Sixteen of the 26 women who experienced PPD (61.5%) had already been depressed in pregnancy; 21 of those with PPD (80.8%) had at least one subsequent episode. Only three of the 26 women with PPD (11.5%) had never been depressed in pregnancy and did not become depressed again later in the child’s life.

During pregnancy, depressed women reported significantly more symptoms of anxiety than did non-depressed women to experience symptoms of anxiety in pregnancy, $M = 7.1$ (SD 4.5) v. $M = 4.4$ (SD 2.4). This association was examined with analysis of variance, which yielded significant effects of APD, $F(1, 117) = 7.43, p < .01$, and PPD, $F(1, 117) = 9.88, p < .005$, but the interaction only approached significance.

Maternal depression and the infant’s environment before and after birth. Maternal depression was associated with several dimensions of the antenatal and postnatal environments (Table 2). Women with APD smoked significantly more cigarettes during pregnancy. PPD was also associated with having smoked more cigarettes during pregnancy and with a shorter period of breastfeeding after the birth.

The interaction between PPD and the child’s sex was associated with dimensions of the intrauterine environment (Table 3). Subsequent analyses of variance that were undertaken to clarify these associations revealed that daughters of women with PPD had been exposed to more severe levels of antenatal anxiety, whereas sons of women who became depressed post partum had been exposed to higher levels of alcohol in utero (Table 3).

Emotional disorders (ED) in adolescence. Thirty-three adolescents (27.3%) met DSM-IV criteria for ED at either the 11 or 16 year assessment. At age 11, the most common form of ED was separation anxiety (SAD), with 13 children (11%) meeting DSM-IV criteria; at age 16, the most common emotional disorder was depressive illness (MDD, dysthymia, or depressive episode not otherwise specified), with 16 adolescents (13%) meeting DSM-IV criteria. At age 16, only two adolescents diagnosed with an anxiety disorder were not also suffering from depression. Across adolescence, 11 boys (20.4%) and 22 girls (32.8%) were diagnosed with ED, which was not a significant difference.

Disruptive behaviour disorders (DBD) in adolescence. Twenty-nine adolescents (24%) met DSM-IV

Table 2 Intercorrelations among maternal illness, perinatal environment and outcomes in adolescence

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<td>3. Re-exposure</td>
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<td>6. Anxiety</td>
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<td>7. Smoking</td>
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<td>9. Weight</td>
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<td>10. Feeding</td>
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<td>11. ED</td>
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<td>12. DBD</td>
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<td>13. IQ</td>
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N = 121.

*p < .05, **p < .01.

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criteria for either conduct disorder (CD) or oppositional defiant disorder (ODD) at either 11 or 16 years of age. At both ages, there was substantial comorbidity between CD and ODD, kappa = .54, p < .001 at age 11, and kappa = .54, p < .001 at age 16. Seventeen boys (31.5%) and 12 girls (17.9%) were diagnosed with DBD; the sex difference was not significant. There was significant association between DBD and ED, kappa = .18, p < .05.

Adolescent IQ. The mean IQ scores were in line with population norms, $M = 96.8$, SD = 16.3, range 59 to 134. There were no statistical outliers in the distribution, and so no participants were excluded on the basis of their IQ scores; only two scores were more than 2 standard deviations below the sample mean. Adolescents who were diagnosed with ED had significantly lower IQ scores, $M = 91.4$ (SD = 15.0) v. $M = 98.7$ (SD = 16.5), t (119) = 2.22, p < .05. IQ was not significantly associated with DBD. Girls and boys did not differ in IQ. Social class was significantly associated with adolescent IQ, $M = 95.6$ (SD = 15.4) for working-class adolescents v. $M = 105.7$ (SD = 20.8) for middle-class adolescents, t (119) = 2.21, p < .05. However, the effect of class disappeared when maternal IQ was controlled for in analysis of covariance. Social class was unrelated to ED and DBD.

Tests of hypotheses with respect to emotional disorders

Hypothesis 1: PPD v. APD. Logistic regression analysis was used to test the hypothesis that any association between PPD and emotional disorders in adolescence might be explained by APD. The hypothesis was tested while controlling for the adolescent’s sex and several dimensions of the intrauterine environment.

Sixteen of the 38 adolescents whose mothers had been depressed in pregnancy (42.1%) were diagnosed with ED in adolescence, as opposed to 20% of adolescents whose mothers had not been depressed at that time, $\chi^2 (1) = 6.14$, $p < .01$, OR = 2.82, CI 1.22 to 6.51. Twelve of the 26 adolescents whose mothers had PPD (46.2%) had emotional disorders in adolescence, in contrast to 22.1% whose mothers had not been depressed at that time, $\chi^2 (1) = 5.95$, $p < .05$, OR = 3.02, CI 1.22 to 7.51.

The first logistic regression model tested for associations with APD and PPD, and for the two-way interactions between the child’s sex and depression at these times. When APD was entered at the first step, it significantly predicted ED in adolescence, Wald statistic = 5.92, $p < .05$, OR = 2.82, CI 1.22 to 6.51. When PPD was entered at the second step, APD was no longer significant. However, when the interactions were entered at the third step, the interaction of APD with offspring sex predicted ED in adolescence, Wald statistic = 3.80, $p < .05$. Chi-square analysis showed that the association between APD and ED was only significant for girls, $\chi^2 (1) = 8.91$, $p < .005$: 13 of 23 girls whose mothers had been depressed in pregnancy (56.5%) were diagnosed with ED in adolescence, as opposed to 20.5% of other girls. In contrast, 20% of boys were diagnosed with ED, whether or not their mothers had been depressed in pregnancy.

Intrauterine factors. Depression in pregnancy was associated with foetal exposure to nicotine and maternal anxiety symptoms; low birth weight was significantly associated with exposure to nicotine and emotional disorders in adolescence (Table 2). However, when antenatal anxiety symptoms, smoking, and birth weight were included in the regression model, the interaction between depression and offspring sex remained significant, Wald statistic = 4.13, $p < .05$, and the intrauterine variables were no longer significant predictors of ED.

Hypothesis 2: Later exposure to maternal depression explains the apparent effect of APD. The preceding analysis showed that, once APD had been controlled for, PPD did not exert a significant effect on the adolescent’s risk for emotional disorders. However, it remains possible that the presumed effect of APD, moderated by the adolescent’s sex, could itself be explained by later exposure to maternal depression. In a follow-up model, the significant interaction between APD and offspring sex was entered at the first step, and the extent of re-exposure to maternal depression after 3 months post partum at the second step (Table 4). Only the latter variable predicted ED in adolescence, Wald statistic = 9.52, $p < .005$. The interaction between depression in pregnancy and the child’s sex was reduced to a non-significant trend, Wald statistic = 4.06, $p < .10$. Two subsequent analyses tested the same model, controlling for DBD and IQ, respectively. Findings were unchanged.

The final analysis tested for the effect of later exposure to maternal depression after 3 months post
Table 4 Prediction of emotional disorders in adolescence from prepartum exposure to maternal depression

Logistic regression analysis of timing of mother’s perinatal illness and emotional disorders (ED) in adolescence

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B (S.E.)</th>
<th>Lower</th>
<th>EXP(B)</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex x APD</td>
<td>1.68 (.96)</td>
<td>.82</td>
<td>5.36</td>
<td>35.27</td>
</tr>
<tr>
<td>Extent of later exposure*</td>
<td>.57 (.18)</td>
<td>1.23</td>
<td>1.77</td>
<td>2.54</td>
</tr>
</tbody>
</table>

\* \( p < .10 \), \( *p < .01 \).
\( R^2 = .12 \) (Cox & Snell), \( .17 \) (Nagelkerke), \( \chi^2(3) = 15.12, p < .002 \).

Table 5 Prediction of disruptive behaviour disorders in adolescence from later exposure to maternal depression in childhood

Logistic regression analysis of timing of mother’s illness and disruptive behaviour disorders (DBD) in adolescence

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B (S.E.)</th>
<th>Lower</th>
<th>EXP(B)</th>
<th>Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent of later exposure**</td>
<td>.50 (19)</td>
<td>1.14</td>
<td>1.64</td>
<td>2.37</td>
</tr>
<tr>
<td>Mother’s CD symptoms*</td>
<td>.29 (14)</td>
<td>1.03</td>
<td>1.34</td>
<td>1.75</td>
</tr>
</tbody>
</table>

\* \( p < .05 \), \( **p < .01 \).
\( N = 120, R^2 = .11 \) (Cox & Snell), \( .16 \) (Nagelkerke), \( \chi^2 (2) = 13.82, p < .001 \).

partum, controlling for the mother’s prior history of depression (which provides some indication of the adolescent’s genetic risk for emotional disorder, in the absence of direct exposure). The link between the extent of exposure to depression after 3 months post partum and the risk for ED in adolescence was not explained by evidence of a prior history of depression in the mothers. Rather, when evidence for prior depression was taken into account, only the extent of exposure to maternal depression after 3 months of age predicted ED in adolescence, Wald statistic = 10.63, \( p < .001 \).

Tests of hypotheses with respect to disruptive behaviour disorders

Hypothesis 1: PPD v. APD. Parallel logistic regression analyses were undertaken to test whether any effect of PPD on DBD could be explained by APD, while controlling for the adolescent’s sex and other aspects of the intrauterine environment. There was no effect of APD, or of PPD, nor the interaction of either with the child’s sex. Univariate analyses showed that there were no significant associations between features of the intrauterine environment and DBD (Table 2). Thus these variables were not included in the regression model.

Hypothesis 2: Effects of APD or PPD are explained by later exposure to maternal depression. Test of this hypothesis was unnecessary, insofar as neither PPD nor APD were significant predictors of DBD in adolescence. We therefore tested for the direct effect of the extent of exposure to maternal depression after 3 months post partum, while controlling for the mother’s own history of conduct problems in her adolescence. The extent of exposure to maternal depression after 3 months significantly predicted DBD in adolescence, Wald statistic = 8.94, \( p < .005 \). Furthermore, the link between later exposure to maternal depression and DBD in adolescence was not explained by the mother’s previous problems in the same domain of functioning. In a final regression model (Table 5), the adolescent’s exposure to maternal depression after 3 months was entered at the first step and the mother’s report of her juvenile conduct symptoms at the second. Both variables independently predicted DBD in adolescence.

Tests of hypotheses with respect to intellectual ability

Hypothesis 1: PPD v. APD. The hypothesis that any effects of PPD on mean IQ across adolescence might be explained by APD was tested with linear regression, controlling for the adolescent’s sex and other aspects of the intrauterine environment. APD did not predict IQ, and the interaction between APD and sex was not significant. However, the main effect of PPD and the interaction between PPD and adolescent sex were both significant predictors of IQ, \( F (2, 116) = 5.13, p < .001 \), adjusted \( R^2 = .12 \). Offspring of women who had not experienced PPD had higher IQ scores in adolescence than the offspring of women with PPD, but the difference was more striking for boys: \( M = 103.1 \) (SD 17.4, range 64 to 134) v. \( M = 80.9 \) (SD = 17.0, range 59 to 112) for the sons of well versus depressed women, as opposed to \( M = 95.8 \) (SD = 13.8, range 61 to 123) v. \( M = 92.2 \) (SD = 12.3, range, 68 to 112) for the daughters of well versus depressed women.\(^2\)

The intrauterine environment. PPD was significantly associated with antenatal anxiety symptoms and smoking in pregnancy (Table 2); an interaction between PPD and the child’s sex had been found for the mother’s antenatal anxiety symptoms and alcohol use in pregnancy, as well as the child’s IQ (Table 3). However, when included in the regression model, none of these variables predicted adolescent IQ, and their inclusion did not remove the significant effect of PPD nor the significant interaction between PPD and offspring sex, \( F (5, 115) = 4.68, p < .001 \), adjusted \( R^2 = .13 \).

\(^2\) PPD and the interaction between PPD and offspring sex significantly predicted WASI Full Scale IQ scores at 16, as well as WISC Full Scale IQ scores at 11 (previously reported in Hay et al., 2001).
Breastfeeding. Because depressed mothers were less likely to breastfeed, and because breastfeeding was associated with IQ (Table 2), breastfeeding was examined as a potential mediator of the effects of PPD on IQ. When breastfeeding was entered into the regression model, it explained additional variance, $R^2$ change $= .11$, $F (1, 117) = 16.32$, $p < .001$, but did not remove the significant effect of PPD, nor the significant interaction between PPD and offspring sex.

Hypothesis 2: The apparent effect of PPD is explained by the extent of later exposure to maternal depression. In the next regression model, PPD, the interaction between PPD and offspring sex, and breastfeeding were entered at the first three steps, followed by the number of time periods during which the mother was depressed from 12 months to 16 years post partum. The extent of later exposure to depression predicted adolescent IQ, accounting for significant $R^2$ change, $F (1, 116) = 5.77$, $p < .05$, $R^2 = .04$, and, when later exposure was included in the model, the main effect of PPD was no longer significant. However, the interaction between PPD and offspring sex and breastfeeding remained significant predictors of adolescent IQ.

When maternal IQ was entered at the final step, its inclusion led to significant $R^2$ change, $F (1, 115) = 24.58$, $p < .001$, $R^2 = .13$, and the effect of later exposure to depression was no longer significant. The main effect of PPD became significant once again and the other effects remained so (Table 6).

Discussion

Maternal depression at different points in a child’s life exerted different effects on the developing child. Depression during pregnancy appeared to place girls on a trajectory to emotional disorders in adolescence (see O’Keane, 2006), but that effect was accounted for by later exposure to the mother’s illness. Later exposure to maternal depression also promoted disruptive behaviour. Neither APD nor PPD had clear effects on psychopathology that were not bound up with subsequent exposure to the mother’s lifelong depressive illness (see Campbell & Cohn, 1997).

In contrast, PPD appeared to exert a direct impact on cognitive development, especially for boys. This finding was not explained by the mother’s depression or anxiety symptoms in pregnancy, or the intrauterine environment, despite the fact that the sons of women who became depressed post partum had also been exposed to more alcohol. Prior alcohol use in mothers who later succumb to PPD is most parsimoniously treated as a coincidence. However, whilst not explaining the effect of PPD on intellectual development, this earlier insult may have rendered the boys in this sample more vulnerable to a less than optimal postnatal environment, leading to the 20-point decrement in boys’ IQ scores. This finding adds to a body of consistent evidence for small to medium effects of PPD on attention and cognition across diverse samples (Galler et al., 2000; Hart et al., 1998; Hay & Kumar, 1995; Murray, 1992), which is in line with other research demonstrating effects of the early caregiving environment on cognitive development (Bornstein & Tamis-Lamonda, 1997; O’Connor et al., 2000). Intervention studies should target cognitive as well as emotional and behavioural outcomes. Such interventions are likely to be successful, as it is clear that the infants of mothers with PPD recover from early sensorimotor difficulties in more advantaged samples (Murray et al., 1996).

Our findings suggest that mothers’ lifelong depressive illness creates a risky environment, before and long after the infant’s birth. Children of women who are depressed in pregnancy are at genetic risk for depressive disorder. However, the recurring sequence of episodes of maternal depression during the child’s lifetime, often accompanied by disruption in family arrangements and the child’s routines and activities, creates gene–environment correlation that increases risk for both affective disorder and DBD. The latter outcome is further exacerbated by the mother’s own history of adolescent conduct problems.

Nonetheless, despite the clear link between lifelong depression in mothers and problems in offspring, it seems unlikely that the intergenerational transmission of disorder is entirely genetic (Kim-Cohen et al., 2005). Although the present design does not allow for the estimation of genetic versus environmental influence, it is noteworthy that depression prior to the child’s birth did not predict his or her risk for emotional disorder. Rather, exposure in the child’s lifetime was implicated. The greater the extent of exposure to maternal illness, the more likely it was that the child would develop a broader range of problems.

Owing to the size of the sample, and the use of clinically significant diagnoses as opposed to symptom scales, our analyses did not have sufficient statistical power to detect the small effects of ante-

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**Table 6** Prediction of intellectual ability in adolescence from postpartum exposure to maternal depression

Linear regression analysis of timing of mother’s perinatal illness and mean IQ across early and middle adolescence

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B (SE)</th>
<th>Lower</th>
<th>Upper</th>
<th>95% CI for B</th>
<th>Beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPD*</td>
<td>-.66</td>
<td>-.12</td>
<td>.12</td>
<td>-.16</td>
<td></td>
</tr>
<tr>
<td>Sex × PPD**</td>
<td>.10</td>
<td>.01</td>
<td>.19</td>
<td>.22</td>
<td></td>
</tr>
<tr>
<td>Breastfeeding*</td>
<td>.04</td>
<td>.01</td>
<td>.08</td>
<td>.18</td>
<td></td>
</tr>
<tr>
<td>Extent of later exposure</td>
<td>-.17</td>
<td>-.12</td>
<td>.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother’s IQ***</td>
<td>.40</td>
<td>.11</td>
<td>.66</td>
<td>.40</td>
<td></td>
</tr>
</tbody>
</table>

$N = 121$, $p < .05$, $**p < .01$, $***p < .001$.  
$N = 121$, $R^2 = .40$, Adjusted $R^2 = .38$, $F (5,115) = 15.57$, $p < .001$.  

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natal risk factors observed in very large cohorts. However, it is also the case that, in any long-term follow-up study, regardless of sample size, some apparent effects of infants’ experiences before birth might similarly be mediated by genetic factors and cumulative environmental adversity. In the SLCDS, where over 80% of the sample of infants was retained for 16 years, and where extensive clinical interviews were conducted at all time points, the effects of cumulative, as well as early, exposure to maternal depression were well documented. There is need for more long-term follow-up studies of larger samples with in-depth interviews, to determine which early experience effects persist and are not explained by continued adversity.

Our findings are likely to generalise to other disadvantaged urban populations, and therefore have implications for policy and practice. Clinical guidelines designed to support women who experience PPD need to be broadened. In these relatively disadvantaged British communities, nearly a third of pregnant women were depressed. Women need psychological support in pregnancy, as well as in the months after childbirth. Because most women who experience perinatal depression suffer from a lifelong disorder, they need advice in managing chronic illness, not just short-term amelioration of their present dysphoria. Finally, interventions designed to help women who experience mental health problems before or after childbirth should take into account the needs and likely outcomes for infants, as well as mothers, including the infants’ cognitive needs. More infant-centred interventions, with sustained support into the school years, are required.

Conclusions
Perinatal depression is a robust predictor of children’s problems. However, the causal chain of events is incompletely known. Perinatal illness predicts later exposure and cumulative adversity for families, which promotes adolescent disorder. PPD seems to affect cognition directly, while the effect of APD on emotional disorder is mediated by re-exposure to the mother’s illness. Perinatal depression does not predict DBD but later exposure to maternal depression does so. The child’s sex appears to moderate the impact of APD and PPD on ED and IQ, respectively, with girls more vulnerable to APD and boys to PPD; these findings require replication in larger samples. Characteristics of the intrauterine environment are significantly associated with maternal depression, and so their effects attenuate when that confound is taken into account.

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